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## Manufacturing Novel Polymeric Material without Synthetic Chemistry

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### Abstract

Direct Digital Manufacturing is a family of emerging technologies which are able to produce parts directly from a digital definition without the need for moulds or other specialist tooling. This is a rapidly growing area and to date the many advantages of Direct Digital Manufacturing have focused on the possibility of mass personalization and the ability to produce parts with complex shapes which are not possible using conventional technology. Recent work at CDRSP-IPLEIRIA has developed the use of Direct Digital Manufacturing techniques to produce meta materials, materials which exhibit new properties not displayed by the materials they are prepared from. In other words, at the point of manufacturing of an object, we can select the meta material it is produced from, rather than opt for a specific polymer which has a long supply chain right back to the petrochemical plant and even longer if we take account of the development time to design the monomers and optimize the polymerization technology. We are proposing that a major advantage of direct digital manufacturing is that the material system can be defined at the point of manufacturing by the manufacturing process itself. This takes the possibility of personalization to its ultimate limit.

### Biography

Geoffrey Mitchell is Professor and Vice-Director of the Centre for Rapid and Sustainable Product Development at the Polytechnic Institute Leiria in Portugal. Geoffrey Mitchell carried out his doctoral work at the University of Cambridge. Prior to his current role he was Professor of Polymer Physics at the University of Reading, UK. His research work bridges physics, biology, chemistry and technology and he is a Fellow of both the Institute of Physics and the Royal Society of Chemistry as well as the Royal Society for the Encouragement of Arts, Manufactures and Commerce. Geoffrey Mitchell is passionate about direct digital manufacturing which enables products to be manufactured directly from a digital design without the need for specialist tooling or moulds and the development of novel materials to support the emerging technologies.

## Polymeric Nanoparticles for the Intracellular Delivery of Biotherapeutics

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### Abstract

Many biotherapeutics among which nucleic acid-based drugs, pharmaceutical proteins and antigens, have to be delivered intracellularly to exert their biological effects. However, these therapeutics, because of their hydrophilic character and large size, do not spontaneously pass cellular membranes. An attractive approach to deliver these therapeutic in the target cell is to load them in nano-sized carriers.

As first example, we designed reduction-sensitive cationic dextran nanogels in which an antigen (ovalbumin, OVA) was reversibly immobilized to the hydrogel network via disulfide bonds. These bonds are stable in the extracellular environment but are cleaved in the cytosol of dendritic cells due to the presence of glutathione resulting in triggered released of the loaded antigen. These OVA-loaded nanogels indeed showed intracellular release of OVA up on internalization by DCs and subsequently boost the MHC class I antigen presentation leading to activation of T-cells. In a prophylactic model, 90% of the mice vaccinated with OVA conjugated nanogels + poly I:C) as adjuvant were protected against tumor formation for 55 days. In a therapeutic model, 40% of the mice eliminated their tumor cells, which was remarkable compared to other groups in which none of the mice showed tumor cell killing [1, 2].

In another approach, cationic polymers containing either azide or strained alkyne groups were synthesized as electrostatic glue which complexed charged single stranded RNA (PolyU) to form a self-crosslinked polyplex core. An azide-modified model antigen (ovalbumin, OVA) and a BCN-modified mannosylated or galactosylated polymer were sequentially conjugated to the RNA core via disulfide bonds using copper free click chemistry to form the shell of the polyplexes. The generated reducible virus mimicking particles (VMPs) with a diameter of 200 nm and negatively surface charge (−14 mV) were colloidally stable in physiological conditions. The mannosylated VMPs (VMP-Man) showed 5 times higher cellular uptake by bone marrow derived DCs (BMDCs) compared to their galactosylated VMP (VMP-Gal) counterpart. Moreover, VMPMan efficiently activated DCs and greatly facilitated MHC I Ag presentation in vitro. Vaccination of mice with VMP-Man elicited strong OVA-specific CTL responses as well as humoral immune responses [3].

Recently, we reported on PEGylated NPs based on a hydroxylated PLGA polyester for the selective delivery of saporin, a cytotoxic protein, in the cytosol of HER2 positive cancer cells. This selective uptake was achieved by decorating the surface of the NPs with the 11A4 nanobody that is specific for the HER2 receptor. Confocal microscopy observations showed rapid and extensive uptake of the targeted NPs (11A4-NPs) by HER2 positive cells, but not by HER2 negative cells. Importantly, a dose dependent cytotoxic effect was only observed on HER2 positive cells when these were treated with saporin-loaded 11A4-NPs in combination with photochemical internalization (PCI), a technique that uses a photosensitizer and local light exposure to facilitate endosomal escape of entrapped nanocarriers and biomolecules. The combined use of saporin-loaded 11A4-NPs and PCI strongly inhibited cell proliferation and decreased cell viability through induction of apoptosis. These results suggest that the combination of the targeting nanobody on the NPs with PCI are effective means to achieve selective uptake and cytotoxicity of saporin loaded NPs [4].

In conclusion, polymeric nanoparticles are attractive carrier systems for the targeted intracellular delivery of biotherapeutics.

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### Biography

Wim Hennink obtained his Ph.D. degree in 1985 at the Twente University of Technology on a thesis with a biomaterials research topic. From 1985 until 1992 he had different positions in the industry. In 1992 he was appointed as professor at the Faculty of Pharmacy of the University of Utrecht. From 1996 on he is head of the Pharmaceutics division. At present he is the head of the Department of Pharmaceutical Sciences, Utrecht University. His main research interests are in the field of polymeric drug delivery systems. He published over 520 papers and book chapters and is the inventor of 20 patents.

## Recent Studies on the Synthesis and Functions of Advanced Nanocomposite Gel

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### Abstract

Stimuli-responsive hydrogels, such as poly(N-isopropylacrylamide) (PNIPA) hydrogel, have been extensively studied from both scientific and industrial application points of view. However, conventional PNIPA hydrogels consisting of chemically crosslinked network had some serious disadvantages, particularly weak and brittle mechanical properties, because of the network structure.

We developed a new type of PNIPA hydrogel which solves all these problems simultaneously. The novel hydrogels, nanocomposite (NC) gels, were prepared by in situ free radical polymerization using exfoliated clay, instead of an organic crosslinker, and consisted of a unique organic (polymer)/inorganic (clay) network structure. NC gels exhibited high transparency, high degrees of swelling/de-swelling, and superb mechanical properties. Also, NC gels exhibit a number of interesting new characteristics related to the properties of their gel-air and gel-water interfaces, coil-to-globule transition, optical anisotropy, self-healing, harvesting cells, and control of morphology.[1] Herein, I present recent developments on the syntheses and functions of NC gels; e.g., the synthesis of NC gels by initiator-free photopolymerization in aqueous media using plasma-treated clay,[2] the synthesis of new type of NC gels with ternary PNIPA-clay-silica structure and exhibiting anomalous increases in mechanical properties, the generation of large retractive tensile forces in brine comparable to human muscle due to the salt-induced coil-to-globule transition of PNIPA,[4] and instant strong adhesive behavior of NC gel toward hydrophilic porous materials.[5]

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### Biography

Kazutoshi Harguchi was born in 1950 in Japan. He received his PhD from Kyushu University in 1978, and soon joined Kawamura Institute of Chemical Research (KICR). He was a post-doctoral fellow of Liverpool University in 1979-1981. He became a director of KICR in 2001, and a general manager (senior director) in 2006-2014. From April 2014, he is a professor of Nihon University. He was a vice president of the Society of Polymer Science, Japan during 2016-2018. His major research fields are polymer nanocomposites, smart hydrogel, and biomaterial. He received the Award of the Society of Fiber Science and Technology, Japan in 2003, the Award of the Society of Polymer Science, Japan in 2010, and SPSJ Award for Outstanding Achievement in Polymer Science and Technology in 2018.

## Portugal 2020, Which Plastics?

**Maria Elvira Callapez**

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### Abstract

“New materials such as synthetic polymers are considered a ‘symbol of technological progress and growing industry’ and have rapidly become widespread consumer products”. This talk aims at presenting a history of plastic in Portugal. By the ‘history of plastic’ is meant the historical approach to the temporal evolution of a broad field of relationships involving plastic since its arrival in Portugal at the beginning of the twentieth century. Among them: the technological and scientific developments involved in the production and adaptation of plastics to the Portuguese context, the objects produced with plastic and the influence they had on social and cultural habits, the history of companies that started working from an early age, the production and the use of plastics, the relationship between plastics and ecology, and the implication of the entry of plastics into spheres such as architecture, design or fashion.

Born in the mid-1930s, through the hands of two factories, the “ Sociedade Industrial de Produtos Eléctricos” (‘SIPE’) and ‘Nobre & Silva’, the plastics industry has not only emerged as one of the main sectors of national economic development, but also as an agent of social, cultural, artistic, urban and environmental change. The evolution of the Portuguese plastics industry from its origins as well as the dynamics of the appropriation and adoption of techniques, processes of manufacturing of materials will be analyzed.

### Biography

Maria Elvira Callapez holds a PhD in History and Philosophy of Science (2002). From 2004 to 2007 she was a Post Doc at University of California, Berkeley. She has taught in master’s and doctoral programs. She has been member of executive committee of International Committee for the History of Technology, since 2011. She is a research fellow at Centro Interuniversitário de História da Ciência e Tecnologia. She is PI of a awarded research project (PTDC/IVC-HFC/174/2014, on Contributions for a History of Plastics in Portugal, funded by Foundation of Science and Technology. The exhibition Plasticity - a History of Plastics in Portugal in the Leiria Museum, an output of her project, "The Triumph of Bakelite - Contributions for a History of Plastics in Portugal" awarded the 2019 Dibner Award for Excellence in Museum Exhibits.

## Photo-responding Water-solubilization of Itaconic BIONYLONs Contributable to Marine Environment Protection

**Tatsuo Kaneko[1*], Md. Asif Ali[1], Kenji Takada[1] and Maiko Okajima[1,2]**

*[1]Japan Advanced Institute of Science and Technology, Japan*
*[2]Green Science Material Inc., Japan*

### Abstract

Plastic wastes scattered over earth environment are causing ecological damage. Ghost fishing which is unexpectedly happening to catch marine animals by fishing gear such as nets or long lines have been lost, dumped, or abandoned, without anyone profiting from the catches. If the drifting fishing gears automatically corrode and disappear by natural function under marine environment, such a tragic problem will be solved.

We developed bio-Nylon which are durable at use but are corrosive by external stimulus such as sun-light and/or rein-water, by using itaconic acid (IA). IA, which is a multifunctional biomolecule mass-produced by the fermentation of Aspergillus sp, has two carboxyls and double bond. We have prepared itaconic acid-derived bio-Nylon via salt-type monomers composed of diacidic IA and diamines. These salts thermally converted into polyamides in the presence of sodium dihydrogen phosphate through the aza-Michael addition, followed by intramolecular cyclization to create a pyrrolidone ring in the polymer main-chain. Polyamides with molecular weights ranging over 28 000 showed high values of glass transition temperature, Young's modulus, and mechanical strength. In addition, the polyamides became soluble in water by ring-opening reaction of the pyrrolidone. The ring-opening reaction was induced by ultra-violet photo-irradiation, which is very important for development of environmentally-corrosive fishing gears to avoid the ghost-fishing. Moreover, our researches are extended to high-performance polymers such as polyimides by external stimuli to make the polymers water-soluble and degradable in environment, aiming at design of high-performance bioplastics having controlled degradability. The authors acknowledge JST ALCA (JPMJAL1010).

### Biography

Tatsuo Kaneko received Ph.D. (1998) from Tokyo Tech. He joined the faculty as Assis Prof at Hokkaido Univ (1997), at Kagoshima Univ (2001), at Osaka Univ (2004), then as Assoc Prof (2006) and Full Prof (2016) at JAIST. He also joined as Visiting Assoc Prof at UCLA (2012). Research interests include gels, LCs, biopolymers, and bioplastics, for which he has received awards from eight Japanese scientific societies and foundations. International prizes such as "Best presentation" at ACS National Meeting, "Distinguished Award" at IUPAC-NMS, and "Gottfried Wagener prize" The 9th German Innovation Award have also been given.

## Magnetic Polymer Nanocomposites: Opportunities in Imaging and Therapy Applications

**Manuel Banobre-López*, Marta Ribeiro and Juan Gallo**

*Advanced (magnetic) Theranostic Nanostructures Lab, INL– International Iberian Nanotechnology Laboratory, Portugal*

### Abstract

The incorporation of a magnetic functionalization in polymeric matrices opens a series of opportunities in the biomedical field. In the last years, hybrid organic-inorganic nanocomposites have attracted lot of attention, since they combine the drug encapsulation efficiency of the organic matrix and the physico-chemical properties of the inorganic counterpart. In particular, magnetic polymer hybrid nanocomposites are especially interesting because the additional magnetic functionalization enables imaging and combinatorial therapy performances, such as non-invasive magnetic resonance imaging (MRI), magnetic hyperthermia and drug delivery.

In this talk I will focus on some magnetic hybrid polymeric nanocomposites that we have synthesized in our lab, going from the chemistry to their functional validation, and also covering both fundamental and applied perspectives. On the one hand, I will describe sub-micrometer magnetic polymer nanocomposites as suitable models to study the effect of magnetic interactions on their performance as contrast agents in MRI and heat generating sources in magnetic hyperthermia. On the other, I will talk about magnetic macro-hydrogels obtained from biopolymers as potential theranostic agents able to integrate imaging and magnetically-assisted drug delivery.

### Biography

Manuel Bañobre-López graduated in Chemistry from the University of Santiago de Compostela, Spain, and obtained his PhD degree in Solid State Chemistry from the same University. Currently, he leads the Nanomedicine Group and the Advanced (magnetic) Theranostic Nanostructures Lab (AmTheNa) at the International Iberian Nanotechnology Laboratory at Braga, Portugal. His research interest focuses on the engineering of multifunctional (magnetic) nanostructures as medical platforms for theranostic applications, mainly focused on disease-targeted non-invasive imaging and magnetically-assisted therapies. He has led competitive research projects funded by EU, national and regional bodies. He has published > 70 peer-reviewed papers and has been granted 2 patents.

## Polymer Nanocomposites: From Laboratory Concept to Large Scale Production

**Thomas Gkourmpis**

*Innovation & Technology, Borealis AB, Sweden*

### Abstract

Polymer nanocomposites combine the properties of the matrix with those of the filler additive. This opens a wide range of possibilities and allows for the creation of fundamentally new materials that exhibit improved mechanical, electrical and thermal properties. This combination of filler and polymer allows for immense versatility and design capabilities and as consequence research in nanocomposites has been ever-growing. Traditionally carbon black has been the filler of choice due to its relatively simple structure, product versatility and reduced cost. Over the years more advanced carbonaceous fillers like fullerenes, nanotubes or graphene have been developed spearheading a revolution in the area of polymer nanocomposites. Due to their anisotropic dimensions and unique geometry these advanced fillers allow for the creation of extended network structures in the matrix with minimal concentrations. The main advantage of carbonaceous fillers is their tendency to allow for electrical conductivity, but if this is not desirable then options like glass fibres, talcum or even clays are available offering significant performance enhancements, especially in terms of mechanical reinforcement. In this presentation, we will discuss the various challenges that arise from commercial production and use of polymer nanocomposites, especially the issues around melt mixing and dispersion. We will examine the role of thermodynamics during the mixing process as well as the influence of the chain conformation along various length scales in facilitating the efficient dispersion of the filler into the matrix.

### Biography

Thomas Gkourmpis research is focused on the molecular organisation of amorphous and semi-crystalline polymers and their processing using computational models coupled with time resolved x-ray and neutron scattering. A program linking crystallisation with the different length scales available in a polymer is underway. Another project deals with the fundamental understanding of structure-property relationships in polymer nanocomposites for a number of technologically and commercially important applications.

## Biomaterials for *In Situ* Tissue Regeneration

**Saba Abdulghani**

*Polytechnic of Leiria, Portugal*

### Abstract

This review focuses on a somewhat unexplored strand of regenerative medicine, that is in situ tissue engineering. In this approach manufactured scaffolds are implanted in the injured region for regeneration within the patient. The scaffold is designed to attract cells to the required volume of regeneration to subsequently proliferate, differentiate, and as a consequence develop tissue within the scaffold which in time will degrade leaving just the regenerated tissue. This review highlights the wealth of information available from studies of ex-situ tissue engineering about the selection of materials for scaffolds. It is clear that there are great opportunities for the use of additive manufacturing to prepare complex personalized scaffolds and we speculate that by building on this knowledge and technology, the development of in situ tissue engineering could rapidly increase. Ex-situ tissue engineering is handicapped by the need to develop the tissue in a bioreactor where the conditions, however optimized, may not be optimum for accelerated growth and maintenance of the cell function. We identify that in both methodologies the prospect of tissue regeneration has created much promise but delivered little outside the scope of laboratory-based experiments. We propose that the design of the scaffolds and the materials selected remain at the heart of developments in this field and there is a clear need for predictive modelling which can be used in the design and optimization of materials and scaffolds.

