Issue 6, June 2019

European Network of Materials Research Centres

NEWSLETTER

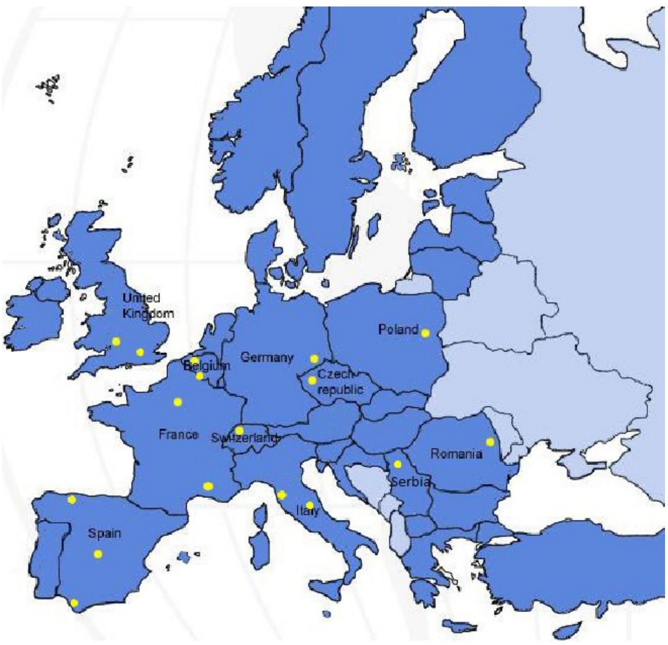
Breakthrough of new Networking between European Materials Research Centres

Welcome

Welcome to the sixth issue of ENMat Newsletter. ENMat has been founded in September 2005, to create a powerful network of leading Materials Research Centres in Europe. We expect to stimulate beneficial interdisciplinary activities between members of the network as well as to increase the efficiency of the transfer of results from R&D to industry. We also expect to improve opportunities for participation in activities in the frame of EU supported projects.

26th ENMAT meeting and COMAT congress, Pilsen, Czech Republic

Highlights in this Newsletter



Members

- Institute Mines Telecom (IMT), Centre des Matériaux des Mines d'Alès (C2MA), École des Mines d'Alès, Alès Cedex, France
- Centre for Materials Science and Engineering (CISIM), University of Pisa, Pisa, Italy
- Centre for Materials Science and Engineering (CMSE), Ghent University, Ghent, Belgium
- Czech Society for New Materials and Technologies (CSNMT), Prague, Czech Republic
- Department of Materials, University of Birmingham, UK
- Empa - Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland
- Fraunhofer Institute for Ceramic Technologies and Systems (IKTS), Dresden, Germany
- Institute of Research on Electron Microscopy and Materials (IMEYMAT), University of Cádiz, Spain
- Laboratoire national de métrologie et d'essais (LNE), Paris, France
- Materials Design Division, Warsaw University of Technology (WUT), Warsaw, Poland
- "Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania
- Universidad Complutense de Madrid, Madrid, Spain
- University of Westminster, London, UK
- PROLABIN & TEFARM, SME, ex-spin-off company of the University of Perugia, Perugia, Italy
- Materia Nova, University of Mons, Mons, Belgium
- University of Novi Sad, faculty of Technology, Novi Sad, Serbia
- Institute of Chemistry of Organo Metallic Compounds (ICCOM)-CNR, Pisa,Italy

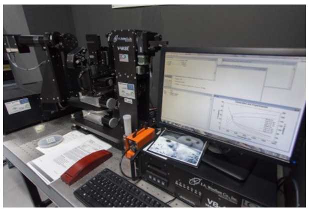
ENMat Members - IMEYMAT

The aim of the IMEYMAT is to combine and share efforts, resources and ideas, to become a benchmark centre in topics of material research and especially, in the development and application of techniques based on TEM and SEM microscopy as a fundamental tool in their study. The members of the Institute collaborate with researchers and technologists from public centres and professional from the industry, committed to local and regional development, with international vocation. The University of Cádiz is a reference institution in electron microscopy due to the value of its instrumentation facilities; the high impact capacity, experience, and productivity of its scientists; and its network of active and fluid contacts with leading groups in the application of these techniques worldwide. This uniqueness is considered to be the most distinctive feature of the Institute of Research on Electronic Microscopy and Materials (IMEYMAT). We focus on doing synergies for the development of materials: in this specialized and interdisciplinary Institute, scientists from fields of Chemistry, Solid State Physics or Material Science and Engineering, work together to apply electron microscopy, as well as other complementary techniques (optical, scanning probe and scanning electrochemical microscopy; and physical-chemical characterization by other methods). These studies include pre-preparation techniques for solid samples, and computation for modelling, simulation, or image analysis.

FEI TITAN3 Themis 60-300 TEM Microscope.

The generation of nanofluids for heat or coolant transfer, photovoltaic and photocatalysis technology that uses the properties of nanostructures, state-of-the-art methods of environmental catalysis for the treatment of air or water pollution and in catalysis for the production of clean energy, production of electrodes and biosensors based on nanoparticles, electronic engineering of synthetic diamond, of carbon nanotubes, of thin semi-conductor layers or by means of the nano-mechanization of materials with ion beams, synthesis of biomaterials with silica aerogels and purification with hydrophobic gels, or additive manufacturing, integrating materials such as graphene into polymeric matrices for 3D printing are the main lines of research of the IMEYMAT Institute.

The IMEYMAT researchers have privileged access to state-of-the-art facilities and laboratories valued at about 30M€, that include direct management features in the form of Peripheral Research Services, and equipment and instruments that scientists in the divisions of “Electronic Microscopy”, “Laboratory for the Preparation of Solid Microscope Samples”, “Photoelectronic Spectroscopy” and “Additive Manufacturing” of the Scientific Research and Technology Central Service (SC-ICYT) of the UCA are responsible for. They are also able to use the “X-Ray Diffraction” and “Atomic Spectroscopy” divisions of the Central Facilities (SC-ICYT); and of the Supercomputing Cluster of Research Support (CAI) of the UCA.


Optical multimode profilometer, Zeta, Model Zeta300


Sample preparation laboratory.

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ENMat Members – UOB

The School of Metallurgy of Materials sits within the College of Engineering and Physical Sciences (EPS) at the University of Birmingham (UoB). Metallurgical studies at Birmingham dates back to 1881 when the first students were registered for an option in Chemistry in the Mason Science College in the City, with a separate Department of Metallurgy created in 1887. This was consolidated when the College became a University in 1900.

The School is currently ranked in the top 5 UK universities for materials and mineral engineering undergraduate studies by The Guardian University Guide (2019) and a top 100 university for materials science in the QS World University Rankings (2019). At postgraduate level, there is a comprehensive choice of research degrees: MRes, PhD and EngD, with a wide range of generous scholarships available in all research areas. These research programmes are supported by outstanding academic, research and professional services staff, a superb range of equipment and facilities, and excellent links to industrial partners.

The School of Metallurgy and Materials had a reputation in physical metallurgy and the famous ‘Cottrell atmosphere’ theory was developed by Sir Alan Cottrell in 1940s within the School. This has led to our strength in metallic materials and processing. Now, the School encompasses a wide range of research interests in the processing, characterisation, assessment and modelling of materials and is considered to be the leading School for many areas of metallurgical research. Research is organised within four key themes:

- Advanced Materials Processing

Driven by innovation in manufacturing methods, our work focuses on application in industry. Our extensive capability includes additive manufacturing, solidification technology and thermomechanical processing via experimental and modelling techniques.

- Materials for a Sustainable Future

Our interests focus on technologically relevant energy materials, their modelling, characterisation and recyclability.

- Multifunctional Materials and Devices

We develop smart materials with wide ranging applications from consumer electronics to biomedical applications. Our expertise includes composites, functional ceramics, polymers and surface engineering.

- High Performance Materials and Extreme Environments

Driven by the behaviour of materials during their life cycle, we have expertise in structural integrity, in-service degradation and the evolution of material properties & microstructure across a range of length scales.

Continual investment is made in key research activities and collaborations, with internationally-renowned partners, through initiatives such as the High Temperature Research Centre, the Advanced Materials and Processing Lab, Birmingham Centre for Strategic Elements and Critical Materials, Birmingham Energy Institute, Rolls-Royce Strategic Partnership and the National Centre for Nuclear Robotics.


School of Metallurgy and Materials

High-temperature research centre

In the Research Excellence Framework (REF) exercise – the system for assessing the quality of research in UK higher education institutions, the School was ranked in the top quartile in the UK for world-leading research. Overall 86% of the research in the School was recognised as internationally excellent of which 31% was given the higher accolade of being world-leading. The School’s portfolio of projects helps provide an understanding of how materials behave and how they can be used and improved; essential to the development of new products. The School attracts significant levels of funding from Industrial Partners, the European Commission (EC), UK Research Councils and other organisations in order to deliver high quality, high impact research.