### Biography

Saba Abdulghani carried out her Bachelor of Engineering degree and PhD at the Materials Department of Queen Mary University of London in Biomaterials. Following her PhD, Saba was awarded a Marie Curie Post-Doctoral Fellowship to work on the Biomechanics of cemented hip prostheses at Lund University. In 2008, Saba moved to Portugal to work at the Rheumatology research unit, Instituto de Medicina Molecular (IMM) on the mechanical properties of osteoporotic bone where she won an ECTS fellowship.

## Tacticity and Chirality Effects in Molecular Self-assembly of Polymers

**Jing-Cherng Tsai**

*Department of Chemical Engineering, National Chung Cheng University, Taiwan*

### Abstract

The presence of stereoregular tactic repeating units in polymer architecture results in the formation of crystallinity, which offers elevated physically properties (e.g., high crystalline melting temperature and mechanical strength) and various applications. The presence of stereoregular chiral repeating units in polymers not only imparts crystallinity but also provides unique optical properties and applications (e.g., materials for resolution of enantiomers). Currently, stereoregular tactic polymer can be typically prepared via stereospecific polymerization of a-olefins in the presence of a stereoselective coordination polymerization catalyst (e.g., metallocene, Ziegler-Natta). Chiral polymers, in contrast, are typically prepared from chiral monomers (monomers possess structural chirality) so that the generated polymers have either main-chain or side-chain chirality depending on the position of the chiral center. In this talk, our recent efforts in the syntheses of stereoregular chiral block copolymers (from chiral mandelic acid) and tactic block copolymers will be presented. The self-assembly studies of these polymers and block copolymers were found to provide unique nanomorphologies because of the presence of chiral and tactic repeating units.3,4,5,6 Efforts to elucidate these unique chirality and tacticity effects in molecular self-assembly are currently underway.

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[5] Tsai, J. C. and R.-M. Ho* et al PNAS 2019, 116, 4080.

### Biography

Jing-Cherng Tsai is a professor in Department of Chemical Engineering, National Chung Cheng University, Taiwan. During 2014-2017, he held the position of Chairman for Department of Chemical Engineering, National Chung Cheng University. In 1991, he had his Ph.D. in Organic Chemistry (with Professor Kenneth. M. Nicholas), University of Oklahoma. His research interests are Polymer syntheses, coordination polymerization, stereoregularity control in polyolefin syntheses, syntheses of chiral polymers, industrial technology research for PE, PP, SEBS and polyolefins.

## Scientific Advances and Challenges in Sustainability of Food Packaging Materials

**Keith Vorst[1,2*] and Greg Curtzwiler[1,2]**

[1]*Polymer and Food Protection Consortium, Iowa State University, USA*
[2]*Food Science and Human Nutrition, Iowa State University, USA*

### Abstract

Increased use of waste stream diversion strategies and efforts to prevent marine pollution has resulted in widespread adoption of refuse plastics and alternative biobased plastics for consumer products. These efforts have increased the need to understand performance, quality, and safety of refuse and biobased plastics. Recent global efforts to utilize landfill and marine refuse plastic have identified gaps in understanding performance and safety concerns during processing and consumer use. The use of alternative biobased materials has raised question of sustainability including food source diversion, quantifiable positive environmental impact, and potential regrettable substitute concerns. Limited work has been done characterizing waste diverted material and biobased content by blend for performance, safety, and consumer application. Previous work by Bernard et al. 1997 and Curtzwiler et al. 2017 have identified potential methods for characterization of blended virgin and post-consumer content or PCR materials. Recent preliminary studies have been done by our research team demonstrating performance gains using biobased materials. This study helps fill data gaps in performance, cost, availability, safety, and potential environmental impact of food packaging materials. Results of this research will increase the understanding and adoption of mixed plastic refuse streams from landfill and marine environments as well as appropriate use of biobased materials for consumer and industrial products.

### Biography

Dr. Vorst serves as the Director of the Polymer and Food Protection Consortium in the Department of Food Science and Human Nutrition at Iowa State University in Ames, IA. Dr. Vorst's research areas include the technical development, and safety of food and industrial packaging projects. Dr. Vorst worked in industry for major packaging companies and served as a consultant for a major automotive manufacturer prior to joining academia in his current position at Iowa State University. Dr. Vorst has over 50 publications and 12 published or pending patents for plastic characterization, contamination monitoring, carbon nanotubes, and polymer design.

## Suitability of Poly(Butylene Succinate) as a Direct Melt Paperboard Coating for Rapid Reheat Applications

**Greg Curtzwiler[1,2*] and Keith Vorst[1,2]**

[1]*Polymer and Food Protection Consortium, Iowa State University, USA*
[2]*Food Science and Human Nutrition, Iowa State University, USA*

### Abstract

Paper-based food packaging materials generally require supplemental treatments for most applications, such as perfluorinated chemicals and petroleum-based polymers. These approaches are effective but limit sustainable end-of-life options (e.g., recycling and composting). Landfill diversion strategies are needed to divert food packaging waste as consumer demand for ready-to-eat convenience meal kits and single use packaging continues to increase municipal solid waste accumulation. This work evaluated the suitability of poly(butylene succinate) as a direct melt coating on recycled paperboard for grease and moisture resistance in rapid reheat applications in food service and convenience food packaging applications. Preliminary data indicate PBS as a viable alternative to perfluorinated chemicals and petroleum polymers due to the ability to heat seal, resist oil migration at elevated temperatures, and oxygen/water vapor barrier properties.

### Biography

Dr. Greg Curtzwiler is an Assistant Professor in the Polymer and Food Protection Consortium at Iowa State University. His research is focused on commercially viable sustainable materials for adhesives and coatings in the packaging and automotive industries including bio-based, compostable, and recycled polymers. Greg has 20 publications and nine patents to his credit. He is currently working on understanding the structure-property relationships between renewably sourced biobased polymers, hydroplasticization, and compatibilization of biobased waste diverted fillers for adhesives and coatings.

## Functional Polymers for Deterministic Doping

**Michele Laus[1*] and Michele Perego[2]**

*[1]University of Eastern Piedmont, Italy*
*[2]MDM laboratory, IMM-CNR, Italy*

### Abstract

Doping represents the cornerstone of current semiconductor technology[1,2]. Nowadays precise control over dopant dose and distribution at the nanoscale is required to support further evolution in microelectronics, photovoltaics, solar fuel conversion, sensors and quantum computation. An effective and simple bottom-up process for precisely controlling the surface density of phosphorus atoms, at first tethered on non-deglazed silicon substrates and then injected into the silicon, is presented. Shuttling polypeptoids, end-terminated with a P containing functional moiety, were synthesized by automated solid phase synthesis which enables precision sequence control and near absolute monodispersity up to chain lengths of 100 monomeric units, and end-grafted on the non-deglazed silicon substrates. The phosphorous atoms were fixed to the silicon oxide surface during the grafting reaction whereas their surface density was set by the polymer molar mass, according to the self-limiting nature of the "grafting to" process. O2 plasma hashing was used to remove the polymeric materials and residual carbon atoms from the surface without affecting the tethered P-containing moieties. The discrete amounts of the P implanted atoms are precisely predetermined by proper selection of the molar mass of the grafting polypeptoids.

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### Biography

Prof. Michele Laus is Full Professor of Industrial Chemistry and Polymeric Materials at the University of Piemonte Orientale. He is the Coordinator of European Polymer Conferences (EUPOCs), President of Italian Association for Science and Technology of Macromolecules (AIM) and General Secretary of the European Polymer Federation (EPF). He is author of more than 250 papers published in international scientific journals dealing with polymer nanoparticles, micellar polymerizations, radical and catalytic controlled processes and block copolymers-based technology

## Reinforced PLA Composites for Use in Medical Applications

**Yuanyuan Chen**

*Athlone Institute of Technology, Ireland*

### Abstract

Polylactic acid (PLA) is a type of biodegradable thermoplastic aliphatic polyester that derived from renewable resources. PLA attracts a lot of research attention due to its renewability, biodegradability, biocompatibility, and good mechanical properties. PLA has a long safety history in medical field and a variety of medical implants have been developed from PLA, such as sutures, stents, and bone fixation devices, such as screws, pins, rods and plates.

Fully biodegradable coronary stents made from PLA, which provide transient vessel support with drug delivery capability, and degrade away after service without the long-term limitation of metallic stents, appear to be an ideal option to treat coronary heart disease. However, the PLA biodegradable stents have much thicker stent strut due to the weak mechanical properties of PLA, compared to traditional metallic stents. Therefore, in order to develop PLA biodegradable stent with thin stent strut, a reinforced PLA composite is a potential solution. In this work, halloysite nanotubes (HNTs) were used as reinforcing fillers and compounded with PLA. HNTs are a type of clay with a chemical formula of $Al2Si2O5(OH)4 \cdot H2O$. HNTs have a tubular structure with a high aspect ratio, the length of HNT particles ranges from 0.2 to 2µm, and the inner and outer diameters of the tube range from 10 to 40nm and 40 to 70nm respectively with a length of 1000-2000nm. The high aspect ratio of HNTs helps to reinforce polymers in composites by optimizing the load transfer from the polymer matrix to the nanotubes. The main findings of HNTs reinforced PLA composites are:

Both HNTs and surface treated HNTs reinforced PLA composites were cytocompatible and blood compatible.
Surface treated HNTs dispersed better than nontreated HNTs within PLA.
Surface treated HNTs increased the degree of crystallinity of PLA.
HNTs increased the Young's modulus of PLA by 12.9%, while surface treated HNTs increased by 25%.
Both HNTs and surface treated HNTs reduced thermal stability of PLA.
By the end of the 6th month BSF degradation study, surface treated HNTs reinforced PLA displayed 30.6% average molecular weight reduction, while retaining 74% of Young's modulus.

### Biography

Dr Yuanyuan Chen holds an honour degree in Nursing from Southwest Medical University, China in 2004. She also holds an honour degree in Mechanical & Material Engineering (2013) and a PhD in Polymer Engineering (2018) from Athlone Institute of Technology, Ireland. She is dedicated to developing biodegradable medical implants. she was awarded "Women in Research" in 2018 and works as a postdoctoral researcher in Athlone Institute of Technology in the field of biodegradable polymeric composites for use in medical implants.

She is an active member of European Society for Biomaterials (ESB), Society of Plastic Engineering (SPE) and several COST actions, including ENIUS for developing urinary stents; BIONECA for regenerative cardiology; iPROMEDAI for developing antimicrobial coating; NEWGEN for patient-specific bone tissue engineering. She writes articles for SPE magazine and she is an invited speaker for Polymer Connect Conference. She has published 6 peer-viewed research papers, 2 book chapters, and over 10 conference publications

## Orientationally Cross-Linked Hydrogels of Extracellular LC Mega-Saccharides Secreted from Freshwater Cyanobacteria, Aphanothece Sacrum

**Maiko Okajima[1,2*], Zhan Shuo[1], Kittima Amornwachirabodee[1], and Tatsuo Kaneko[1]**

[1]*Japan Advanced Institute of Science and Technology, Japan*
[2]*Green Science Material Inc., Japan*

### Abstract

Hydrogels are composed of three-dimensional network structures of synthetic and/or natural polymers which are able to absorb and to retain significant amount of water. The hydrogels have been extensively used in various biomedical applications such as drug delivery, cell carriers and/or entrapment, wound management, and tissue engineering. Sacran which is extracted from biomaterials of freshwater cyanobacterium, Aphanothece sacrum is a megamolecular polysaccharide with very high molecular weight range over 10 MDa. Sacran has a function of liquid crystals (LC) in thin aqueous solution and a super-absorbent property to induce a cation scavenging property and an anti-inflammatory activity on external and internal skin surfaces. Here we found that the sacran physical hydrogel with a good orientation behavior can be prepared from the films/fibers made under mechanical stress. Practically sacran solution with a concentration of 0.5 % was dried at 60 °C for 12 h to create the thin film (about 50 micrometer), and the film as immersed into pure water to form anisotropic hydrogels. This phenomenon was observed only in high-molecular weight sacran but not in other polysaccharides. Furthermore, it was found that the swollen degree of the gels was controlled by the preheating temperature ranging 70-140 °C, to adjust the swollen degree of the hydrogels from 10 to 400 times. The uniaxially-oriented fibrous

hydrogels were additionally prepared by a cation-assisting cross-kinking by injection method. The following biofunctions of these hydrogels were further found, would healing, anti-bacterial, and anti-inflammatory. The authors gratefully acknowledge Grant-in-Aid supports from A-step, (AS2915173U) of JST, Japan.

### Biography

Maiko Kaneko Okajima who received PhD from Tokyo Tech is a research fellow of the School of Materials Science at JAIST, Nomi, Japan, and R&D manager of Green Science Materials Inc. Japan. She has approximately 65 publications. She has been involved in scientific and industry-academic collaborative projects in the fields of cyanobacterial biology, polysaccharides, biomedics design etc. Additionally, she has engaged in establishment of start-up company on cyanobacterial polysaccharides and their applications as biomedical and cosmetic ingredients.

## Resin Synthesis and Characterizations for Carbon Materials

**Nathanaël Chaussoy[1,2*], Damien Brandt[1] and Jean-François Gérard[2]**

*[1]CEA le Ripault, France*
*[2]IMP INSA Lyon, France*

### Abstract

Metals and ceramics are widely used for high temperature applications but in aerospace industry they are limited by their weight. Composites with a fiber reinforcement and polymer matrix can offer relevant alternatives. They can display mechanical and thermal properties better than all other materials with comparable density. Usually, materials for thermal protection systems are based on composites with a char precursor polymer matrix. Phenol-formaldehyde resins are widely used for this application with a char yield close to 60 % and an excellent dimensional stability.[1] However, the key issue is the free formaldehyde and free phenol contents of resins. Since 2004, formaldehyde is recognized as a carcinogenic agent and could be banned in 2022 by the REACH regulation. Phenol is toxic and suspected as carcinogenic. Consequently, in the near future, phenolic resins will need to be substituted. Thanks to literature, several routes have been identified and tested to achieve this goal of an optimization of the phenolic resin chemistry. This lecture will be focused on the synthesis and characterization of REACH compliant resins with high char yield.

### Biography

Nathanaël Chaussoy is a chemist specialized in organic chemistry. Passionate about chemistry, He graduated with a Bachelor degree in chemistry (2013) at Orleans University (Orléans, France) and with a Master degree in molecular chemistry (2015) at University Pierre and Marie Curie (Paris, France). Currently he is preparing a PhD on polymer materials at CEA le Ripault near Tours (France).

## The Dual Role of Electricity on Scaffolds: Preparation and Applications

**Fábio F. F. Garrudo[1,2,3], Miriam Sousa[1], Filipa Pires[1,3], Quirina Ferreira[3], Caitlyn Chapman[2], Pauline Hoffman[2], Ranodhi N. Udangawa[2], João C. Silva[1,2], Laura Sordini[1,3], Flávio A. Ferreira[1], Diogo Nogueira[1], Giulia Filippone[1], Carlos A. Rodrigues[1], Paiyz Mikael[2], Joaquim M. S. Cabral[1], Jorge Morgado[3], Robert J. Linhardt[2] and Frederico C. Ferreira[1*]**

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*[2]Center for Biotechnology and Interdisciplinary Studies, Rensselaer Polytechnic Institute, USA*
*[3]Department of Bioengineering and Telecommunications Institute, Higher Technical Institute, University of Lisbon, Portugal*

### Abstract

Tissue engineering strategies can support the development of disease models and regenerative therapies for neurodegenerative diseases. Polymeric based scaffolds have gained a central role as initial substitutes of the extracellular matrix (ECM). These provide structural cell organization, allow transport of key molecules and offer initial cues for tissue formation. The wide variety of polymers properties allows to tailor scaffold 3D structure, biodegradability, hydrophilicity and stiffness. The application of electrical fields on polymer processing techniques, such as cell encapsulation, electrospray and electrospinning, allows to obtain nano/micro structures with ECM components dimensions. On the other hand, electrical current plays a crucial role on living tissues, with increasing number of emerging therapies relying on the electrical stimulation regenerative potential. The use of electroconductive polymers opens a new role for scaffolds on the localized delivery of electrical currents to guide stem/progenitor cells differentiation. Here, we present the collaborative efforts to build electrospun nanofiber or/and electroconductive scaffolds to enhance neural stem cell (NSC) differentiation. Poly-ε-caprolactone (PCL) or functionalized PCL nanofibers were optimized as biodegradable substrates. Poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS), polybenzimidazole (PBI), polyacrylonitrile (PAN) and polyaniline (PANI) are among the conductive polymers used to prepared scaffolds in different configurations. Chemical doping with strong acids (PBI), cyclization (PAN), polymer ratio optimization (PANI/PCL) and cross-linking (PBI-PEDOT) were used to increase scaffold conductivity and stabilization. Our results show a positive effect on used materials electroconductivity without compromising materials biocompatibility. NSCs were able to successfully proliferate and/or differentiate on all substrates tested, with and without electrical stimulation. This work highlights the dual role of electricity to prepare scaffolds, with extremely small dimensions, and suitable for NSC culture stimulation, opening the way for smart platforms to study or regenerate neural and muscle tissues.

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### Biography

Frederico C. Ferreira completed his Ph.D. in 2004 from Imperial College London (IC) and his MBA from Nova Business School in 2008. He is an Assistant Professor at DBE/iBB of Instituto Superior Técnico. He has published c.a. 70 SCI papers, h-index of 19 and 130 presentations. His current research interests, balance between fundamental and applied research, with emphasis on membrane systems. The three current research lines aim at the development of new materials, processes and reactors for: (1) tailored materials to mimicking stem cell microenvironments; (2) advanced separations in pharmaceutical industry; and (3) biorefineries for aviation biofuels, enzymes and biosurfactants.

## Modification of Rheological Properties for Biopolyesters

**Masayuki Yamaguchi**

*Japan Advanced Institute of Science and Technology, Japan*

### Abstract

It is well known that broadening of molecular weight distribution and incorporation of long-chain branches are the promising

methods to enhance elasticity of a polymer melt, that is required for good processability, although biomass-based polyesters such as poly(lactic acid) and poly(3-hydroxybutyrate) have narrow molecular weight distribution without long-chain branches. Therefore, new methods to provide marked melt elasticity are required for them to be available for various processing operations such as foaming, blow-molding, and thermoforming.

In this presentation, we will demonstrate three novel methods to provide the melt elasticity; 1. Addition of flexible nanofibers, 2. Addition of critical gel, and 3. Addition of a polymer with long-chain branches. The biomass-based polyesters modified by these methods exhibit marked strain-hardening behavior in transient elongational viscosity with pronounced extrudate swell. These rheological properties are required to improve the processability.

### Biography

M. Yamaguchi, a professor of Japan Advanced Institute of Science and Technology, obtained his master degree in 1989 and doctor of engineering in 1999 at Kyoto University. Before joining JAIST, he has been working at Tosoh Corporation from 1989 to 2005. The main topic of his research is applied rheology of polymeric materials.

## Natural Active Component Loaded Biopolymer-Based Electrospun Nanofibers

**Branka Pilić[1*] and Aleksandra Miletić[1]**

[1]*Faculty of Technology Novi Sad, University of Novi Sad, Serbia*

### Abstract

Conventional techniques like extrusion, injection molding or compression are not suitable for production of cosmetics and sanitary products containing natural compounds. Within all these techniques high temperature and/or pressure is applied which has harmful effect on thermosensitive natural ingredients. Besides this, samples prepared this way are usually thick and lack in flexibility, with low porosity and “plastic” feel on the skin. To ensure the activity of those materials it’s important to have surface rich in active compounds, because the diffusion through the volume is very slow, and, in short exposure time, often insufficient for getting an effect.  Also, loading of polymeric matrix with natural compounds need to be very high, for successful surface activity, which increases the price of the final products.

To avoid losses of valuable active compounds, encapsulation can be done by employing electrospinning technique. Electrospinning is a fiber-forming technique, where the process is running at room conditions, and fiber production goes from highly viscous polymer-based solution influenced by the high voltage. Depending on the process parameters, it is possible to obtain different structures and morphologies of nanofibers and tailor materials’ properties according to application requirements. Sensitive components like essential oils and plant extracts are now often encapsulated in nanofibers. Electrospinning of biopolymers, functional natural acids and  nanostructured protective systems based on natural nanofibrile for nonwowen textiles will be presented.

Acknowledgements: (This project has received funding from the Bio Based Industries Joint Undertaking under the European Union’s Horizon 2020 research and innovation program under grant agreement No. 745839 and III 45022)

### Biography

Branka Pilić, Ph.D., is a Full Professor, Head of the Departament of Material Engineering at the Faculty of Technology Novi Sad, University of Novi Sad. Her research interests are: processing, modification, and characterization of synthetic, bio-based and biodegradable polymer and their nanocomposites, electrospinning of nanofiber, and waterborne active dispersions. She has over 30 papers published in ISI Journals and over 100 publications at national and international conferences. She has been is involved in many national project, and international project funded by EU Commission.  At the moment, she is coordinator for the beneficiary Faculty of Technology Novi Sad, University of Novi Sad in HORIZON 2020 project POLYBIOSKIN Grant Agr. No. 745839, 2017-2021.

## Graphene-based Polymers Macrostructures for Water Remediation

**Paula A. A. P. Marques[1*], Ana Bessa[1,2], Eddy Domingues[1], Bruno Henriques[2], Gil Gonçalves[1], and Eduarda Pereira[2]**

[1]*TEMA, Mechanical Engineering Department, University of Aveiro, Portugal;*

[2]CESAM & LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, Portugal

### Abstract

Water is one of the most precious resources on the planet. The development of effective sorbent materials to remove contaminants from real waters is a challenge. Graphene-based materials for water remediation is emerging as a promising solution to address several environmental challenges. Graphene is a two-dimensional layer structure being the ideal filler for polymer-based hydrogels. Graphene has shown unique advantages in substantially improving the combination properties of traditional polymer hydrogels, acting as the gelator to self-assemble into the hydrogels, which after freeze-drying originates aerogels presenting a porous macrostructure.

Here, we present the development of macrostructures by combining graphene oxide (GO) with two polymers, chitosan (GOCH) and polyethyleneimine (GOPEI). Their performance was evaluated for the removal of mercury (Hg) under realistic environmental concentrations (50 µg L-1) from spiced ultra-pure, tap, river and sea waters. We concluded that a small amount (10 mg L-1) of both adsorbents proved a highly efficiency for Hg removal from spiced ultra-pure (>98%) and tap water (>91%). However, the GOCH completely loosed its efficiency in river and sea waters, while GOPEI kept a good performance in river (90%) and sea (81%) where the existence of co-ions and different Hg-speciation are usually inhibitory factors of a good removal efficiency. The kinetic modelling was performed as well as a detailed material characterization to evaluate the adsorption mechanisms involved. The sorption kinetics showed to be very fast, with Hg removal by GOPEI always taking from 1 to 6 hours. That relevant features under realist conditions make GOPEI aerogels a very sustainable approach for a practical application.

### Biography

Paula Marques (Principal Researcher) graduated in Chemistry in the Universidade de Aveiro (UA) in 1993, completing her Master's in Chemistry and Physics Teaching in 1997 and the PhD degree in Materials Science Engineering (Biomaterials specialization) in 2003 in the same institution. Paula's research interests are the engineering and development of carbon-based nanostructured composites for health and environmental applications. She published +80 papers in international journals, seven book chapters, three books, has one national patent registered and three requested. The quality of her work is expressed by the number of citations (+3791) and h-index of 33. Paula participated in 25 R&D projects with 9 in progress, being presently the coordinator of a H2020-FETOPEN project (A step forward to spinal cord injury repair using innovative stimulated nanoengineered scaffolds) and of a CENTRO-01-0145-FEDER-030513, PTDC/NAN-MAT/30513/2017 (Graphene based materials and water remediation: a sustainable solution for a real problem?). orcid: http://orcid.org/0000-0002-7498-452X

## Respirometry Methods for Measuring Biodegradation in Different Media from Soil to Sea.

**Andrej Holobar**

*CEO, ECHO D.O.O, Slovenia*

### Abstract

Bioplastics can be naturally biodegradable in various ecology environments such as compost, sewage wastewaters, sea or algae environments of sweet or saltwaters. For this reason, it is very important to have suitable laboratory methods and equipment to simulate different degradation conditions. It is also desired that the experiments can be performed in one instrument with different setups. In algae simulating sea or natural water environment it is very important to have good conditions, which simulate natural environment. Algae are aquatic, photosynthetic organisms, which occupy a broad range of habitats across all latitudes, they are widespread in freshwater, marine, and terrestrial ecosystems. Algae are the most important group of organisms participating in the circulation of matter and energy in ecosystems. For the biodegradation experiments often green microalgae Chlorella vulgaris (CCAP 211/11S) is used. C. vulgaris is selected as a test organism because of easy cultivation, its common presence in the environment, fast growing and short generation time as well as good performance in different types of wastewater. The synergy between bacteria, typically heterotrophic species, that use organic matter and O2 for growth while releasing CO2, and photosynthetic autotrophic microalgae, which use CO2 and sunlight for growth, incorporating nutrients (nitrogen, phosphorous), allows for better efficiencies in water pollutants removal. The question on how this system works in biodegradation of bioplastic is very important for ecologists, researchers and producers of bioplastics. With the help of modular respirometer, environmental conditions can be changed to

simulate natural environmental conditions during biodegradation. With such design it is possible to make a test of degradation process in the solid (compost) and the liquid phase (sea water, wastewater or algae). The tests are running in real time, whereas the production or consumption of gases (oxygen, carbon dioxide or others, $CH_4$, $NH_3$, $H_2S$) are being monitored. It is an illusion to expect that the waste bioplastic will appear only at the designated places. Bioplastics, which decomposes in the compost, can also be found in the rivers or seas, therefore it is important to understand what impact this plastic has to our environment. For this reason, it is necessary to determine the degree of biodegradation of bioplastics in various environments, where the bioplastic waste can be found in nature. With such approach we can determine the influence of bioplastics to the environment and thus prevent the pollution of our nature.

### Biography

Andrej Holobar is the CEO of the company ECHO, d.o.o. He had his bachelor's in chemistry and Chemical Technology at the University of Ljubljana. He had his masters in the same field at the University of Ljubljana. He was awarded Innovation Award in 2010 for computer-controlled gas mixing device

## Cellulose-based Chiral Hierarchical Structures

**M. H. Godinho[1*], A. Almeida[1], P. Almeida[1, 2], S. Fernandes[1], Ricardo Chagas[1] and R. Raupp da Rosa[1]**

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*[2]Departmental Physics Area, Lisbon Higher Institute of Engineering, Lisbon Polytechnic Institute, Portugal*

### Abstract

Nature produces numerous hierarchical cellulose-based structures that span from molecular to the nano, micro and macro scales [1]. Cellulosic materials are at the origin of different tunable photonic structures [2]. These structures are a source of inspiration to the next generation of biomimetic materials. In addition to this, the analysis of natural structures provides insights into evolutionary structure-function relationships in plants [3]. In this work, we will focus on biomimetic materials, idealized from cellulose-based anisotropic systems, with structural coloration similar to those displayed by plants, animal feathers and some cuticles of beetles.

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10.1002/adma.201703655 (2018) (back front page).

[2] -"Mind the Microgap in Iridescent Cellulose Nanocrystal Films" S.N. Fernandes, P.L. Almeida, N. Monge, L.E. Aguirre, D. Reis, C.L.P. de Oliveira, A.M.F. Neto, P. Pieranski, M.H. Godinho*, Advanced Materials, 10.1002/adma.201603560 (2016) (front cover).

[3]"Spotting plants' microfilament morphologies and nanostructures", Ana P. Almeida, João

Canejo, Urban Mur, Simon Copar, Pedro L. Almeida, Slobodan Žumerb, and Maria Helena Godinho*, Proceedings of the National Academy of Sciences U.S.A. (PNAS), 116(27) 13188, (2019).

### Biography

Associate Professor with Habilitation of FCT/UNL, Head of SBMG at CENIMAT and Vice-director of CENIMAT. Vice-president International Liquid Crystal Society (ILCS) 2016-2020. Graduation in Chemical Engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal, D.Sc, PhD and MSc in Materials Science from New University of Lisbon, Portugal. Nato/Invotan fellow at the Laboratoire de Physique de la Matière Condensée at Nice University in France. Invited overseas lecturer by the British Liquid Crystal Society (2016). Next chair of the International Liquid Crystal in Lisbon 2020.

## New trends in injection mold design for plastics

**Pedro Martinho**

*Polytechnic Institute of Leiria, Portugal*

### Abstract

Nowadays, new plastic injection mold design strategies are being developed. The design of a plastic injection mold is strongly related to the series of production. Mold requirements and specifications should be defined depending on the number of parts to be produced. It is also important to consider the use of additive manufacturing technologies in the production line, namely to produce the molding elements (blocks or other inserts). The interconnection between additive manufacturing technologies and conventional ones on molds production adds value to the mold production chain, since additive manufacturing technologies make a difference when interoperable with the set of the manufacturing process. However, this also raises several challenges. Designing for additive manufacturing is different compared with conventional fabrication technologies. In each case, it is necessary to identify their specific manufacturing capabilities as well as their constraints. Designers and mold manufacturing engineers also have new requirements to fulfill, namely the capability and skill to reduce waste and energy consumption for more sustainable production. The main subject of this lecture is to address new aspects to be considered in order to improve performance when designing injection molds for plastics.

### Biography

Associate Professor of the Polytechnic Institute of Leiria, Portugal. He graduated in Mechanical Engineering at University of Coimbra, received his MSc in Molds Design and Manufacturing and PhD in Science and Engineering with Polymers and Composites, both from University of Minho, Portugal. He teaches several subjects related to polymers and composites materials, rapid prototyping and tooling technologies. He has several publications in conference proceedings, book chapters and journals, related to polymers, molds design and manufacturing for plastic parts. He is member of the Institute of Nanostructures, Nanomodeling and Nanofabrication and of the Center for Rapid and Sustainable Product Development.

## Mixing the Unmixable

**Ana Paula Piedade[1*], João Cordeiro[1], Cláudia Buga[1] and Hermínio C. de Sousa[2]**

*[1]CEMMPRE, Department of Mechanical Engineering, University of Coimbra, Portugal*
*[2]CIEPQPF, Department of Chemical Engineering Engineering, University of Coimbra, Portugal*

### Abstract

Biopolymers, obtained from renewable natural sources, such as starch and cellulose appear as a green alternative to petroleum based polymers, since they are biodegradable and nontoxic, leading to a growing commercial interest on their use. They present their self as an ecological and sustainable alternative to petroleum based polymers and, consequently, as a solution for the water and soils pollution caused by these synthetic organic materials.

We have produced nanocomposites, where a more hydrophilic polymer or copolymer matrix is reinforced with nanofibrils of hydrophobic bacteria cellulose. To allow the homogeneous distribution of the reinforcement material hot melt was used to mix the hydrophilic matrix of Tetronics®, Pluronics® and polycaprolactone (PCL) with the biopolymer. The nanocomposites were 3D printed and the stress produced in the conformed material, due to the mismatch of the matrix/reinforcement properties, was used to evaluate their morphing-changing ability when subjected to an external stimulus, i.e., their suitability as a 4D printing material.

### Biography

A.P. Piedade has a BSc in Biochemistry, a MSc in Cellular Biology and a PhD in mechanical Engineering. Part of her research interests is focused on the production of biopolymers from completely renewable and ecological sources, such as cellulose produced by bacteria.

## A new Recycling Method for Polyanion-based Thermal Insulator Composites

**Matteo Cibinel*, Giorgia Pugliese, Lucia Marsich and Vanni Lughi**

*Department of Engineering and Architecture, University of Trieste, Italy*

### Abstract

Biopolymer-based materials are an attractive alternative to conventional thermal insulation systems thanks to their reduced environmental impact and natural availability. In particular, polysaccharides such as cellulose chitosan and alginate are being extensively studied as binderagents in composites or as aerogels mainly due their biodegradability. A number of researchers have already explored the use of alginates as thermal insulator material; however, a drawback is the fact that disposal seems to be only available end-of-life option. This unprofitable scenario is even more critical for the case of polysaccharide-based composites specifically developed to recycle industrial waste. In this work, we present a recycling process for an alginate-based thermal insulation foam, in which the original material is fully recovered and the thermal and acoustic insulation performances are maintained. The original foam is produced with a patented process [1][2] in which alginate is used as the host poly-anionic matrix for industrial fiberglass waste. Upon addition of a cation (calcium), the alginate is capable of forming a gel via ionotropic gelification due to electrostatic interaction with its negatively charged backbone. The dried foam is obtained by freeze-drying. At this point, a water solution of a chelator (Ethylenediaminetetraacetic acid disodium salt, EDTA-2Na) with a higher affinity toward the cation is added, resulting in the cation chelation and the disassembling of the matrix; a homogeneous solution is thus obtained. Upon deactivation of the chelator via acidification, the cations become available to crosslink the polymer. With a subsequent freeze-drying step, the recycled foam is re-obtained.  As a proof of concept, we have used alginate as the polyanion; however, in principle, any composite material based on a matrix made via ionotropic gelification can be recycled with this process.

G. Kyaw Oo D'Amore et al., "Innovative thermal and acoustic insulation foam from recycled waste glass powder," J. Clean. Prod., vol. 165, pp. 1306–1315, 2017.

M. Caniato and A. Travan, "Method for recycling waste material," EP Patent 16425023.5, 2016.

Biography ^II´m a third year PhD student at the Nanotechnology school of Trieste. In 2017 I earned my master degree in Material Engineering from the University of Trieste. During the first years of my studies I´ve become interested in material related problems of the biomedical area, which I was able to explore during my MS and BC thesis. More recently, I gained personal interest in energy related problems and green technology. Because of that, I have decided to deepen my studies through a PhD. My research is focused on developing a green nano-composite material with tailored fire resistant and thermal insulating properties.

## Polyurethane films and nanocomposites made from polycarbonate-based waterborne dispersions and nanofiller

**Milena Spírková*, Jiri Hodan, Ludka Machová and Sabina Krejčíková**

*Institute of Macromolecular Chemistry CAS, Czech Republic*

### Abstract

Waterborne polyurethane dispersions (PUDs) belong to promising materials for coating/film preparation meeting the requirements of strict environmental legislation and regulations. PUDs based on polycarbonate-based macrodiols can lead to 2D products of different properties: polyurethane (PU) films composed of nanoparticles made from solely linear chains are fully recyclable but their mechanical properties are limited as compared to materials composed of branched/crosslinked PU nanoparticles. The built-in of the D,L-lactide-based diol in PU chain of PUD influences especially the hydrolytic stability of PU materials. The broader modification of functional properties can be further achieved by addition of different water-dispersible nanofillers into PUD. Colloidal silica, natural bentonite and starch are examples of nanofillers used.