Additive Manufacturing


High-performance battery


Plasma surface engineering

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MATERIALS AND ADDITIVE MANUFACTURING IN EUROPE

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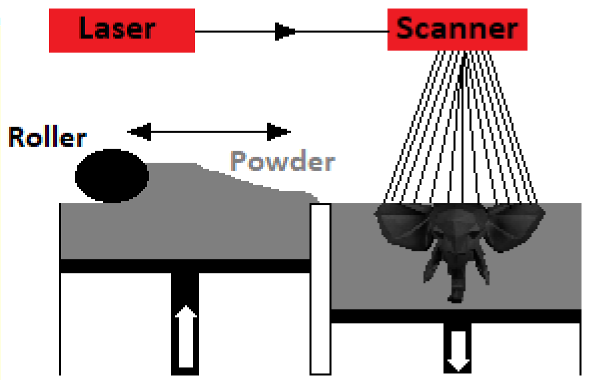
Additive Manufacturing (AM) is currently an extremely evolving science area which enables to produce components in many cases unproducible or with significantly higher added value than standard-produced components. AM technologies still have a relatively young degree of maturity besides their huge application potential. There is a recognized problem of reduced capability in additive manufacturing (AM) due to the limited materials palette and the lower performances obtained in respect to materials produced by conventional processes. As far as metallic-based materials are concerned, today, the primary challenge for AM regarding materials is the capability in the reliable manufacturing of high-quality parts for a wide variety of materials. Only a few of the more than 5,500 alloys used today in conventional processes, can be additively manufactured. This is due to the formation of intolerable microstructures with large columnar grains, high residual stress and/or periodic cracks because of the melting and solidification dynamics during the printing process. Therefore, it is of great industrial interest to determine novel approaches for processing an extended range of alloys. There is a clear need for parts with enhanced or superior mechanical and physical properties (electrical and thermal conductivity, optimized wear properties, high strength and corrosion resistance, biocompatibility, antimicrobial properties, etc.) that are not reached using alloys available for AM.



schematic representation of the Selective Laser Sintering process. It is a promising AM technique based on the use of materials in powder

How plasma technologies can support the development of additive manufacturing?

Materia Nova research center is working on the development of new material qualities for Additive Manufacturing (AM) techniques. The goal is to develop new material combinations for parts with high mechanical strength and for specific applications which are not state-of-the-art.

AM technologies are one of the main technical routes in realizing production in an "industry 4.0" environment. Manufacturing is done directly from the designed part without the need of preparing supportive tools. AM is extremely flexible in generating complex shapes which are not or difficult to achieve with competing techniques and, it is the most competitive technique for the fabrication of single or low number series of complexly shaped or individually designed parts.

In the metallic sector, powder bed based AM techniques are most advanced and, over the past 5 years, the development of manufacturing machines has been more and more oriented to production. Today, only a limited number of metallic materials are qualified for AM parts manufacturing, concentrating on the most important base areas for applications, such as specific Al, Ti, steels and Ni alloys. Much research is done now enlarge the selection of materials for reaching demanded parts properties and for increasing the market volume. However, the specific production characteristics, such as local melting, rapid solidification and cooling, in combination with technical issues, such as laser light absorbance, make it difficult to use well-known alloy compositions for this purpose.

Materianova investigates and develops material combinations which are suitable to achieve major enhancements in AM parts manufacturing and mechanical/functional parts properties. The technical approach is to combine materials in form of a based (alloy) powder with appropriate thin coatings which are alloyed during the manufacturing step.

Particularly, Materia Nova develops coatings on powders in order to improve the laser additive manufacturing of copper and aluminum which are critical to work with due to low laser absorption and high surface reactivity against oxygen or water respectively. Alloying and rapid cooling during manufacturing are key aspects of this very new and pre-competitive approach. By combining both aspects, the manufacturing conditions are significantly enhanced due to the coating properties (protective, laser absorption) as well as the properties of resulting materials through alloying with the coating materials.

References

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Zhang, H., Zhu, H., Qi, T., Hu, Z. & Zeng, X. Selective laser melting of high strength Al-Cu-Mg alloys: processing, microstructure and mechanical properties. Mater. Sci. Eng. A 656, 47–54 (2016)

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Different technologies for AM of advanced ceramics.

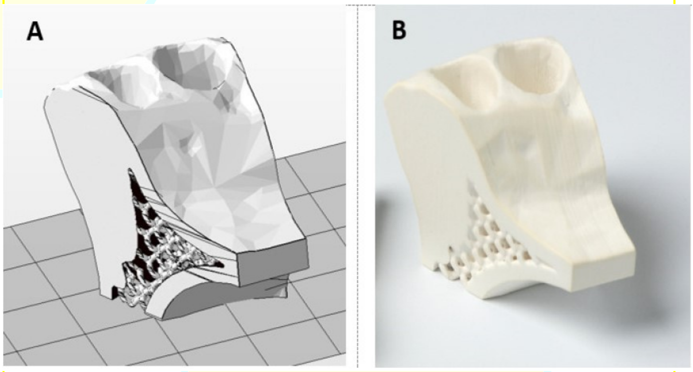
Fraunhofer IKTS has been using AM methods for ceramic components since the 1990s and was a founding member of the Fraunhofer Additive Manufacturing Alliance, which was established in 1998. Today, Fraunhofer IKTS offers complete AM solutions ranging from powder and suspension/feedstock development and production method selection to functionalisation and quality control of novel parts and systems:

-- Powder bed-based additive manufacturing methods: 3D printing (binder jetting) and selective laser sintering (SLS)

-- Suspension- or feedstock-based additive manufacturing methods: lithography-based ceramic manufacturing (LCM), laminated object manufacturing (LOM), thermoplastic 3D printing (T3DP), and fused filament fabrication (FFF)

-- Functionalisation through application methods: inkjet printing, aerosol jet printing, screen printing, jet dispensing, and diode laser sintering

-- Non-destructive testing methods for in-line process monitoring:
laser speckle photometry (LSP), optical coherence tomography (OCT), and standard analysis methods (ultrasonic testing, X-ray computed tomography, etc.).