The presentation will be aimed at PUD preparation, PU film and 'green' PU nanocomposite film preparation and their basic characterization. All PUs feature high level of supramolecular ordering issuing in spherulites formation of micrometer size.

The detailed consideration will be aimed at degradation studies of materials. The degradation efficiency was estimated as changes of property of untreated films as compared to characteristic of films immersed into (i) phosphate saline buffer (PBS; pH 7.4) or into (ii) 10 % $H_2O_2$ + 0.1M $CoCl_2$, both at 37 ºC. While the first medium examines hydrolytic stability of the film, the second one models accelerated in vivo degradation process. Depending on the constitution, potential biomaterials being either stable or degradable can be prepared.

Acknowledgement: The authors thank to the Czech Science Foundation (project 18-03932S) for financial support.

### Biography

Dr. Milena Špírková has been working in the Institute of Macromolecular Chemistry CAS,

Prague, Czech Republic, now in the Nanostructured Polymers and Composites Department as senior scientist. She has a good experience in the polymer (mainly polyurethane) synthesis and atomic force microscopy. She was or she is responsible for 12 scientific as well as industrial projects granted by the Czech Science Foundation, Grant Agency of the Academy of Sciences of the Czech Republic, Ministry of Industry and Trade and European Union (FP7-REGPOT). She is the author and co-author of 152 original papers with 2393 citations; source Web of Science.3

## Network Topology in DGEBF resins: Understanding Chemical Barrier performance.

**John Patrick Anthony Fairclough[1], Stephen Knox[1,2], Alec Shackleford[1], Anthony Wright[3] and Colin Cameron[3].**

[1]*Department of Mechanical Engineering, The University of Sheffield, UK*
[2]*Department of Chemistry, The University of Leeds, Leeds, UK*
[3]*AkzoNobel, International Paint Limited, U.K.*

### Abstract

Epoxy resins find a wide range of uses, from protective coating to composite matrices. These thermoset resins are a cornerstone of our modern world, contributing significantly in a range of technologies in the fight against climate change. A major issue with all polymer systems and epoxy resins is that they are far more permeable than inorganic coatings. However, they are preferred due to their ease of processing and toughness. Networks based on DGEBF monomers rather than DGEBA are generally found to

exhibit an improved chemical performance. Aromatic amines were found to give improved networks when compared to their aliphatic analogues. In both cases, a denser network was formed which showed reduced and slower sorption. 1,3- substitution of six-membered rings was found to produce networks of a higher quality than 1,4- analogues, irrespective of very similar densities. Individual isomers of DGEBF were synthesised from their respective regioisomer of bisphenol. Networks produced with these isomers (as well as mixtures of different compositions) demonstrated the reduced performance caused by ortho- substitution. Across the work it was demonstrated that none of the individual physical/thermal properties probed (Tg, crosslink density, density, T_) was an indicator of chemical performance, though generally a combination of properties indicating a well-packed network gave a good indication of performance. Density was shown to be the most important of these factors in indication.

### Biography

Professor Patrick Fairclough completed a BSc in Physics at the University of Birmingham in 1990. He then started a PhD in Neutron Scattering at Birmingham. He graduated from Birmingham with his PhD in 1995. A postdoc in polymer science took him to UMIST in Manchester in 1994 (after briefly working as a service engineer). The postdoc lasted until 1997 when he was recruited to the Department of Chemistry at the University of Sheffield. In 2013 he took up the chair in Composite Engineering in the Department of Mechanical Engineering.

## Tire Compounds Based on Thermoplastic Matrix for Multipurpose Moulding Processes

**Artur Mateus[1], Filipe Nogueira[1], Hugo Marques[1], Cyril dos Santos[1] and José Carvalho[2]**

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*[2]Biosafe – Indústria de Reciclagens, S.A*

### Abstract

With the growing number of cars worldwide, over the past two decades, recycling of used tires has undergone a significant evolution. A succession of laws and regulations, along with technological progress and new market opportunities, push the used tire recycling industry into the 21st century. Currently, rubber, metals and textile fibers can be recovered and used in a wide range of products, as well as in industrial applications. The main product of tire recycling used is rubber granules. As of the 21st century, this product has been in great demand, being its main applications in sports and safety surfaces, road pavements, airports and specialties (industry in general). Sports surfaces represent 61% of the market, safety 29%, road surfaces 6% and specialties 4%. In terms of prospects for future evolution for the different markets mentioned above, it appears that they are going to maturity, that is, the sales of granules for these applications are intended to maintain the created infrastructures. In addition to this, these markets are mainly linked to applications for recreational purposes, and public investment in particular, on which the continuity of contention is expected. This work based on the TT2V|TransformTires2Value project finds motivation in the environmental, technical and socio-economic impact that raw materials based on rubber mixtures derived from old tires and polymeric matrices can have on the development of highly added value products for applications in areas such as industry, safety, construction, environment, sport and agriculture/gardening. The aim of this work is to demonstrate and validate the industrial applicability of knowledge associated with new raw materials based on the recycling of old tires and capable of being applied - after formulation and processing by special thermoplastic matrix moulding - in several real situations. Several thermoplastic processing processes are being evaluated, such as injection moulding, extrusion, rotational moulding and Long Fiber Thermoplast (LFT). The main objectives that are being explored in this experimental work are: determination of generic characteristics of composites that guarantee the specifications of each part selected for demonstration ; production of composites, ie, elastomer powder modified thermoplastics (EPMT), optimized for the binomial production process and application of parts definition of EPMT processing parameters by different molding processes (injection, extrusion, rotational molding and compression) in semi-industrial environment. The main results achieved will be presented thinking in further demonstrations and validations of industrial applicability of EPMT for high technical requirement products used after formulation and transformation by moulding technology in different real situations.

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## Biography

Artur Mateus is an Adjunct Professor of Mechanical Engineering Department, on Rapid Tooling and Manufacturing, at the Polytechnic Institute of Leiria (PIL), since 1997. Also is Vice-Director of the Centre for Rapid and Sustainable Product Development at the Polytechnic Institute of Leiria (PIL). He is member of the scientific and technological council of the Incubator for startups, OPEN (Marinha Grande – Portugal). Artur Mateus has a PhD in Polymer Physics from the University of Reading (UK), a MSc from the Technical University of Lisbon (Portugal) and a first degree in Mechanical Engineering from the University of Coimbra. He has co-edited three books, authored and co-authored more than 70 papers published in books, international journals, and proceedings of international conferences. Artur Mateus has participated in more than 60 Research Projects, national and international, in consortium with companies and firms related to Rapid Tooling and Manufacturing, rapid design and advanced materials processing

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# Performance and Processing of Moulded Pulps from Agro-wastes: Effects of Micro vs. Nanocellulose and its Modification

**Nattakan Soykeabkaew*, Phattharasaya Rattanawongkun, Supattra Klayya, Nutchanad Kunfong, Nattaya Tawichai and Uraiwan Intatha**

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## Abstract

Moulded pulp packaging materials has received growing attention recently due to favourable environmental, social, and economic drives. In Thailand, several underutilized agro-wastes can be used as alternative resources to produce pulps replacing virgin wood pulps. In this research, pulps from the plentiful local agro-wastes (e.g. banana pseudostem, pineapple leaves, and rice straw) were prepared using a soda process, moulded into sheets, and then evaluated their performances. To improve weak pulps, the concepts of adding (i) stronger micro-sized fibers and (ii) nano-sized celluloses were attempted. Firstly, when different agro-waste pulps were mixed together (up to 50 wt%), a positive deviation from linear mass fraction additivity in mechanical properties of most mixed sheets was found. It indicated an increase in bonding degree in these sheets. Secondly, nanofibrillated celluloses (NFC) were prepared using a microfluidizer, then mixed into a pulp slurry (up to 5 wt%), and compressed into sheets. A noticeable reinforcing effect of NFC at very low loading contents (<1 wt%) in both strengthening and toughening the sheets was shown. In addition, at our industrial partner factory in Chainat province, when trying to use NFC in their existing packaging production line, it was found to be practical and resulted in satisfied products. However, a slower drainage of the NFC mixed pulp during the process was also noticed. To overcome this problem, NFC was slightly chemically modified via esterification. Results showed that the modified nanocellulose not only helped reducing draining time but also increased mechanical performance and water resistance of the moulded pulp.

## Biography

Dr. Nattakan Soykeabkaew is an Assistant Professor of Materials Science at Mae Fah Luang University, Chiang Rai, Thailand. Her research of interest is in the fields of Cellulose-Based Materials, Single Polymer Composites and Nanocomposites, which focus mainly on the extraction, treatment, and modification of applicable raw materials from biomass as well as fabrication, structure-properties, and applications of their potential products. The materials of interest include: 1) agricultural wastes, 2) recycled materials, 3) bio-based polymers and composites, and 4) nanocelluloses. Assist. Prof. Soykeabkaew received her D.Phil. (Materials Science and Engineering) from Queen Mary, University of London, UK in 2007.

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# Functional Supramolecular Polymers for Conductive and Biocompatible Materials

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[4]*Catalan Institution for Research and Advanced Studies (ICREA), Spain*

### Abstract

Molecular and supramolecular nanomaterials are one of the fields that have attracted intensive research due to their potential applications such as development of dynamic protein biochips or multicomponent systems. With the objective of studying new responsive and supramolecular polymers we have explored two different supramolecular interactions. First, tetrathiafulvalene molecules substituted with a carboxylic acid group (TTFCOOH) were bound as redoxactive moieties into a poly(4vinyl pyridine) (P4VP) skeleton through hydrogen bonds, resulting in an organic film capable of charge transport. The charge transport along the organic donor molecules hydrogen bonded to the polymer matrix was demonstrated employing Electrostatic Force Microscopy (EFM). On the other hand, curcumin is a natural hydrophobic polyphenolic diketone with many therapeutic properties including antioxidative and anticancer activity. The modification of curcumin structure, has allowed the achievement of a new family of derivatives called curcuminoids (CCMoids). With the objective of studying a new supramolecular coordination polymers, a naphthol-based curcuminoid was prepared as electron-rich guest together with a viologen-guest molecule as electron-deficient using cucurbit[8]uril as a host of both molecules to form the supramolecular assembly through charge-transfer interactions. In addition, the formation of the ternary complex makes possible to dissolve the curcuminoid derivative in water, being crucial toward CCMoids delivery applications. Finally, the structure of the resulted supramolecular assembly has been characterized using electron microscopy techniques and atomic force microscopy.

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### Biography

I achieved my PhD with honours at the ICMAB-CSIC. After, I moved to Imperial College London to lead a collaborative project with Toyota Motors. I successfully developed a new in situ methodology for thermal conductive nanomaterials by the preparation of ZnO nanoparticles and carbon nanotubes nanocomposites. Next, I joined the University of Twente to develop a new methodology for the preparation of multifunctional surfaces and for positioning of proteins at surfaces. Nowadays, I work at the ICMAB leading projects to develop molecular devices based on surfaces and polymers to be applied in chemical and biological sensors and molecular electronic fields.

## Marine Biopolymers: New Materials for Sustainable Films and Coatings

**Maria Manuel Gil**

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### Abstract

The modern food industry is facing challenges and requires specific approaches to overcome them. One of these challenges is related to the packaging of food products with a short shelflife period, especially those susceptible to oxidative and microbiological deterioration. Although the use of conventional packaging materials such as plastics is effective for food transportation and distribution, it compromises product shelf-life and creates serious environmental problems. Thus, the search for new methods for more efficient preservation methods of food products is an emerging field of study that is gaining attention. Seaweed is a versatile organism that produces various kinds of polysaccharides that are extensively used in the development of biopolymers. These biopolymers have received increased attention for their food applications, more specifically regarding their functionalities in the preparation of antimicrobial edible films and coatings and due to their unique film-forming ability and excellent mechanical properties. However, its application as a coating in food products and mainly in seafood is limited. The addition of antioxidants is necessary to maintain the colour and minimize lipid oxidation. It is therefore essential to develop a multifunctional and sustainable film and coating based on recyclable biopolymers, such as macro and microalgae polysaccharides, with the incorporation of seaweeds extracts, with a high antioxidant content, in order to overcome the lack of these compounds in the formulation for seafood products. This work reviews the development and application of biopolymers formulated exclusively with marine naturally occurring, sustainable and effective compounds that will provide an important competitive advantage for producers.

### Biography

Professor at the Polytechnic of Leiria (Portugal) and Coordinator of MARE-Marine and Environmental Sciences Centre, Polytechnic of Leiria. She obtained her Degree in Food Engineering (2000) and PhD in Food Science and Engineering (2009) at the College of

Biotechnology, Catholic University (Portugal). She is principal investigator of several research projects, and evaluator for different international agencies. Her current research focuses on add economic value to marine resources, including areas such as edible films and coatings from marine resources to extend shelf-life of food products, development of marine bio-based ingredients as additives in food formulations, risk/benefit assessment associated with seaweeds consumption.

## Mechanical Milling: A Useful Top-down Approach to Produce Bio-Nano-Composites Using Materials from Renewable Sources

**Giuliana Gorrasi**

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### Abstract

The homogeneous dispersion of nanoparticles into polymer matrices is attracting great interest from basic and applied research (1). Unfortunately, the achievable results are generally limited by the re-aggregation of the nanoparticles which determines the size distribution and the adhesion of the nanoparticles to the polymer matrix. Other limitations are related to the temperature and mechanical stress that must be applied to the polymer matrix during the dispersion process. Therefore, it is necessary to find out new methods to achieve homogeneous dispersions with higher ecological and economical sustainability. Solid state mixing, such as mechanical milling (MM), might be an interesting green and solvent free alternative. It has been used to produce novel polymer nanocomposites, and can be attractive also from an economical point of view (2-3). MM involves several advantages: i) control of degradation processes deriving from the use of high temperatures, ii) strong reduction in the disposal of substances harmful to the environment, such as solvents, iii) possibility of compatibilizing mixtures of incompatible materials. The simultaneous production and dispersion of nano-particles, the promotion of mixing processes that can occur mechanically-chemically and the possibility of manipulating thermosensitive organic molecules, such as antimicrobials, oxygen-scavengers, and molecules with pharmacological activity, has allowed to get new materials for targeted applications. The present communication aims at report the last recent advances in the fabrication of bio-nano-composites via the ball milling, using bio-based polymers and several green active fillers.

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### Biography

Giuliana Gorrasi is Associate Professor of Chemistry at the Department of Industrial Engineering of University of Salerno (Italy). Her research activity is focused on the study of the correlation between structural organization and physical properties of polymeric materials, composites and nanocomposites. The innovative and original contribution of the scientific production within this theme is represented by the use of mechanical milling as an ecological and economical alternative to obtain a homogeneous dispersion of nano-fillers inside polymeric matrices. The use bio-based matrices and natural fillers, used as drug delivery, allowed to obtain novel materials with structural and functional properties.

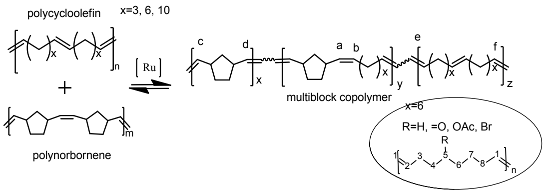
## Macromolecular Cross-Metathesis as a Route to New Multiblock Copolymers

**Yu.I. Denisova*, M.L. Gringolts, E.Sh. Finkelshtein and Y.V. Kudryavtsev**

*Topchiev Institute of Petrochemical Synthesis RAS, Russia*

### Abstract

Recent studies demonstrate increasing interest to multiblock copolymers as promising functional materials with enhanced mechanical properties. In this paper, we discuss our synthetic efforts on preparing multiblock copolymers from mixtures of olefinically unsaturated polymers via macromolecular cross-metathesis reaction. This reaction belongs to interchain exchange type and proceeds via breaking up of C=C double bonds and formation of new ones in the presence of Ru-based Grubbs' initiators. With this approach, we have synthesized copolymers of norbornene with cyclooctene, cyclopentene, cyclododecene, butadiene, and isoprene, which are hard or even impossible to obtain by other methods. We were also able to introduce various functional groups (acetoxy-, carbohy-, hydroxy-, trimethylsilyl-, bromine) in the copolymers either by use of substituted monomers for obtaining the initial homopolymers, or by post-modification of the cross-metathesis products. In situ 1H and ex situ 13C NMR were implemented for monitoring of the reaction kinetics in terms of the Ru-carbene concentrations and dyad composition of the copolymer product. A quantitative model of the reaction kinetics was developed that makes possible to regulate the degree of copolymer blockiness. In its turn, the chain structure determines copolymer crystallinity and tendency to microphase separation, which were probed with DSC, including thermal fractionation, and rheological measurements. In some cases the macromolecular cross-metathesis was accompanied by hydrogenation of C=C double bonds, which may lead to an increase in the copolymer crystallinity. At low polymer concentrations, one should also take into account intramolecular cross-metathesis, which results in the formation of cyclic macromolecules.



The study was supported by the Russian Science Foundation (Project 19-73-10207)

## Biography

Dr. Yulia Denisova earned her MD at the Kuban State University of Technology (Krasnodar) in 2009 and PhD in Polymer Chemistry at the Topchiev Institute of Petrochemical Synthesis RAS (Moscow) in 2013, where she works now as a Senior Research Fellow of the Laboratory for Polymer Modification. Her research interests lie in the area of polymer synthesis and modification, in particular, obtaining novel multiblock copolymers via cross-metathesis and other macromolecular reactions.

# Biomimetic Inspired Materials for Purification in Pharmaceutical Industry

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[3]*The Discoveries Centre for Regenerative and Precision Medicine, Lisbon Campus, Higher Technical Institute, University of Lisbon, Portugal*

## Abstract

Active pharmaceutical ingredients (APIs) available in the market are mostly synthesized in organic solvent media, using highly reactive molecules that may persist in the final formulation, some as genotoxic impurities (GTIs). Some GTIs are able to react with DNA, increasing carcinogenic risk. Although desirable to avoid the use of GTIs, this is not always possible. Therefore, there is a call to develop simple, robust and economical routes to remove GTIs to limits below a Threshold of Toxicological Concern (1.5 µg/day). Such adsorbents should be highly selective to target ultra-low GTI levels with minimal API losses, while being compatible with organic solvents. We report two different strategies for the development of new adsorbing materials for selective removal of GTIs from API organic solvent solutions, corresponding to: i) a molecularly imprinted polymer (MIP), designed to remove a specific aromatic amine GTI; and ii) a polybenzimidazole polymer functionalized with a DNA base (PBI-adenine), designed to remove a broad range of DNA alkylating agents, mimicking the DNA-GTI adduct formation that takes place in vivo. These platforms proved to be robust materials, able to remove more than 95% of the GTIs from organic solvent API mixtures, in a single stage. (Sep. Purif. Technol., 2016, 163, 206-214; PBI-adenine: Sep. Purif. Technol., 2017, 179, 438-448; PBI-adenine: React. Funct. Polym., 2018, 131, 258-265). Acknowledgements: The authors thank funding from FCT (SelectHost: PTDC/QEQ-PRS/4157/2014), iBB (UID/BIO/04565/2013; UID/DTP/04138/2013, Programa Operacional Regional de Lisboa 2020 (Lisboa-01-0145-FEDER-007317), and CNPq (Brasil, 205201/2014-8), and Hovione PharmaScience Ltd for supplying APIs and technical know-how.

### Biography

PhD in Inorganic Chemistry at the University of Lisbon. Teresa is a Researcher at iBB - Institute of Bioengineering and Biosciences at IST where she develops her research activities: i) Novel materials for membranes and imprinted polymers; ii) New processes for genotoxins removal from pharmaceuticals and chiral resolutions; iii) Engineering processes for wastewater treatment and added value compounds recovery.

## New Silver(I) Coordination Polymers with Antibacterial Action Against *Escherichia Coli* and Staphylococcus Aureus

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### Abstract

In the last two decades, a tremendous amount of attention has been directed towards the design of antibacterial silver(I)-based materials, including coordination polymers (CPs) built up with a great variety of oxygen and nitrogen-containing ligands. Herein, a family of six new silver(I)-based CPs, having the general stoechiometric formula [Ag($H_2$DMPMB)(X)] (X = $NO_3$, 1; $CF_3CO_2$, 2; $CF_3SO_3$, 3; $BF_4$, 4; $ClO_4$, 5; and $PF_6$, 6) and incorporating the flexible ditopic pyrazolyl-type ligand 4,4'-bis((3,5-dimethyl-1H-pyrazol-4-yl) methyl)biphenyl ($H_2$DMPMB), has been prepared by the chemical precipitation method involving the reaction of silver(I) salts with $H_2$DMPMB in the 1:1 molar ratio, in alcohols, or acetonitrile at room temperature for two-hours. The new silver(I)-based polymeric materials were characterized by means of Fourier transform infrared spectroscopy (FTIR), elemental analysis (EA), and thermogravimetric analysis (TGA), allowing for the proposition of their structures. The obtained silver(I) CPs showed a remarkable light insensitivity and stability in the air, are insoluble in water and in most common organic solvents, and possess appreciable thermal stabilities spanning the range 250–350 °C. The antibacterial activity of the obtained silver(I) CPs was tested against the Gram-negative bacteria Escherichia coli (E. coli) and Gram-positive bacteria Staphylococcus aureus (S. aureus) using the Tetrazolium/Formazan test (TTC), by measuring the bacterial viability at different time intervals. The complete reduction of both bacterial strains occurred after 24 h of exposure to all silver(I) CPs, the bacterial viability values for S. aureus reaching 8% for compounds 3, 5, and 6 after only two-hours.

Acknowledgements: This work was supported by a grant of Ministery of Research and Innovation, CNCS – UEFISCDI, project number PN-III-P1-1.1-PD-2016-0409, within PNCDI III.

### Biography

Aurel Tăbăcaru was born in Galati (Romania), in 1984. He received BSc in Physics-Chemistry in 2008 from the "Dunărea de Jos" University of Galati (Romania) and the PhD in Chemistry in 2013 from the University of Camerino (Italy). He is presently Lecturer at the "Dunărea de Jos" University of Galati (Romania) in the Department of Chemistry, Physics and Environment, from Faculty of Sciences and Environment. His current field of research interests is related to the development of new coordination compounds and modified metal oxide nanoparticles. He is co-author of 27 papers in peer-reviewed ISI journals and 1 book.

## Self-assembly of Amphiphilic Homopolymers and Diblock Copolymers with Amphiphilic Blocks

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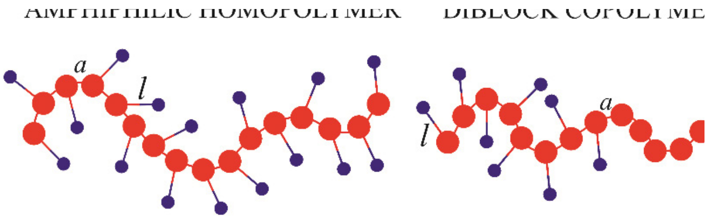
*[3]Nesmeyanov Institute of Organoelement Compounds RAS, Russia*

### Abstract

Self-assembly of macromolecules possessing local amphiphilicity is characterized by very rich morphological behavior. Among them are many thermosensitive polymers (as PNIPAm-based systems), biopolymers and amphiphilic molecular brushes. The shape and

size of macromolecular aggregates as well as of single condensed macromolecules depend on the molecular characteristics and external conditions in solution.[1,2] In particular, the formation of vesicle particles with very thin shell is observed for some amphiphilic homopolymers with solvophobic and solvophilic parts in monomer units separated by a certain distrance.

In the lecture, a theoretical analysis of morphology of single amphiphilic homopolymers and diblock copolymers with solvophobic and amphiphilic blocks in solution is presented. Amphiphilic monomer units are described as dimers with solvophobic and solvophilic parts connected by a fixed length bond. It is the surface activity of amphiphilic monomers that leads to a variety of spacial structures which are rich in surfaces. The solvophobic blocks in collapsed diblock copolymer macromolecules tend to intramolecular segregation from the amphiphilic blocks. The calculated morphology diagrams are presented in comparison with



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### Biography

Elena N Govorun is an Associate Professor at the Moscow State University, Faculty of Physics and Senior Research Fellow at the Topchiev Institute of Petrochemical Synthesis. Her research interests are in the field of theory of macromolecular systems including the self-assembly phenomena in complex systems containing polymers and surfactants. Elena is involved in the collaboration with several groups performing computer simulations.

## *In Situ* Gellable Poly(Amino Acid)S for Controlled Drug Delivery

**Benjámin Gyarmati[1*], Barnabás Áron Szilágyi[1], Anil Misra[2], Mo Alavijeh[2] and András Szilágyi[1]**

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*[2]Pharmidex Pharmaceutical Services Ltd, United Kingdom*

### Abstract

Bioavailability of liquid drug formulations can be improved by the use of in situ gelling polymers. A biocompatible synthetic poly(amino acid) was chosen as the backbone of a thiolated and a S-protected, bioadhesive polymer. Thiolated poly(aspartic acid)s were prepared by reacting polysuccinimide with cysteamine, whereas S-protected polymers were synthesized by attaching 6-mercaptonicotinic acid (MNA) onto the thiolated derivatives. Gelation was monitored by oscillation rheology. Thiolated polymers could be converted to hydrogels upon oxidation, while aqueous solutions of the two type of polymers were gelated in situ without any external agent. In vitro safety of the polymers was evaluated by a number of tests: free radicle damage assay, metabolism enzyme assays, haemolysis assay and cellular toxicity. S-protected polymers had a slight oxidizing effect, while a protective effect was observed for thiolated polymers. Thiolated polymers did not inhibit the metabolic CYP enzymes, but the presence of disulphide groups seriously affected the enzymatic activity. All of the polymers synthesized had a negligible haemolytic or cytotoxic effect supporting their pharmaceutical use.

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University of Technology and Economics (BME FIKP-BIO). B. Gyarmati acknowledges the János Bolyai Research Scholarship of the Hungarian Academy of Sciences and the ÚNKP-19-4-BME-421 New National Excellence Program of the Ministry of Human Capacities. This work has been supported by the European Union NanoMed Grant (734641).

### Biography

Benjámin Gyarmati graduated as a chemical engineer from Budapest University of Technology and Economics and obtained his PhD degree at the same university in the topic of pH- and redox responsive hydrogels. His primary interest is the development of poly(amino acid) based, multiresponsive hydrogels for applications in controlled drug delivery with a particular focus on in situ gellable, bioadhesive materials. He co-authors 30 scientific papers with more than 300 independent citations and with a Hirsh index of 11.

## Nature-inspired Smart Drug Delivery Platforms Based on Electrospun Nanofibers and Plasmonic Hydrogels for Near-infrared Light-controlled Polytherapy

**Filippo Pierini[1*], Paweł Nakielski[1], Sylwia Pawłowska[1], Chiara Rinoldi[1], Yasamin Ziai[1], Olga Urbanek-Świderska[1], Luciano de Sio[2], Antonella Calogero[2], Massimiliano Lanzi[3], Krzysztof Zembrzycki[1], Michał Pruchniewski[1], Elisabetta Salatelli[3], Tomasz A. Kowalewski[1], and Alexander Yarin[4]**

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[2]*Sapienza University of Rome, Italy*
[3]*Alma Mater Studiorum-University of Bologna, Italy*
[4]*University of Illinois at Chicago, United States*

### Abstract

Nature offers a large variety of examples of functional structures with different properties which are inspiring scientists to develop novel materials. One of the most fascinating characteristics of natural structures is the ability to evolve, adapt and improve their functionality to fulfil different tasks over time. This feature is of particular interest in the development of materials for biomedical applications, since the therapeutic needs of the treated tissues change in accordance with the patient treatment stage. Additionally, it is well known that monotherapeutic treatments are not effective enough to successfully fight the most challenging diseases (e.g. cancer). In recent years, huge efforts have been made by scientists to design and fabricate nanomaterials mimicking the typical multifunctional capability shown by natural materials.

The present study is based on the idea that the stimuli-responsiveness of hydrogels based on plasmonic nanoparticles can trigger a series of material physical changes, arranged in a nature-inspired cascade, when they are merged with electrospun nanofibers. The near-infrared light-stimulated changes can be used to activate and/or regulate specific therapeutic treatments simultaneously.

Here we describe a novel jellyfish-inspired material based on electrospun poly(L-lactide) nanofibers and a plasmonic hydrogel made by photothermal-responsive gold nanorods and a thermoresponsive hydrogel. The nanostructured material chemical, morphological and structural properties, as well as its biocompatibility, were investigated. Finally, the potential applicability in the field of on-demand polytheraply (e.g. photothermal therapy and controlled-drug delivery) was tested.

This work was supported by the National Agency for Academic Exchange (NAWA) grant no. PPI/APM/2018/1/00045/U/001 and the National Science Centre (NCN) grant no. 2015/19/D/ST8/03196.

### Biography

Dr. Filippo Pierini received his Ph.D. degree in Advanced Chemical Methodologies from Alma Mater Studiorum - University of Bologna (Italy). He is now an associate researcher of the Department of Biosystems and Soft Matter at the Institute of Fundamental Technological Research of Polish Academy of Sciences (Poland) and he is the head of the Pierini Research Group. His current research focuses on the development of nanostructured materials for biomedical applications, with a particular interest in the study of multifunctional and stimuli-responsive devices made by soft matter as well as electrospun nanofibrous materials.

## Single Point Incremental forming of Composites: Mold Free Composite Manufacturing

**John Patrick Anthony Fairclough[1], Victor Cedeno-Campos[1] and Pablo Jaramillo[1]**

*Department of Mechanical Engineering, The University of Sheffield, UK*

Abstract

Traditional composite manufacture requires the creation of a mold over which the fabric is layered, infused with resin and then cured. The textbook definition of a mold is that it “supports the composite while it is being cured”. Why not just support a small section of the composite while this section is cured and then move to the next section? The advent of advanced robotics has made this vision possible. We have created a testbed prototype systems that allows us to cure thin (10 plies) of pre-preg carbon fibre in a truly freeform system without the use of a mold. The testbed uses simple copper tools to consolidate the fabric; apply heat and cure the composite before moving along the fibres to cure the next section in an incremental fashion. The same system can also be used for thermoplastics, with polypropylene being the test material we have chosen.

### Biography

Professor Patrick Fairclough completed a BSc in Physics at the University of Birmingham in 1990. He then started a PhD in Neutron Scattering at Birmingham. He graduated from Birmingham with his PhD in 1995. A postdoc in polymer science took him to UMIST in Manchester in 1994 (after briefly working as a service engineer). The postdoc lasted until 1997 when he was recruited to the Department of Chemistry at the University of Sheffield. In 2013 he took up the chair in Composite Engineering in the Department of Mechanical Engineering.

## Microstructure Formation in Styrene – Vinyl Pyridine Block Copolymers Doped with Au Nanoparticles

**Yaroslav V. Kudryavtsev[1,3*], Yaroslav I. Derikov[1], Alexei S. Merekalov[1], Alexander A. Ezhov[1,2] and Anatoly V. Berezkin[1]**

[1]*Topchiev Institute of Petrochemical Synthesis RAS, Russia*
[2]*Faculty of Physics, Lomonosov Moscow State University, Russia*
[3]*Frumkin Institute of Physical Chemistry and Electrochemistry RAS, Russia*

### Abstract

We study the hybrid composites, in which a microphase-separated polystyrene – poly(vinyl pyridine) diblock copolymer prevents the aggregation of Au nanoparticles and provides their preferential location and ordering in the domains of a given type. Our synthetic approach not involving additional stabilizers is effective for both organophilic Au nanospheres and initially hydrophilic Au nanorods. It enables the preparation of stable sols of Au nanorods or nanospheres with sizes of up to tens of nanometers in various organic solvents [Beilstein J. Nanotechnol. 2018, 9, 616]. It appears that the diblock copolymer stabilizers are the most effective compared with thiol-terminated polystyrene, thiol-terminated poly(vinyl pyridine), and decanethiol [Polym. Sci., Ser. C 2018, 60, Suppl. 1, 240-250]. Thin films of Au nanospheres or nanorods in the diblock copolymer matrices are made by spin casting followed by solvent vapor annealing. The content of Au nanoparticles in the composites is up to 5% by mass, they are dispersed and located mainly within the vertical or horizontal cylindrical domains of vinyl pyridine, while the nanospheres are localized near the domain walls and the nanorods are generally oriented perpendicularly to the cylinder axis [Polym. Sci., Ser. C 2018, 60, 20-27]. These data are discussed regarding the results of our recent simulations by dissipative particle dynamics [J. Chem. Phys. 2017, 146, 144902]. Application of a constant electric field along the composite film surface leads to the formation of vertical cylinders aligned into threads tens micrometers long, which can be potentially interesting for practical applications.

### Biography

Yaroslav V. Kudryavtsev has obtained his Ph.D. in 1997 from the Lomonosov Moscow State University, passed Habilitation in 2005 at the Semenov Institute of Chemical Physics, and become a professor of the Russian Academy of Sciences in 2016. He is the head of the Laboratory for Polymer Modification at the Topchiev Institute of Petrochemical Synthesis in Moscow. Yaroslav’s scientific interests are focused on studying

## Polymeric Films Based on Thermo- and pH-sensitive Interpenetrating Polymer Networks Microgels for Biomedical Applications

**Oxana Vyshivannaya[1, 2*], Irina Nasimova[2] and Elena Kozhunova[2]**

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[2]*Faculty of Physics, M.V. Lomonosov Moscow State University, Russia*

### Abstract

Stimuli-responsive polymer microgels have proven to be conventional objects suited to create functional materials – superabsorbents, carriers for drugs and dyes, etc. The advantages of using microgels instead of macrogels are the shorter response times to external stimuli and opportunities for managing the internal structure and mechanical properties of the material. The main objective of the presented work is to synthesize the microgels based on poly(N-isopropylacrylamide) (PNIPAM) and poly(acrylic acid) (PAA) interpenetrating networks (IPN), to investigate their properties and to produce the stimuli-responsive polymer films by assembling of IPN miscrogels. To obtain the microgels with IPN structure, in the first stage, the PNIPA microgels were synthesized by thermo-induced precipitation polymerization, then the second subnetwork was obtained by in situ polymerization of acrylic acid within PNIPA microgel particles. Different types of cross-linking agents and cross-linking mechanisms were used to govern the inner network structure of IPN particles. Polymer films were produced by assembling of IPN microgel particles on substrate and temperature treatment, crosslinking by multivalent ions or recrosslinking of disulfide bridges, which are a part of the structure of one of used crosslinking agents. The termo- and pH-induces swelling behavior of obtained films was investigated. The absorption and thermo-induced release of organic dyes and drugs by presented polymer films were studied to demonstrate the potential possibilities of their biomedical application.