(A) 3D-model of a single-material functionally graded ceramic material component. (B) sintered result of the printing process

References

Gozalez, P.; Schwarzer, E.; Scheithauer, U; Kooijmans, N; Moritz. T. Additive Manufacturing of Functionally Graded Ceramic Materials by Stereolithography , 143, e57943, 1-8, 2019

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INTERREG PROJECTS

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the European strategy to support innovation in economy

Interreg Europe (www.interregeurope.eu) helps regional and local governments across Europe to develop and deliver better policy. By creating an environment and opportunities for sharing solutions, they aim to ensure that government investment, innovation and implementation efforts all lead to integrated and sustainable impact for people and place.

Solutions exist that can help regions become the best that they can be.

Today, the EU's emphasis is very much on paving the way for regions to realise their full potential – by helping them to capitalise on their innate strengths while tapping into opportunities that offer possibilities for economic, social and environmental progress.

To achieve this goal, Interreg Europe offers opportunities for regional and local public authorities across Europe to share ideas and experience on public policy in practice, therefore improving strategies for their citizens and communities.

Interreg Europe assists three types of beneficiaries:

- Public authorities – local, regional and national
- Managing authorities/intermediate bodies - in charge of the Investment for Growth and Jobs programmes or European Territorial Cooperation
- Agencies, research institutes, thematic and non-profit organisations – although not the main target group, these types of organisations can also work with Interreg Europe by first engaging with their local policymakers in order to identify options for collaboration with Interreg Europe
- Organisations that work with Interreg Europe must also be based in one the 28 EU Member States, Switzerland or Norway.

Four topics were selected for financial support in order to make the best use of limited funds. The more focused the actions, the higher the chances they deliver effective results:

1. Research and innovation: Partners can work on
a) Strengthening research and innovation infrastructure and capacities.
b) Innovation delivery through regional innovation chains in the chosen 'smart specialisation' field

2. SME competitiveness: allows regions to improve their policies in supporting SMEs in all stages of their life cycle to develop and achieve growth, and engage in innovation

3. Low-carbon economy: addresses the transition to a low-carbon economy in all sectors through policies aimed at raising the share of renewable energy sources in the energy mix or promoting sustainable transport.

4. Environment and resource efficiency: Two distinct fields are open for cooperation:
a) Protection & development of natural and cultural heritage.
b) Transition to a resource-efficient economy, promoting green growth and eco-innovation

Interregional Cooperation Projects

Interreg Europe will co-finance up to 85% of project activities carried out in partnership with different policy organizations based in different countries in Europe. The project partners must identify a common interest and then work together for 3-5 years.

Initially, partners will share experience, ideas and know-how about how best to deal with the issue at hand. Each partner region must:

- Produce an action plan specific for each region
- Set up a stakeholder group
- Participate in the Interreg Europe Policy Learning Platform

After this stage, each partner must monitor progress of the implementation of their action plan and report to the lead partner. Pilot actions may be supported during this period.

Depending on the number of partners involved, duration of interregional learning etc., the average total ERDF budget of a project is expected to be EUR 1-2 million. Interreg Europe launches calls for proposals throughout the programming period. Each project involves partners from at least three different countries, two of which must be EU member states.

Interreg Europe is co-financed by the European Regional Development Fund (ERDF): 359 million € for 2014-2020. Close to 90% of the budget is for funding the interregional cooperation projects and almost 70% of it has already been allocated in the three calls for project proposals. The fourth call for project proposals closed on 22 June 2018 and 170 applications are under evaluation.

Examples of INTERREG PROJECTS

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BIOPROD : New strategies for the production and formulation of low toxicity biopesticides

The objective of the BIOPROD project is to remove the main obstacles related to the development of new natural biopesticides, more respectful of the environment and accessible at a reasonable cost. The project aims to develop an industrial and competitive production and purification process, an efficient formulation and a reduced toxicity from lipopeptide-producing microorganisms. Thus, the actions that will be carried out in this project will mainly focus on :

- The optimization of the molecules production and purification conditions by developing innovative processes using high throughput screening methods
- The sizing of installations and up-scaling to achieve future industrial production of lipopeptides.
- The production of detailed biodegradability and toxicity studies of the molecules on different models in order to evidence the positive impact of these new biopesticides in respect to existing ones.
- The realization of numerous formulation tests in order to make these molecules marketable, more stable, more active and easier to use.

These different actions will be complemented by a cross-border market study to determine the practices and expectations of the distributors of plant protection products and farmers. The results will be compared, in order to have an adapted communication according to the territories to promote these new phytosanitary molecules, the ultimate result of this project being the placing on the market in a future, and thus to improve the protection of the environment through the use of new biopesticides more respectful of nature and humain.

Partners : Materia Nova, Ghent University, Lille University, Reins University, Liège University / Gembloux Agro-Biotech, Lipofabrik, ISA Lille,UCLouvain, Pole NSL.