This work was financially supported by the by Russian Science Foundation (project No 17-73-20167).

### Biography

M.Sc.: 2003–2009 Physics Department, Moscow State University (Moscow, Russia), graduated with honours. Ph.D. in polymer science: 2009–2012 Physics Department, Moscow State University (Moscow, Russia). Professional experience: 2009–2012 Training at National Institute for Material Science (Tsukuba, Japan) as a part of Ph.D. program. 2012–present Research associate, A. N. Nesmeyanov Institute of Organoelement Compounds (Moscow, Russia). Research interests: experiment, thermoresponsive polymers, “smart” materials, polymer gels, microgels, polyelectrolytes, polyelectrolyte complexes, light scattering

## Macroporous Polymeric Hydrogels Based on Polyvinyl Alcohol

**M.I. Shtilman, A.A. Artyukhov, A.I. Piskareva and D.E. Lesovoy**

*D. Mendeleev University of Chemical Technology of Russia, Russian Federation*

### Abstract

Polymeric hydrogels are widely used in various fields related to medicine and biotechnology. A number of unique properties make these polymer systems quite attractive for a number of fields of medicine and medical biotechnology, such as tissue and cell engineering, technology of implants and biologically active systems, and a number of others.

At the same time, despite the large number of works in the field of creating such systems, the problem of developing a hydrogel material that satisfies the widest range of requirements of possible biomedical applications (such as, for example, the degree of cell adhesion, toxicity, porosity, and its nature, biodegradability, etc.) and having at the same time availability, comparatively simple production technology and relatively low cost, still remains unsolved.

As part of our research, we obtained new biocompatible materials based on cross-linked polyvinyl alcohol hydrogels of various structures and the possibility of their use in biomedical fields was investigated. The object of the study was polymer hydrogels obtained by radical polymerization of methacrylic derivatives of polyvinyl alcohol. The use of the modified polymer-containing multiple bonds in the side chain made it possible to obtain chemically cross-linked hydrogels that are stable when heated, unlike physical hydrogels (cryogels) of polyvinyl alcohol. As part of the work, we have studied not only hydrogels on the basis of “pure”

acrylated polyvinyl alcohol, but also materials based on its copolymers with acrylic derivatives of 2-hydroxyethyl starch, as well as low molecular weight charged monomers. The introduction of 2-hydroxyethyl starch into hydrogels made it possible to regulate the rate of biodegradation of hydrogel materials more effectively, and the introduction of charged low-molecular monomer units markedly improved cell adhesion on their surface. In vitro and in vivo experiments demonstrated the high biocompatibility of the macroporous systems obtained. A correlation between the composition of the synthesized systems and the rate of their biodegradation, the nature of interaction with cell cultures and the internal media of the body was found.

The possibility of using the developed polymer systems as a basis for implants replacing soft tissue defects and postoperative cavities, highly effective wound coverings, drug carriers in ophthalmology, substrates for cell and tissue engineering, including those with predetermined biodegradation times in the body, is demonstrated.

### Biography

Mikhail I.Shtilman is the head of Biomaterials department and professor at the Mendeleyev University of Chemical Technology of Russia. He completed his Ph.D. Diploma in 1964 and D.Sc. Degree in chemistry in 1985. His main research interests lie in the synthetic design of polymeric biomaterials with specific properties – biocompatibility, compatibility with blood, biodegradability, bioactivity – for medicine, agriculture, biotechnology, genetic engineering. He developed a new two-semester course of lectures for masters and graduated students “Application of Biomaterials. He is research supervisor of 45 Ph.D. theses and 4 D.Sc. Author of more 850 articles, patents, theses, and 7 monographs. He was awarded The Leibnitz Medal, The Leonard Euler Medal, “Orden of Ehre” by European Academy of Natural Sciences.

## Design of Nano Polymeric Materials Using 3D Computational Tools

**Joana M.R. Curto[1,2*], Flávia P. Morais[1]**

*[1]FibEnTech-UBI, University of Beira Interior, Portugal*
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### Abstract

The development of porous nanomaterials requires the porosity and pores distribution optimization since the majority of structure, strength, surface and liquid interaction properties relate with them. An innovative approach was performed using several 3D computational tools to design nanomaterials with optimized properties for special tissue materials applications. The electrospinning method was used to obtain nano fibrous structures and to obtain a surface layer to some materials made from different polymers. SEM images were used to characterize these structures and to measure fiber and pores dimensions, using image analysis techniques. The porosity optimization was crucial for obtaining materials with strength and surface properties. The liquid interaction, such as the contact angle and absorption properties were quantified, as well as key consumer properties, such as rugosity, flexibility and the exposure time to the functional molecules. The 3D computational simulations helped to design the porous materials structure and to obtain the desired pore dimension and pore distribution, improving the molecules’ incorporation time, and a more uniform molecule release over time. It was possible to obtain structures with different porosities and pore distributions and select the ones to be made in the laboratory. The structure flexibility was improved using nano cellulose as the main component in the surface layer and as an additive. The 3D computational tools were efficient to design and optimized porous structures, allowing the formation of new systems, capable to transport molecules to be used in special tissue materials.

### Biography

Joana Curto has her expertise in the development of polymer-based materials. To design innovative nano fibrous polymeric materials she uses a combination of experimental and computational techniques. She coordinates several projects in the field of materials, is a Chemistry Professor at University of Beira Interior and Researcher at FibEnTech - Fibers and Environmental Technologies Research Unit.

## Chitosan Extracted from Mushrooms: Physicochemical and *In Vitro* Cytotoxic Properties

**Alona Oberemko[1*], Asier M. Salaberria[2], Rita Saule[1], Gintautas Saulis[1], Milda Gumbite[3], Jalel Labidi[2] and Vykintas Baublys[1]**

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[2]*University of the Basque Country (UPV/EHU), Spain*
[3]*Vytautas Magnus University Academy of Agriculture, Lithuania*

### Abstract

Mushroom-derived preparations are known as potential natural tools for the prevention and treatment of many pathological states because of high amount of carbohydrates, proteins, vitamins, and minerals. Chitosan samples from two mushroom species (Boletus bovinus and Laccaria laccata) were obtained and characterized by viscosimetry, attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR), elemental analysis (EA), nuclear magnetic resonance spectroscopy ($^{13}$C NMR), X-ray diffraction (XRD), and thermogravimetric (TGA) analysis. Properties of the fungal chitosan samples were compared to commercial low-molecular weight chitosan, crustacean chitosan (Cervimunida johni), and chitosan obtained from an insect (Hilobius abietis). In addition, the cytotoxic properties of chitosan on cancerous hepatoma and non-cancerous Chinese hamster ovary cells were evaluated in vitro. The cells were cultivated on films with different chitosan concentrations and Petri dishes after preincubation with chitosan solutions. As a conclusion, this study clearly revealed that low-molecular weight chitosan films and solutions with high degree of deacetylation can act cytotoxically on both tumor MH-22A and normal CHO cells in vitro. Consequently, this work may be useful for further investigations of natural anticancer products in medical areas.

### Biography

Dr. Alona Oberemko is a PhD-student in Biochemistry of Vytautas Magnus University (Kaunas, Lithuania), author of 15 scientific articles, 36 abstracts, 2 books and 3 useful model patents of Ukraine. In 2011 she had a successful defense of her first PhD-work in cytology, cell biology and histology in Government Institution "Institute of Urgent and Recovery Surgery named after V. K. Gusak of the National Academy of Medical Sciences of Ukraine" (Donetsk, Ukraine).

## Enhancing Synthetic Scaffolds Biological Performance and Osteoinductive Properties Using Stem Cell-Derived Extracellular Matrix

**^IJoão C. Silva[1,2,3*], Marta S. Carvalho[1,2,3], Ranodhi Udangawa[3], Carla S. Moura[4], Joaquim M. S. Cabral[1,2], Cláudia L. da Silva[1,2], Frederico C. Ferreira[1,2], Deepak Vashishth[3] and Robert J. Linhardt[3]**

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### Abstract

The large numbers of bone fractures that require intervention in an aging population have increased the clinical demand for tissue-engineered bone. Bone tissue engineering (BTE) offers the possibility of creating new functional bone tissue by combining stem cells, biomaterial scaffolds and differentiation-inducing factors. Additive manufacturing techniques such as 3D melt-extrusion have been used to fabricate scaffolds for BTE applications, offering the advantage of a precise control over scaffold structural properties such as shape, size, porosity and mechanical strength. Electrospinning has also been used in BTE to fabricate fibrous and porous scaffolds mimicking the hierarchical organized fibrillar structure and architecture found in native bone extracellular matrix (ECM). However, these scaffold fabrication techniques often work with biocompatible and biodegradable synthetic polymers lacking bioactive sites and proteins, which hampers scaffold's biological performance. Recently, cell-derived ECM has been employed as scaffolds for tissue engineering, creating a biomimetic microenvironment that provides physical and biochemical cues for cell adhesion, proliferation and differentiation. Despite the enhanced bioactivity of cell-derived ECM, its application in the regeneration of hard tissues such as bone is still limited by its insufficient mechanical properties. In this study, we presented two different strategies combining mesenchymal stem/stromal cell (MSC)-derived ECM with synthetic biomaterials (i.e., polycaprolactone (PCL)) to fabricate scaffolds with enhanced osteoinductivity and appropriate mechanical support. MSC were seeded and expanded in 3D-extruded porous PCL scaffolds, followed by exposure to a decellularization protocol to produce MSC-ECM decorated 3D PCL scaffolds. In a different strategy, co-culture cell-derived ECM powders were combined with a PCL polymer solution and electrospun to fabricate cell-derived ECM PCL electrospun scaffolds. In both systems, cell-derived ECM scaffolds showed improved cell proliferation, mineralization and osteogenic gene expression in comparison to pristine scaffolds, highlighting the potential of this strategy to generate scaffolds with enhanced biological performance and osteoinductive properties for efficient bone repair.

## Biography

João Carlos Silva is a PhD student in Bioengineering: Cell Therapies and Regenerative Medicine working in a collaborative project between SCERG-iBB/IST – Universidade de Lisboa and Rensselaer Polytechnic Institute, NY-USA. His PhD work is focused on the development of novel scaffold-based bioengineering strategies for osteochondral regeneration. João holds a Master Degree in Biomedical Engineering from IST and worked one year as a research assistant in 3B's Research Group – Universidade do Minho. He is also author and co-author of 7 original research articles in international peer-reviewed scientific journals and 1 patent, and presented his work in over 10 international scientific conference meetings.

# *Chlorella vulgaris* and Tea Tree Essential Oil-based Biopolymeric Delivery Systems for Cosmetic Applications

**Flávia P. Morais[1*], Rogério M.S. Simões[1] and Joana M.R. Curto[1,2]**

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*[2]CIEPQPF, University of Coimbra, Portugal*

## Abstract

Significative growth of cosmetic products in which all the skincare compounds are biomolecules, biocompatible and biodegradable, constitute a request of an educated consumer, corresponding to a premium cosmetic segment. For this purpose, a cellulose-based delivery system was developed to retain biomolecules for dermic applications. The cellulose-based matrix was built with microfibrillated cellulose, carboxymethylcellulose and nanofibrillated cellulose combined with a crosslinking agent, the alginate, to obtain a 3D matrix capable to retain and release bioactive components of microalgae Chlorella vulgaris and tea tree essential oil. Cellulose based 3D matrices using nanocellulose have the unique advantage of being tailored designed for the retain, transport and delivery of different molecules. This support matrix was designed to retain the functional biomolecules, by optimizing the porosity and pore dimensions using 3D computational tools. The tea tree essential oil is a well-known source of benefic dermic molecules and the algae has important biomolecules and mineral salts. The biopolymers structures were characterized using SEM, FTIR-ATR, EDX, DSC. The oil and the algae components were successfully incorporated in a 3D polymeric matrix. The therapeutic biomolecules release profiles were quantified by DSC and FTIR-ATR analysis and the results indicated that the delivery system with algae promoted a controlled release of these molecules over a prolonged period when comparing with tea tree essential oil alone. The algae and cellulose-based delivery system proved to be an interesting option for dermic applications because the therapeutic biomolecules exposure time was improved, and this factor consists of a competitive benefic for dermic systems.

## Biography

Flávia P. Morais, B.Sc. (2015) and M.Sc. (2017) in Medicinal Chemistry, University of Beira Interior, and FibEnTech - Fiber Materials and Environmental Technologies. She developed her research in nanocellulose based porous systems and polymeric molecule delivery systems. Now, she is a Ph.D. student and researches the fibrous materials field, namely the optimization of cellulose based tissue materials and design of 3D structured biomaterials. Applies experimental methodologies to improve tissue materials application and 3D computational tools and image analysis for the structure's optimization.

## Glass Transition Temperature (Tg) by Molecular Dynamics Simulations

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[2]*Faculty of Automatic Control and Computer Engineering, "Gheorghe Asachi" Technical University of Iasi, Romania*

### Abstract

The glass transition temperature of polymers is correlated with various characteristics of the macromolecules. Flexible polymers have lower temperatures than the rigid ones. Flexibility combines together a few influence parameters: the polarity of the substituents and their distribution on the chain, the presence of hydrogen bonds and rigid cyclic structures. Other factors to be linked to the glass transition temperature are the molecular mass, the morphology, the size of the side chains, the size of substituents in the base chain, composition of the copolymer, cross-linking, degree of crystallinity and additions of micro- and macromolecular substances in the polymeric mass, namely additives.

The data reported in literature on transition temperatures subjects [1,2,3] can hardly serve to draw clear lines on the influence of each factor's contribution to glass transition. This drawback can be solved by modeling using molecular simulations and neural networks. The theoretical approach gives the advantage of treating separately the different factors that play a role in this kinetic phenomenon.

The objective of this work is to link thermal (macroscopic) properties that are experimentally accessible with static and dynamic microscopic properties. Knowing the characteristics that influence the glass transition temoerature, we simulate and optimize the transition modeling, aiming to make phenomenological estimations. To achieve this objective, we run atomistic molecular modeling studies in bulk using the Materials Studio software (Biovia).

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### Biography

Luiza Epure has completed her PhD in 2012 in Chemical Engineering at the "Gheorghe Asachi" Technical University of Iasi. She works as a Lecturer in the Department of Natural and Synthetic Polymers from Faculty of Chemical Engineering and Environmental Protection in Iasi, Romania. Her research focuses on polymer and computational chemistry.

## Multilayer Thin Films Based on Epoxy-amine Polymers and Ag Nanoparticles

**Ivan N. Senchikhin[1*], Vasilina A. Zakharova[1], Anna V. Zaitseva[1] and Elena S. Zhavoronok[2]**

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[2]*MIREA - Russian Technological University, Russia*

### Abstract

We report an approach to prepare thin metal-polymer films by spin-coating from solutions of a reactive epoxy-amine mixture in toluene and Ag nanoparticles (NPs). Composites were produced in two ways. In the first one, Ag NPs were synthesized in situ according to our approach [Senchikhin et al. // Colloid J. 2016], after that a hardener was introduced into the system and a reacting system was deposited on a wafer, spinned and cured. In the second case, nanoparticles were adsorbed on the polymer surface:

the wafer with the matrix was immersed in a dispersion of Ag NPs and held for a predetermined time. Then the wafer was dried and placed in a spin-coater to form the next polymer layer. The films were studied by SEM and AFM. The surface energy of the obtained films was calculated by the OWRK method from the data on the contact angles. As a result, we determined the factors and conditions for producing thin (up to 300 nm) metal-polymer films. We also investigated the possibility of forming both continuous and island-type films on various surfaces. The influence of temperature, rotation speed, the nature and concentration of the solution of the starting oligomers, the nature of the wafer (silicon, mica, glass, Al), as well as the way of introducing nanoparticles into the matrix on the growth and properties of the films was studied. As a result, an approach for creating planar-oriented polymer films, that are promising for creating new multilayer nanocomposites with gradient properties, is proposed.

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### Biography

Ivan Senchikhin is a senior research fellow at A.N. Frumkin Institute of Physical Chemistry and Electrochemistry, RAS (IPCE RAS), and the head of Physical Chemistry of Colloidal Systems Laboratory at the Institute. He obtained his Ph.D. from IPCE RAS under supervision of V.I. Roldughin. His research focuses on physical chemistry of polymer networks and metal-polymer nanocomposites. By employing physical and chemical methods of investigation and theoretical research, he develops new polymer materials and analysis techniques in order to study their supramolecular structure and behavior. His discoveries can pave the way for new polymer systems for biology, medicine and electronic applicatio

## On the Reversibility of 1,2,4,5-Tetrachlorobenzene Solubility in Low-density Polyethylene

**Andrey V. Basko[1], Konstantin V. Pochivalov[1], Yaroslav V. Kudryavtsev[2,3*]**

[1]*Krestov Institute of Solution Chemistry RAS, Russia*
[2]*Topchiev Institute of Petrochemical Synthesis RAS, Russia^I* [3]*Frumkin Institute of Physical Chemistry and Electrochemistry RAS, Russia*

### Abstract

It was argued in [Polym. Sci., Ser. A 2010, 52, 973-984] that the phase diagrams of semicrystalline polymer – low-molar-mass (LMM) substance systems should contain an additional boundary curve reflecting the temperature dependence of the LMM substance solubility in the amorphous polymer regions. Later it was demonstrated [J. Therm. Anal. Calorim. 2019, 138 2481–2489; J. Phys. Chem. B 2019, 123, 10533-10546] that this curve is essential since it allows one to formulate a physically clear picture of the structure evolution upon cooling down of pre-homogenized mixtures. Up until now, this curve could be plotted only from the temperatures corresponding to the disappearance of an LMM phase in the course of stepwise heating of initially two-phase systems. On cooling, the cloud point method allows one to build a polymer crystallization curve only. Phase separation that takes place below this curve cannot be detected in an already clouded sample. Differential scanning calorimetry cannot be used for this purpose as well, since the processes of polymer swelling and amorphization are calorimetrically indistinguishable. At the same time, reversibility of the solubility process requires that one should be able to plot the corresponding boundary curve from the cooling data. In this paper, we propose a way of using optical microscopy to plot out the solubility curve for low-density polyethylene – 1,2,4,5-tetrachlorobenzene mixtures undergoing cooling down from a homogeneous state. We obtain optical images of the system structure at various temperatures and discuss them in terms of the phase diagram constructed from stepwise heating experiments.

“The study was supported by the Russian Foundation for Basic Research (project 19-33-90008)”

### Biography

Yaroslav V. Kudryavtsev has obtained his Ph.D. in 1997 from the Lomonosov Moscow State University, passed Habilitation in 2005 at the Semenov Institute of Chemical Physics, and become a professor of the Russian Academy of Sciences in 2016. He is the head of the Laboratory for Polymer Modification at the Topchiev Institute of Petrochemical Synthesis in Moscow. Yaroslav’s scientific interests are focused on studying

## Identification of Unknown Plastic Wastes and Their Distribution Away from Nigerian Landfills

**Osita Wilfred*, Vera Fitzsimmons-Thoss and Paula Roberts**

*School of Natural Sciences, Bangor University, UK*

### Abstract

The increase in the production of plastics has led to an upsurge in the global challenge emanating from their end of life. This is because most of the mixed plastic wastes end up as pollutants in marine and terrestrial ecosystems, making them difficult to recycle. The disruptive effects of plastics have been identified as a threat to wildlife and food webs because lack of knowledge of plastic composition in the environment and their degradation is yet limited. Identification of various type of plastics becomes necessary if effective solid waste management should be practised and sustained. Presently, there are different techniques widely used for plastic identification and separation such as thermal desorption, gas chromatography-mass spectrometry (GC/MS), Raman, Fourier-transform infrared spectroscopy (FT-IR), and X-ray fluorescence (XRF) but FT-IR Spectroscopy seem to be most preferred to study plastics because it is accepted for characterising all plastics types with less sample preparation. Therefore, in this study, FT-IR spectroscopy was employed in identifying 350 unknown plastics wastes plastics sampled from three landfills in Owerri, Nigeria and their distribution away from the landfills. FT-IR spectra obtained from known plastics were recorded and used to establish the similarity with unknown plastics. Results revealed that PP (36%), PET (27%), and PE (25%) were the most abundant plastic polymer wastes from the landfills. However, the weight of the plastic wastes significantly influenced their movement away from the landfill sites ($p<0.05$), with the lighter ones seen further away. We conclude that the FT-IR technique identified and picked up the frequency peaks of most of the plastic wastes from the landfills hence, it is a good instrument to employ for plastic identification

## Enhanced Flowability of Polycarbonate by Addition of Another Polymer

**Y. Tanaka*, P. Phulkerd and M. Yamaguchi**

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### Abstract

The structure and rheological properties for binary blends of polycarbonate (PC) and polystyrene (PS) were investigated using various PS samples with different molecular weights, such as PS-1k (Mw = 1000), PS-53k (Mw = 53000) and PS-240k (Mw = 240000). Although it has been well known that a conventional PS is immiscible with PC, the blend with PS-1k is found to be miscible from the dynamic mechanical properties and scanning electron microscopic observation. Moreover, it should be noted that the shear viscosity decreases greatly by the addition of PS-53k and PS-240k especially in the high shear rates, whereas the viscosity of the miscible blend with PS-1k is low in the low shear rates. The origin of this significant viscosity drop in the high shear rates occurred for the immiscible blends is investigated from the viewpoint of the polymer-polymer interfacial slippage. The non-linearity, i.e., dependency of oscillatory strain amplitude on the primary component of shear loss modulus, was evaluated using the multi-layered samples composed of PC and PS-240k by a parallel-plate rheometer. It is found that the non-linear response is detected at a small strain amplitude for the multi-layered sample. This non-linear response is presumably attributed to the interfacial slippage between PC and PS. We also examined the slippage on the die wall by changing the dies and find that no slippage occurs on the surface of a die. These results indicate that the marked viscosity drop in the high shear rates is originated from the interfacial slippage between PC and PS.

### Biography

Mr. Yuki Tanaka received the B. E degree in Integrated science and engineering from Shimane University, Japan, in 2018. He is now a master course student of JAPAN ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY, Japan. His research interest includes polymer processing and rheology.

## Mechanical and Optical Properties of Biomass-based Polycarbonate

**Maho Miyashita*and Masayuki Yamaguchi**

*School of Materials Science, Japan Advanced Institute of Science and Technology, Japan*

## Abstract

Polycarbonate (PC) is widely employed in industrial fields. Conventional PC, that is made from petroleum-based bisphenol A (BPA-PC), has high transparency, good mechanical toughness, and heat resistance property. In contrast, the modulus and surface hardness in the solid state are not good enough to widen its application. In addition, its monomer unit has high optical anisotropy. Therefore, a product obtained by injection-molding exhibits a high level of optical retardation.

Isosorbide (ISB), that can be produced from renewable resources such as glucose, has been used as a monomer for various plastics in recent years including isosorbide-containing polycarbonate (ISB-PC). ISB-PC has superior optical properties such as good transparency and low birefringence both in the glassy and rubbery states compared with BPA-PC. In particular, the stress-optical coefficient (SOC) in the glassy state, the ratio of birefringence to stress, of ISB-PC is much lower than that of BPA-PC, which is a great benefit for optical films used in high-quality LCD displays.

In this study, we revealed that the SOC in the glassy state is further reduced by the moisture absorption of the ISB-PC itself. Furthermore, the rheological properties of ISB-PC were also investigated in both solid and molten states, as compared with those of BPA-PC. The elastic modulus in the glassy state is found to be much higher than that of BPA-PC, which is also important for industrial applications. Moreover, the plateau modulus in the rubbery region seems to be lower than that for BPA-PC, suggesting that ISB-PC has higher molecular weight between entanglement couplings.

## Biography

Maho Miyashita is having her Master degree in Materials Science at Japan Advanced Institute of Science and Technology and had her Bachelor degree in Agriculture at Hokkaido University, Japan. Her Research interest are Rheological and optical properties of bio-based polymers.

# Structure and Properties of Polypropylene Containing Poly(Vinyl Alcohol) Fibers

**Riho Nishikawa[1*], Norifumi Aridome[2], Naoki Ojima[2], Panitha Phulkerd[1] and Masayuki Yamaguchi[1]**

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## Abstract

Fiber reinforced plastics have been studied for a long time in plastic industries. In the present study, we focused poly(vinyl alcohol) (PVA) fiber because it has a great potential to provide extremely high modulus and strength. However, PVA is known to be immiscible with most conventional plastics due to its hydrophobicity and unavailable for melt processing due to the strong hydrogen bonding. Therefore, research and development on blends with a conventional plastic obtained by melt-mixing have not been carried out extensively. We proposed a novel technique to produce polypropylene (PP) composites containing PVA fibers by introducing PVA aqueous solution into a molten PP directly in a twin-screw extruder with a vent. The vent region was wide to remove moisture in the extrudate. The obtained PP/PVA (90/10) pellets were injection-molded into dumbbell-shape products. It was found that the PVA fibers, which showed nucleating ability for PP, aligned parallel to the flow direction, and therefore it greatly increased the orientation of PP chains. The high modulus of PVA fibers and enhanced molecular orientation of PP induced by the PVA fibers enhanced the modulus and strength to a great extent with a good heat-resistance.

## Biography

Riho Nishikawa is a PhD candidate of Yamaguchi laboratory in JAIST, Nomi, Ishikawa, Japan from April, 2018. She had her Master degree in Pharmaceutical science in Kanazawa university in March, 2018 and Bachelor degree in Pharmaceutical science in Kanazawa university in March, 2016.

## Material Design of Polyamide Resin to Control the Adhesive Strength with Metal

**Ryo Takatani*, Panitha Phulkerd and Masayuki Yamaguchi**

*Japan Advanced institute of Science and Technology, Japan*

### Abstract

Polyamide 6 (PA6) is known to show good mechanical properties with strong adhesion with a metal. Recently, we found that the addition of a metal salt increases the glass transition temperature greatly, although the blend shows strong moisture absorption. In the present study, we evaluated the effect of the lithium bromide (LiBr) addition on the adhesive strength with a metal plate. LiBr was added to PA6 in a molten state by an internal mixer. The blend sample was inserted into two aluminum plates and heated at 250 °C for 2min. Then the lap-shear test was carried out to measure the adhesive strength. Furthermore, the effect of moisture absorption on the adhesive strength was evaluated by storing the laminated samples in a temperature and humidity chamber at 25 °C at 50% relative humidity. It was found that the adhesive strength between aluminum plates and PA6 is high enough to show the cohesive failure of PA6. The same result was obtained for the sample containing 10wt% of LiBr. After The storage in the humid condition, however, the adhesive strength of PA6 with LiBr decreased greatly to show adhesive failure. This result was attributed to the moisture absorption. The absorbed water molecules are presumably incorporated between PA6 and the aluminum plate and therefore weakens the electrostatic interaction.

### Biography

Mr. Ryo Takatani received the B. E degree in engineering from Kyushu Sangyo University, Japan, in 2018. He is now a master course student of JAPN ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY, Japan. His research interest includes material design of polyamide-based functional polymers.

## Thermoplastic Starch Foams Reinforced with Silylated Starch and Cotton Fibers

**Bruno Felipe Bergel[1], Ludmila Araujo Leite[1], Luana Machado da Luz[1], Ruth Marlene and Campomanes Santana[1]**

*Polymeric Materials Lab, Materials Engineering Department, Federal University of Rio Grande do Sul, Brazil .*

### Abstract

^IDisposable food packaging made from expanded polystyrene (EPS) is usually discarded after use and because it is a difficult material to recycle, generates a large amount of waste. The EPS can be replaced by thermoplastic starch (TPS) foams, which are made from renewable sources and are biodegradable. However, TPS foams are brittle and absorb large amounts of water, which makes it difficult to use. An alternative to these problems is to chemically modify the starch to make it more hydrophobic and add vegetal fibers to reinforce it and to make it tougher. The purpose of the modification is to exchange starch hydroxyl groups for less polar groups such as silane groups. Silicon compounds are well established in polymeric chemistry. The silylation of polar functional groups leads to a noticeable increase in their lipophilic behavior, as well as a drastic increase in the thermal stability of molecules. In this work the starch was silylated using methyltrimethoxysilane (MTMS) and cotton was added to enhance the mechanical properties of the foams. The foams were made using four materials: modified starch, gelatinized starch, polyvinyl alcohol (PVA) and cotton. The addition of cotton improved flexural strength, making the foams less brittle. While the flexural strength of the TPS was 1.15 MPa, the TPS with silylated starch and cotton presented resistance of 4.48 MPa. The water absorption test showed that modified TPS foams absorbed 31 g water/100 g solids while normal TPS foams absorbed 75 g water/100 g solids, which represents an improvement in water resistance.

### Biography

PhD student in Materials Science and Technology at the postgraduate program in Mining, Metallurgical and Materials Engineering (PPGE3M) – Federal University of Rio Grande do Sul (UFRGS). Master in Materials Science and Technology from the postgraduate program in Mining, Metallurgical and Materials Engineering (PPGE3M) - UFRGS. Graduated in Industrial Chemistry from the University of Santa Cruz do Sul (2014). Has experience in Materials Science with emphasis on biodegradable polymers and polymer composites.

## Dual Crosslinkable Alginate-based Hydrogels by Riboflavin Photoinitiator

**Eunu Kim*, Bo Min Hong, Su Bin Bae, Jeena Lee and Won Ho Park**

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### Abstract

Riboflavin, a water-soluble vitamin $B_2$, is widely located in natural environments. It has the maximum absorption wavelengths in the UV and visible region (220-450 nm) and has advantages such as nontoxicity and environmental friendliness. It is a light-sensitive compound that forms several photodegradation products due to its chemical structure when irradiated by UV or visible light. Its photochemical mechanism was analyzed by UV-Vis spectrophotometer. Alginic acid (Alg) is a linear polysaccharide that can easily form hydrogel by ionic bonding, and is widely applied in the field of biomaterials due to its excellent biocompatibility. The $CaCO_3$/GDL system was used as ionic crosslinker to induce homogeneous ionic-crosslinking. In this respect, water-insoluble $CaCO_3$ can be used to impede the ionic crosslinking rate, instead of $CaCl_2$. However, Alg has a low structural stability in the physiological environment due to dissociation of ionic bonds. In order to overcome this disadvantage of Alg hydrogels, covalent crosslinking was introduced to improve their physiological stability.

In this study, the photo-crosslinkable phenol groups were introduced to Alg via a coupling reaction of EDC/NHS chemistry, and Alg hydrogel was prepared by photo-crosslinking between phenol groups in the presence of riboflavin photoinitiator. In addition to ionic crosslinking, the dual crosslinked alginate-tyramine hydrogels were prepared. These single/dual crosslinked alginate-tyramine hydrogels were compared using rheometer, texture analyzer and SEM.

### Biography

Eunu Kim is a master course graduate student and Won Ho Park is an advising professor in Chungnam National University. Current research areas of interest focus on: 1) Stimuli-responsive hydrogel (thermo-, photo-, pH-, ion-sensitive hydrogels); 2) Biopolymer-based tissue engineering scaffolds for skin & bone regeneration; 3) Photo-crosslinkable hydrogels for 3D bioprinting and Cell-printing.

## Mussel-inspired Poly(allylamine)/laponite Composite Hydrogels With Self-Healing Property

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### Abstract

Hydrogels are three-dimensional polymer networks containing a large amount of water, which can be crosslinked chemically by forming covalent bonds or physically by non-covalent interactions. Due to their similarity to extracellular matrix, hydrogels with good biocompatibility have attracted interest in variety of fields including drug delivery, tissue regenerative medicine. Among them, self-healing hydrogels retain their existing structure and mechanical properties even after damage to the interface due to reversible actions. Poly(allylamine hydrochloride)(PAH) is a kind of cationic synthetic polymer with one primary amine on each repeat unit. It has good solubility in water and is mainly used in paper making and coating industry because of its excellent physical properties. 3,4-Dihydroxyhydrocinnamic acid (HCA) was coupled to PAH to mimic the mussel adhesive proteins. By pH control, the catechol group is converted into the o-quinone form as it is oxidized. Therefore, PAH-based self-healing hydrogels were fabricated by the dynamic Schiff-base linkages between amine groups of PAH and catechol-quinone of HCA. The addition of laponite also improved the mechanical properties of the hydrogel and enhanced self-healing properties due to electrostatic interaction. In this study, the structural changes of HCA-modified PAH were examined by $^1$H-NMR. From these results, the PAH-HCA was successfully synthesized. The imine bond formation and self-healing ability of PAH-HCA hydrogels were confirmed through ATR-IR, XPS and rheometry. Also, the rheological and mechanical properties of self-healing hydrogels were investigated according to the adding amount of laponite.