BIOSCREEN : New biosourced and multifunctional molecules for the biocontrol of phytopathogenic agents of crops in the cross-border region

The main objective of the project is to identify new bio-based molecules for the biological control of diseases of plants of agronomic interest cultivated in the cross -border region, to understand their mode of action, and to ensure the communication of knowledge vis-à-vis the target audiences of the cross-border region (professionals, students ...). The project is structured around three main axes:

1) the design of an innovative screening platform to evaluate the protection effectiveness of new bio-based molecules on a set of pathosystems presenting a strong economic impact on the cross-border region;
2) the analysis of the mode of action of the selected molecules;
3) communication and the transfer of knowledge to a target audience on

With the support of

the steps taken, the results obtained as well as the dissemination of information on the research area concerned by the project.

Partners : Materianova, Ghent University, Reims University, Lille University, Université du Littoral Cote d'opale, Université d'Artois, Liège University / Gembloux Agro-Biotech, UCLouvain, ISA Lille,

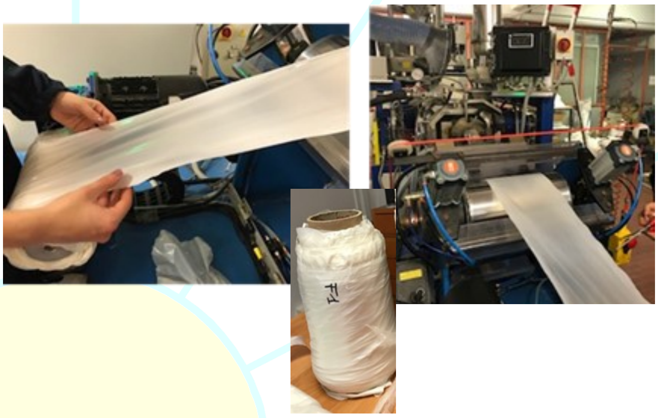
A project for skin health...processing biobased materials by flat die extrusion and electrospinning

Maria-Beatrice Coltelli, Serena Danti, Vito Gigante, Bahareh Azimi
CISIM, Department of Civil and Industrial Engineering, University of Pisa

Cosmetics, personal care, sanitary and advanced medications, designed to protect the skin from the interior and exterior aggressions, had in 2014 a global market value of US$ 47 billion. All these products, being in direct contact with skin and mucous membranes, are still made from fossil-based polymers, non-recyclable and non-biodegradable. Thus, the aim of the EU PolyBioSkin research project is to make innovative bio-based polymers to produce biodegradable non-woven tissues, because of the growing ecological awareness and the consumer demand for products more sustainable for environment, combined with the evolution of the health concept .
The consortium combines the expertise of twelve partners from seven European countries, including five partners from academia and technology institutes: Consorzio Inter Universitario di Scienza e Tecnologia dei Materiali (INSTM, Italy), the University of Westminster (UK), Association pour la Researche et le Developpement des Methodes et processus Industriels (ARMINES France), Tehnoloski Fakuktet Novi Sad (Serbia) and University of Gent (Belgium); six industry participants are also involved.
These innovative textured films and tissues were produced up to now at a semi-industrial scale by the use of two main classes of bio-based polymers, such as polysaccharides, (chitin nanofibrils/chitosan, starch, and biopolyesters, such as polylactic acid (PLA) and polyhydroxyalkanoates (PHAs), all obtained from biobased sources. Moreover, renewable nanostructured chitin nanofibrils and their complexes containing several beneficial molecules were investigated to offer antimicrobial, antioxidant, anti-inflammatory, absorbency, and skin compatibility properties.
Different technologies were investigated in the project such as flat die extrusion and electrospinning of biopolyester and polysaccharides based materials.

Flat die extrusion

Plastic films and multilayer systems can be manufactured using different converting processes such as blown film extrusion, flat die extrusion, extrusion coating, extrusion laminating and co-extrusion.
Flat die extrusion consists of an extrusion through a linear die of adjustable thickness usually between 3 and 1.4 mm. This technology allows the production of polymeric sheets and films (with thicknesses ranging from 50 microns to 1 millimeter) and consists of the extrusion of the molten polymer through a die of rectangular geometry. The material comes out from the die in the form of a molten plate that is immediately in contact with a thermostatic roller to allow cooling and solidification. Due to the motion of the roller, the film undergoes elongation with a consequent reduction in thickness. The film then passes through a second roller and to a measuring, cutting and winding station. The operating parameters to be controlled during flat die extrusion are the extrusion and windup rolls temperatures, distance between die and the first roll and the draw ratio (ratio between windup roll speed and polymer speed at the die exit). All of these parameters have a big influence on the final product characteristics (morphologically and mechanically).
In flat die extrusion, as well as in blown extrusion, the necessity of increasing the melt viscosity of PLA-based blends is often an issue, but usually melt fluidity values higher than those adopted in the blown extrusion are suitable for this processing technique. Films produced through this technique can be used in flexible packaging and they can be used also in multilayer systems.