### Biography

J. N. Lee is a master course graduate student and W. H. Park is an advising professor in Chungnam National University. Current research interests focus on: 1) Biopolymers (alginate, chitosan, hyaluronate, silk fibroin, poly(γ-glutamic acid), cellulose); 2) Hydrogels (stimuli-responsive, enzyme-mediated, polyelectrolyte complex, self-healing); 3) Tissue engineering scaffolds (nanofibrous web, tissue adhesives, 3D bioprinting)

## Glycidyl Methacrylate (GMA)-Modified Silk Fibroin Nanofibrous Webs with Dual Crosslinking

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### Abstract

Silk fibroin (SF) is a natural fibrous protein produced by bombyx mori, antheraea, cricula, samia and other insects. The advantage of SF is excellent biocompatibility, biodegradability, and physical/mechanical properties. It is applied to biomaterials and natural reinforcement materials for biocomposites. However, there is a problem that processing is difficult because melt processing is impossible. Therefore, SF can be dissolved using a limited complex solvents ($CaCl_2$/EtOH/$H_2O$ etc.) to regenerate it. The regenerated SF solution can be prepared in various forms such as powders, fibers, films and hydrogels. In this study, water solubility of SF was significantly improved by modifying glycidyl methacrylate (GMA) in its side chains ($-NH_2$, -OH, -COOH). Therefore, eco-friendly electrospinning of SF was performed using distilled water as a solvent. Optimal conditions were established by adjusting the electrospinning parameters such as polymer concentration, applied voltage, flow rate, needle gauge and spinning distance. The physical crosslinking of SF was obtained by transferring random coil to the beta sheet structure. Furthermore, tyrosine residues in SF were chemically crosslinked by forming di-tyrosine crosslinks between tyrosine via light irradiation in the presence of a photoinitiator. Therefore, the mechanical strength of regenerated SF nanofibrous webs was improved by dual crosslinking systems.

### Biography

Su Bin Bae is a master course graduate student and W. H. Park is an advising professor in Chungnam National University. Current research interests focus on: 1) Biomaterials (silk fibroin, alginate, chitosan, cellulose, hyaluronate, poly(γ-glutamic acid)); 2) Biopolymers applications (tissue engineering scaffolds, wound dressing materials, tissue adhesives, dermal filler, 3D printing bioink); 3) Green chemistry (bio-mimetic materials, eco-friendly electrospinning process and functional nanofibers, hydrogels).

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## Hyaluronate/Tyramine Photo-crosslinkable Hydrogel for Dermal Fillers

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### Abstract

Hyaluronic acid (HA), or hyaluronan, is a linear natural polysaccharide composed of D-glucuronic acid and N-acetyl glucosamine. HA is a non-sulfated glycosaminoglycan (GAG), an essential component of the extracellular matrix (ECM) in many parts of the body, which exhibits excellent viscoelastic property, favorable biocompatibility, and biodegradability. Because of these unique properties, HA has been widely used in biomedical applications such as an aesthetics, wound healing, drug delivery, and tissue engineering scaffolds. The use of injectable materials as a dermal filler for tissue repair has been increasing worldwide. Among them, HA currently occupies most of the dermal filler materials market, and its demands are increasing. However, currently available tissue repair materials use chemical crosslinkers such as BDDE and DVS for structural stability, which can cause side effects such as inflammation and edema due to remaining crosslinkers when injected into the body. Therefore, in this study, tyramine (Tyr) was introduced to provide photo-crosslinking ability to HA, and a photo-crosslinkable hydrogel was prepared using a low toxic vitamin $B_2$ derivative as a photoinitiator. Phenol-modified HA was prepared by EDC/NHS chemical reactions that induce a coupling reaction between the carboxylic group of HA and the amine group of Tyr. The rheological and mechanical properties of the HA-Tyr were analyzed according to various parameters (polymer and photoinitiator concentration, irradiation time). Also, the biological stability and biocompatibility of HA-Tyr hydrogel were examined via in vitro test.

### Biography

Bo Min Hong is a master course graduate student and W. H. Park is an advising professor in Chungnam National University. Current research interests focus on: 1) Biopolymer modification (Alginate, chitosan, hyaluronate, silk fibroin, poly(γ-glutamic acid) and cellulose); 2) Stimuli-responsive hydrogel (radiation, enzyme, temperature, pH, redox and ion); 3) Biomedical materials (tissue engineering scaffolds, wound dressings, dermal fillers, drug delivery, 3D bio-printing, electrospun nanofibrous web and tissue adhesives).

## Electrochemical Catalytic Activity Metallophthalocyanine Functionalized With Graphene Quantum Dots: A Density Functional Theory Approach

**Nguyet. N. T. Pham* and Seung Geol Lee**

*Department of Organic Material Science and Engineering, Pusan National University, Republic of Korea*

### Abstract

Growing worldwide demand for energy has seen the development of energy storage and conversion technologies accelerate. Among various technologies, the polymer electrolyte membrane fuel cell (PEMFC) is a potential device that only produces water as a waste product. The efficiency of polymer electrolyte membrane cells (PEMFCs) depends highly on the rate of the oxygen reduction reaction (ORR). Metallophthalocyanine (MPc) complexes are attractive since their electrocatalytic performance can be tuned by using the different transition metal, the structure of the complex, the C-support matrix, and the oxidant that affects the outcome of the oxidation. In this study, we investigated the effect of graphene quantum dot (GQD) in MnPc and FePc on ORR activity by using density functional theory (DFT). Through all calculations, both MnPc, FePc single-atom-catalyst and GQD-supported these MPcs would be able to facilitate four-electron oxygen reduction mechanisms suitable to apply for efficient non-precious electrocatalyst of PEMFC. Moreover, during two possible oxygen reduction reaction (ORR) mechanism, associative is the energy favorable route with OH* formation is the rate-limiting step in FePc/GQD, meanwhile, the formation of OOH* is the rate-determining step in all three remaining systems. Furthermore, FePc/GQD is the potential alternative non-PGM catalyst that has the highest cell potential as nearly high as the potential (0.79 V) of Pt/C catalyst in oxygen reduction reactions. We concluded GQD is a strong C-support-matrix for high-efficiency catalysts and FePc/GQD is a potential candidate for use in PEMFCs.

### Biography

Nguyet N.T.Pham received the B.S. degree from University of Science, Ho Chi Minh, Vietnam, in 2015. She is currently pursuing her M.S and Ph. D. degree in Department of Orgranic Material Science and Engineering, Pusan National University, Busan, South Korea. Her present research interests are in the areas of energy storage materials, especially catalysts on polymer electrolyte fuel cells.

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## Weight Reduction and Dyeing Properties of Sea-Island Type Ultramicrofiber PET/co-PET Tricot Disperse Dyes

**Jeong Min Kang and Seung Geol Lee**

*Department of Organic Material Science and Engineering, Pusan National University, Republic of Korea*

### Abstract

Artificial leather has been developed as a substitute for natural leather because of the high demand for high-quality products in automobile interiors. Currently, PET is used as a substitute due to its excellent light resistance. In this study, we conducted alkali hydrolysis on sea-island type PET ultramicrofiber tricot fabric with disperse dyes. The optimal alkali hydrolysis treatment condition was set to 25 %omf NaOH with a treatment time of 30 mins at 100 °C. The dyeing conditions were investigated with various dye contents (0.03~0.06 %omf), dyeing temperature (100~135 ℃), dispersant contents (1~9 g/l), UVabsorbent contents (1~5 %omf) and reduction cleaning process conditions for beige color. The dyeability of the PET tricot fabric was evaluated by Munsell color order system, CIE L*a*b* and color strength (total K/S in 360~740 nm with 20 nm interval). We obtained that washing colorfastness, light colorfastness and rubbing colorfastness of dyed sea-island type PET tricot fabrics were achieved to 4-5 grades.

### Biography

Jeong Min Kang received the B.S. degree from Dong-Eui University, Busan, South Korea. She is currently pursuing her M.S. degree in Department of Organic Material Science and Engineering, Pusan National University, Busan, South Korea. Her present research interests are in the areas of polymers and fibers applications.

## Lignin Based Electrospun Fibers

**Turganbay Anar[1,2*], Nazhipkyzy Meruyert[1,2], Lesbayev Bakhytzhan[1,2], Geoffrey Robert Mitchell[3] and Naurzbayeva Gulmira[1,2]**

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*[2]Institute of Combustion Problems, Almaty, Kazakhstan*
*[3]Polytechnic Institute, Leiria, Portugal*

### Abstract

The increasing use of fossil fuels, coupled with increased awareness of our environmental impacts, has led to increased interest in using sustainable resources for new materials and energy sources. We used our own approach to the topic of using lignin for future applications. Experimental works were carried out in according to 2 methods. The first method, although it is more effective, is not desirable, for two reasons. Firstly, the process is very long (8 hours) and requires the preparation of 3 different solutions, one of which is extremely unstable. Secondly, reason is the problem of nanofilter sediment screening, which can be completely, neglected using the second method. The second method has many advantages. For instance, we can produce more lignin (the mass of lumber used with the same amount of solution is 4 times greater) in short time (~ 3 hours compared to 8 hours). The only solvents used in this method are 2 organic acids, which are stable and the extraction process is also much faster. To extract lignin, it was used different kind of sawdust – originated from pine wood and from not classified trees. There was performed an Infra Red analysis of extracted sample to determine if the experiment carried out as expected. Comparing the experimental spectra to the one acquired by Boeriu et al. the most characteristic peaks for lignin are visible in our sample (most important being: wide peak in ~3400 and characteristic peaks at 2920 and 1720).

### Biography

I am Turganbay Anar Burkhatkyzy, was born on October 19, 1993. I am a Kazakh.

In 2011, I entered to the Al-Farabi Kazakh National University, on specilaty “5B072000 Chemical Technology of Inorganic Substances”. Winner of the international scientific conference of students and young scientists “FARABI ALEMI 2015”. After in 2015, I entered to the Al-Farabi Kazakh National University, on specilaty “6M072000 Chemical Technology of Inorganic Substances”. In 2018, I entered the doctoral program in the specialty “6D074000 - Nanomaterials and nanotechnologies”. I have written 9 articles (one of them on the Scopus Data Base) and theses.

## Additive Technology for Energy Materials

**Naurzbayeva Gulmira [1,2*], Nazhipkyzy Meruyert[1,2], Geoffrey Robert Mitchell[3] and Turganbay Anar[1,2]**

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*[3]Polytechnic Institute, Leiria, Portugal*

### Abstract

Additive technologies are called the technology of creating products with difficult geometric shapes due to layer-by-layer synthesis or layer-by-layer growing of products using a digital 3D model.

A distinctive feature of traditional technologies is the manufacture of parts by subtracting material from the work piece; in a 3D printer, parts are built by adding material layer by layer to obtain the finished product.

This work shows the ability of 3D printing of thermite-based energy material that can be used as part of a multifunctional reactive structure. Analyzing the data, a mixture was selected consisting of a thermite mixture Al: $Fe_2O_3$, and nitrocellulose as a binder. The energy efficiency of this mixture will be high, since both components are high-energy compounds.

In our case, a printing system for printing ceramic mixtures is more suitable for printing, since when printing is not carried out by fusing polymers to each other. 3D inkjet printing requires a stable slurry with controlled rheology that flows easily, does not clog in the nozzle and has an effective drying process.

For printing we used a 3D printer made in China by Anet A6. Initially, it is a 3D printer with FDM printing technology. But for scientific activity, its design was slightly changed. The reactivity and burning rates of printed samples were investigated.

### Biography

I am Naurzbayeva Gulmira Markhabayevna, was born on May 20, 1987. I am a Kazakh.

In 2005, I entered to the Al-Farabi Kazakh National University, on specilaty “050731 “Life safety and environmental protection””. After in 2011, I entered to the Al-Farabi Kazakh National University, on specilaty “Ecology”. Winner of the international scientific conference of students and young scientists “FARABI ALEMI 2011”. In 2017, I entered the doctoral program in the specialty “6D073400 - Chemical technology of energetic materials”. I have written 18 articles (one of them on the Scopus Data Base) and theses.

## A New Recycling Method for Polyanion-based Thermal Insulator Composites

**Matteo Cibinel[1*], Giorgia Pugliese[1], Davide Porrelli[2], Lucia Marsich[1], Vanni Lughi[1]**

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[2]*Department of Medicine, Surgery and Health Science, University of Trieste, Italy*

### Abstract

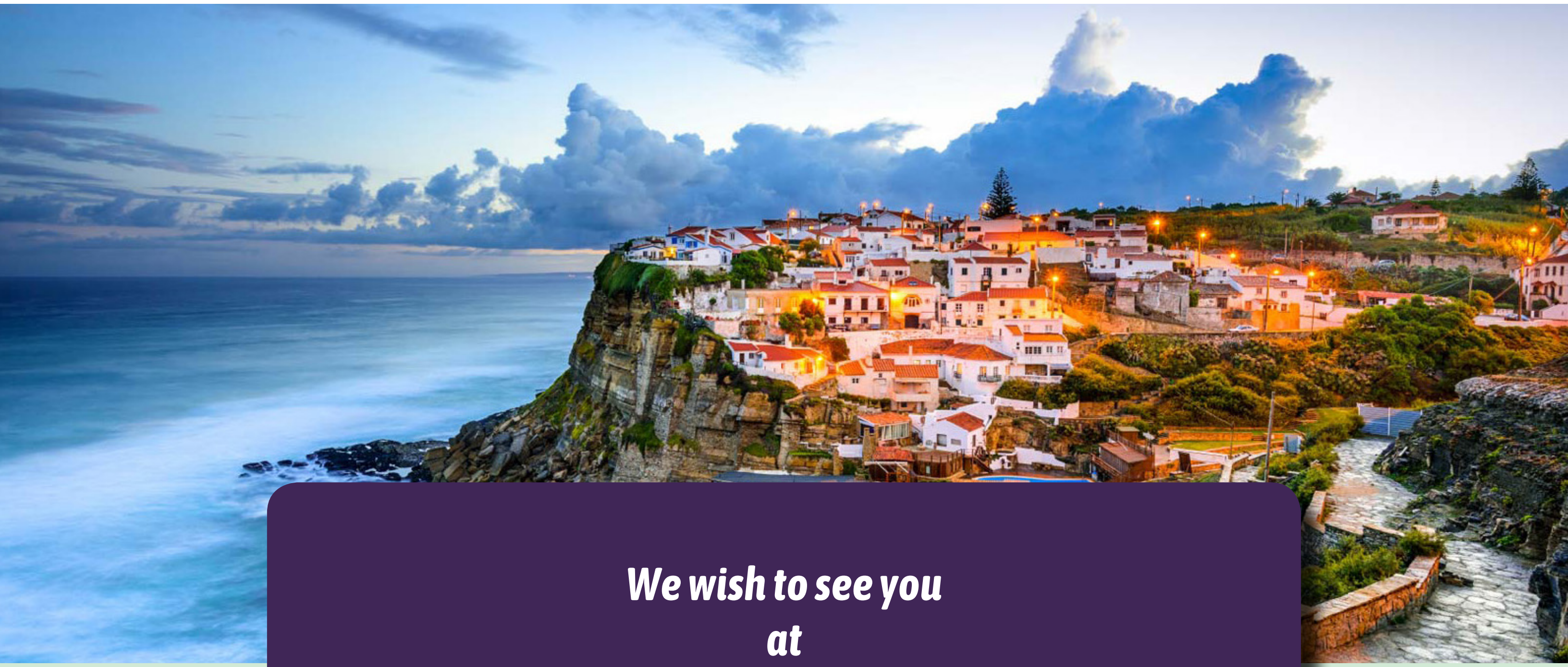
Biopolymer-based materials are an attractive alternative to conventional thermal insulation systems thanks to their reduced environmental impact and natural availability. In particular, polysaccharides such as cellulose chitosan and alginate are being extensively studied as binderagents in composites or as aerogels mainly due their biodegradability. A number of researchers have already explored the use of alginates as thermal insulator material; however, a drawback is the fact that disposal seems to be only available end-of-life option. This unprofitable scenario is even more critical for the case of polysaccharide-based composites specifically developed to recycle industrial waste. In this work, we present a recycling process for an alginate-based thermal insulation foam, in which the original material is fully recovered and the thermal and acoustic insulation performances are maintained. The original foam is produced with a patented process [1][2] in which alginate is used as the host poly-anionic matrix for industrial fiberglass waste. Upon addition of a cation (calcium), the alginate is capable of forming a gel via ionotropic gelification due to electrostatic interaction with its negatively charged backbone. The dried foam is finally obtained by freeze-drying. The recycling process start with the addition of a water solution of a chelator (Ethylenediaminetetraacetic acid disodium salt, EDTA-2Na) which possess a higher affinity toward the cation. This results in the cation chelation and in the disassembling of the original-material alginate matrix; a homogeneous solution is thus obtained. Upon deactivation of the chelator via acidification, the cations become available to crosslink the polymer. With a subsequent freeze-drying step, the recycled foam is re-obtained. As a proof of concept, we have used alginate as the polyanion; however, in principle, any composite material based on a matrix made via ionotropic gelification can be recycled with this process.

[1] G. Kyaw Oo D’Amore et al., “Innovative thermal and acoustic insulation foam from recycled waste glass powder,” J. Clean. Prod., vol. 165, pp. 1306–1315, 2017.

[2] M. Caniato and A. Travan, “Method for recycling waste material,” EP Patent 16425023.5, 2016.

### Biography

I´m a third year PhD student at the Nanotechnology school of Trieste. In 2017 I earned my master degree in Material Engineering from the University of Trieste. During the first years of my studies I´ve become interested in material related problems of the biomedical area, which I was able to explore during my MS and BC thesis. More recently, I gained personal interest in energy related problems and green technology. Because of that, I have decided to deepen my studies through a PhD. My research is focused on developing a green nano-composite material with tailored fire resistant and thermal insulating properties.



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