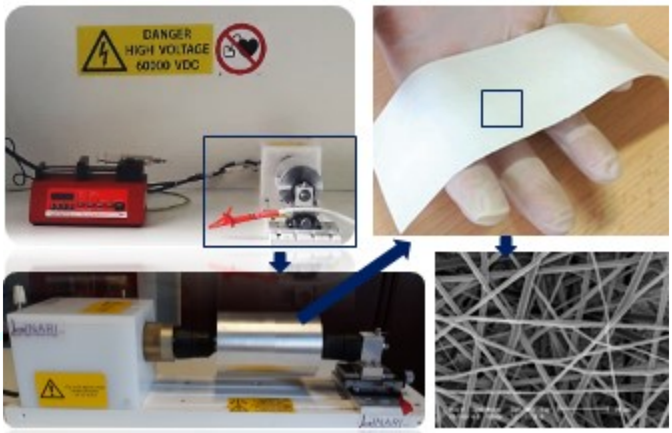


Flat die extrusion of PLA (top) and flat die extruded film roll based on plasticized PLA blends (bottom).

Diaper top-sheets are generally made by using polyolefins with a specific patterning of holes on the surface allowing the controlled passage of liquids through the film. Currently the ongoing POLYBIOSKIN European project developed materials for diaper top-sheet based on biobased formulations to replace traditional ones. The threshold of 90% set up for materials was reached thanks to the strategy of plasticization of PLA based blends with renewable plasticizers. Other additives, such as melt strength enhancers and calcium carbonate, were used for modulating melt viscosity and surficial oiliness of films upon storage respectively. The results were considered much promising for the further scaling up phase.

Electrospinning

With the development of the electrospinning technology it is now possible to make complex non-woven tissues with tailored porosity, thickness and strength useful for skin repair and regeneration. It should be reminded that, while wound repair represents a process to create continuity in the skin structure without the tissue reconstruction, regeneration involves restoration of the function and morphology of the original tissue layers. For this reason, wound repair often results in scar formation, while regeneration is achieved without scar formation. This is one of the POLYBIOSKIN goals. The project, in fact, aims to solve wound healing without hypertrophic scar or keloid formation, by identifying the ideal combination of bio-materials topography, chemical stimulants and concentration of active ingredients to be employed for supporting the organized arrangement of the natural skin layers. The composition of the non-woven tissues, to be made by tissue engineering methodologies, has to influence, for example, the ability of the materials to absorb nutrients and exudates from the wound bed, modulate water permeability and maintain the nature of cell interactions, also supporting their tensional integrity. All these parameters are indispensable to recreate the mechanical features and the microenvironment of the native tissue by the use of specific scaffolds, reinforced with selected bioactive molecules. The function of scaffolds in the regenerative medicine, in fact, is to direct the growth of cells seeded within the porous structures of the scaffolds or of cells migrating from surrounding tissue, combining together three key elements: cells, bio-materials and signaling molecules. By the use of these well structured non-woven tissues, it will be possible to mimic the natural characteristics of the skin, providing a favorable environment for its correct regenerative process.
Electrospinning is a technique which makes use of a polymer solution spun by a syringe within a high voltage electric field. By this principle it is possible to reach ultrafine fibers, resulting in the range from a few microns down to tens of nanometers. In the POLYBIOSKIN project, electrospinning is used to fabricate bioactive and biodegradable antipollution beauty masks and smart wound dressings made up of bio-based polymers like polyhydroxyalkanoates (PHAs).



Electrospining equipment (top left), collector (bottom left), electrospun non woven tissue (top right), SEM micrograph related to the morphology of the electrospun tissue (bottom right)

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RECYCLING OF POLYMERIC MATERIALS

Circular economy strategy is pushing public entities and companies to consider the impact onto environment of final products considering their full life: from the synthesis from natural resources to the waste management. For this reason many companies are designing new products taking into account their end of life, using easily separable parts, preferring mono-material items and selecting compostable plastics for short life applications. Nevertheless the current urban and industrial waste is full of polymeric materials and it can be considered a "metropolitan mine". EU made Directives about several types of waste (packaging, end of life vehicles (ELV) or electric and electronic equipment (WEEE)) to improve their recycling by scheduling over time specific objectives.

Currently researchers are considering not only thermoplastic polymers, but also thermoset materials and composites, considering waste of high performing items, that cannot be produced with more sustainable processes. However their recycling is particularly difficult because these materials cannot be processed in the melt. So new processes and technologies should be explored for valorizing these materials.

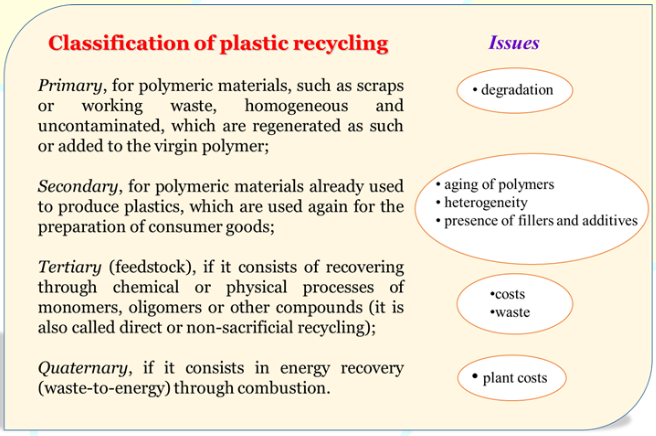
Classification of polymers recycling

Maria Beatrice Coltelli, CISIM-University of Pisa, Italy

Over time, different classifications of plastics recycling technologies have been used in various fields, such as scientific literature and international congresses. The most complete classification is based on raw materials and processes that defines primary, secondary, tertiary and quaternary recycling. Fig.2 shows a summary scheme related to this classification.

By *primary recycling* we mean the recycling of post-industrial materials, such as scraps or processing waste, homogeneous and non-contaminated, which are regenerated as such or added to the virgin polymer in the same process. This type of recycling is considered the simplest to carry out. In fact, if we consider processing of plastic materials such as injection molding or film production, it is easy to see that those that are processing waste can simply be ground and reinserted in the same production cycle. However, it is still necessary to consider the progressive loss of properties of the material subjected to several processing cycles.

Secondary recycling means recycling that takes place from a selected material that is reused to produce consumer goods again in a plant different from that of primary production. Secondary recycling can be classified in post-industrial recycling , easier, and post-consumer , more complicated because of the necessary separation and cleaning operations.



general classification of plastics recycling

Tertiary recycling consists of the recovery through chemical or physical processes of monomers, oligomers or other compounds. Tertiary recycling therefore involves the use of chemical or physical agents to obtain derivatives from polymeric materials that can be reintroduced in the same production cycle or used in others. From a rational point of view, it seems the most interesting, since the "chemical" value of polymers since they are obtained from precious petrochemical compounds is preserved and therefore the polymeric materials would be a reserve of compounds.

Quaternary recycling consists of energy recovery through combustion.

Another type of recycling classification is essentially based on the type of process, in particular if it occurs through transformation in the molten state (*mechanical recycling*) using conventional techniques for processing plastics or reactive (*chemical recycling*). The mechanical recycling is therefore the most widespread since it involves the simple re-processing of post-industrial or post-consumer materials.

References: M.B. Coltelli, M. Aglietto, Riutilizzo dei materiali polimerici, Edizioni Nuova Cultura, 2015

Strategies and Scenarios for Valorisation of Regenerated Phenoplasts Plastics

Josè Marie Lopez Cuesta, IMT-Mines Ales Telecom, France

Summary :

The main goal of this project, involving a partnership between IMT Mines Alès (C2MA research centre), APR2 (recycling company) and Enedis (electricity supplier), was to develop a solution based on material recycling for phenolic moulding compound (PMC, or Bakelite). Indeed, these types of waste end up mainly in landfill, mostly because of the lack of technically and economically viable solutions for recycling.

Phenolic moulding compound material are widely present in End of Life (EOL) electrical meter waste streams. Therefore, Enedis committed to find a valorisation scheme for these materials. A PhD work supported by the companies and the ANRT public agency was aimed to develop a recycling process for PMC issued from this waste stream.

Firstly, a dismantling and sorting scheme was designed. It was based on the study of the waste stream material composition – in particular the plastic stream. The presence of regulated substances (such as halogenated flame retardants, etc.) in plastic formulations was assessed. The objective was to optimize the separation process to recover materials with a high degree of purity.

The proposed recycling solution consisted in using the PMC as a functional filler in a thermoplastic matrix. To do so, a comminution scheme was developed to reduce the size of the PMC part. The particle size distribution, morphology and surface chemistry of the obtained products were characterized. Quasi-static and dynamic mechanical properties of composite materials incorporating micronized PMC were determined. Various coupling schemes were studied in order to increase the adhesion between filler and matrix. The mechanical behaviour of the composite materials was also modelled using finite element methods.

Pictures of old phenoplasts electrical meters

The fire behaviour of the composite material incorporating PMC filler was also studied. Because of the high thermal stability and high char yield of phenolic moulding compound, its potential use as a carbon donor in intumescent flame retardant formulations was finally highlighted.

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Nanofillers pilot plant in Perugia, Italy

Prolabin and Tefarm has developed pilot plants for producing Layered double hydroxides (LDH) with Hydrotalcite-like structure and zirconium phosphates/phosphonates (α-ZrP).

Prolabin & Tefarm srl is an expert in the preparation of functionalised inorgano-organic layered compounds belonging to the classes of Layered double hydroxides (LDH) with Hydrotalcite-like structure and zirconium phosphates/phosphonates (α-ZrP).

LDH and α-ZrP are two families of layered compounds able to host ions in the interlayer space that can be released in a controlled way. Their properties can be tailored by manipulating the operating parameters to meet required specifications. These lamellar solids are innovative products used as: nanostructurant polymer additives, raw materials and carriers of active ingredients for cosmetic, nutraceutic, pharmaceutical, health care applications and heterogeneous solid catalysts.

Prolabin & Tefarm was born in 2008 as a spin-off of the University of Perugia, with the aim of transferring the knowledge acquired in 40 years of academic research in the field of synthesis and functionalization of innovative nanostructured inorganic materials.

LDH and ZrP are biocompatible materials, produced with ecofriendly procedures using only water as a solvent, therefore suitable for companies and research projects that are looking for innovative and green products. Due to the presence of exchangeable ions in the interlayer region of these materials, molecules with ionisable groups can be intercalated via ionic exchange processes to produce new hybrid materials with enhanced properties. The R&D departement is focused on the design and realization of innovative products in the nanocomposite[1], pharmaceutical, and cosmetic[2] fields.

Plant and characteristics of Prolabin and Tefarm products

Prolabin & Tefarm possesses a production site (with a production capacity of tons/year) and is able to study the scale-up process of layered compound/organic hybrids and develop the suitable production protocols for the industrial realization of these materials.

Currently, innovative hybrids constituted by lamellar solids and antibiotic drugs are being applied in 3D hybrid printing within FAST, http://project-fast.eu, a H2020 European project. The idea is to obtain innovative 3D printed bone scaffold with a prolonged antibiotic activity, that will be tested in vivo before the end of 2019. Moreover innovative additives for recycled polymers are applied in PolyCE, www.polyce-project.eu, a H2020 European project, whose goal is that to transform the lifecycle of e-plastic materials into a more sustainable one.

References

1. Bastianini, M.; Scatto, M.; Sisani, M.; Scopece, P.; Patelli, A.; Petracci, A. Innovative Composites Based on Organic Modified Zirconium Phosphate and PEOT/PBT Copolymer. J. Compos. Sci. 2018, 2, 31.

2.Bastianini, M.; Sisani, M.; Petracci, A. "Ascorbyl Tetraisopalmitate Inclusion into Y-Cyclodextrin and Mesoporous SBA-15: Preparation, Characterization and In Vitro Release Study". Cosmetics 2017, 4, 21.

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EVENTS (by Sylvain Buonomo, IMT-École des Mines d'Alès)

- 22-24 May 2019, Brno, CZECH REPUBLIC

METAL 2019 : 28th International Conference on Metallurgy and Materials

- 26-30 May 2019, Cesme-Izmir, TURKEY

PPS-35 : 35th International Conference of the Polymer Processing Society

- 8-10 May 2019, Vitoria-Gasteiz, SPAIN

ESAFORM 2019 : 22th International Conference on Material Forming

- 9-14 June 2019, Crete, GREECE

EPF 2019 : European Polymer Federation

- 11-15 June 2019, Ghent, BELGIUM

AUTEX2019 : 19th World Textile Conference

- 14-16 June 2019, Paris, FRANCE

ECEM'19 : 3rd International Conference on Environment, Chemical Engineering & Materials

- 17-19 June 2019, Stockholm, SWEDEN

BIOPOL2019 : 7th International Conference on Biobased and Biodegradable Polymers

- 17-19 June 2019, Liberec, CZECH REPUBLIC

TRS 2019 : 47th Textile Research Symposium

- 24-26 June 2019, Vienna, AUSTRIA

20th World Congress on Materials Science and Engineering

- 26-28 June.2019, Turku, FINLAND

FRPM19 : European Meeting on Fire Retardant Polymeric Materials

- 1-3 July 2019, Porto, PORTUGAL

ICNF2019 : 4th International Conference on Natural Fibers

- 1-4 July 2019, Lisbon, PORTUGAL

MECHCOMP : 5th International Conference on Mechanics of Composites

- 2-5 July 2019, Thessaloniki, GREECE

NN19 : 16th International Conference on Nanosciences & Nanotechnologies

- 22-24 July 2019, Oxford, UNITED KINGDOM

ICMSN 2019 : 3rd International Conference on Materials Sciences and Nanomaterials

- 11-16 August 2019, Melbourne, AUSTRALIA

ICCM 22 : 22th International Conference on Composite Materials

- 1-5 September 2019, Stockholm, SWEDEN

EUROMAT 2019 : European Congress and Exhibition on Advanced Materials and Processes

- 11-13 September 2019, Dorbin, AUSTRIA

Dorbin-GFC2019 : 58th Global Fiber Congress

- 23-25 September 2019, Hyderabad, INDIA

ADMAT 2019 : International Conference on Advanced Materials and Process for Defense Applications

- 16-18 October 2019, Brno, CZECH REPUBLIC

NANOCON : 11th International Conference on Nanomaterials – Research & Application

- 29-30 October 2019, Paris, FRANCE

ICFMF 2019 : International Conference on Fibers and Fibrous Materials

- 28-29 November 2019, Dresden, GERMANY

International Textile Conference

- 13-14 January 2020, Zurich, SWITZERLAND

ICDCMT 2020 : International Conference on Diamond, Carbon Materials and Technology

- April 2020, Chiba, JAPAN

ISAP : 7th congress of the International Society for Applied Phycology

- 18-20 May 2020, Stuttgart, GERMANY

ESPC : 9th European Conference on Protective Clothing

- 15-19 June 2020, Montecatini Terme, ITALY