SUSTAINABLE FUTURE STARTS WITH CHEMISTRY

POLYMER CHEMISTRY

Łukasiewicz
Industrial
Chemistry
Institute

RESEARCH OFFER

Advanced polymers, composites and laminates:
modern production technologies from renewable and recycled raw materials, including low energy and material intensive construction materials

Efficient processing and recycling of plastics minimising their environmental impact, allowing to reuse materials

Advanced polymer materials for specialised applications (defence industry, personal protective equipment industry, transport equipment, construction industry)

Functional polymer coatings:
coatings with antibacterial, flame retardant, gas barrier and hydrophobic properties with applications in various industries

Polymers and biopolymers with antibacterial, antifungal and antioxidant properties with applications in the food, medical, cosmetics and other industries

Smart, biodegradable, recyclable, active polymers for packaging and other applications

Sustainable agriculture:
organic crop protection products and pesticide minimisation

PVC technologies based on polyvinyl chloride for use in construction, industry and other sectors

Polymer materials analytics:
comprehensive polymer analytics, processing properties, performance parameters, analysis of microplastics and more

Optimisation of chemical processes:
processing, syntheses, modifications of plastics

ADVANCED POLYMERS, COMPOSITES AND LAMINATES

technologies for the production and modification of duroplastics:

- polyester resins, epoxy resins including resins: with special properties, liquid, low-melt, solid epoxy resins, plasticising agents for epoxy resins
- preparation and chemical and physico-chemical modification including composites, nanocomposites and laminates
- synthesis of auxiliary agents for selected engineering resins – including plasticisers obtained from by-products and waste products.

urea, melamine, phenol-formaldehyde resin technologies – including melamine foams and formaldehyde-reduced resins

technologies for polyurethane plastics – new types of insulation materials (modular construction), flexible polyurethane foams

preparation of halogen-free flame retardants, including Intumescent Flame Retardant Systems (IFRs)

building materials with low energy and material intensity – foam materials

research into reducing the flammability of plastics (polyethylene, polypropylene, polyurethanes, polyesters, epoxies, polystyrene and others)

monomers for the synthesis of plastics obtained from renewable or recycled raw materials, biodegradable polymers, with applications in the packaging industry

ADVANCED POLYMERS, COMPOSITES AND LAMINATES

new polymeric materials: functional polymers with the addition of structure modifiers or functionalized hybrid natural or waste fillers

obtaining eco-friendly fungicides and bactericides
modification of polymers with a view to their hygienization

waterborne polyester resin technologies

thermoplastic, solvent-free hot-melt adhesives: polycondensation adhesives (polyamide, polyester), adhesives based on PP, PE, EVA copolymers, APAO and block rubbers (SIS, SBS, SEBS), adhesives with applications in the leather, electrical engineering, furniture construction, packaging and electronics industries

plastics recycling technologies

FUNCTIONAL POLYMERIC COATINGS

Coatings with antifungal and antibacterial properties

Coatings with flame retardant or fire retardant properties

Hydrophobic coatings (self-cleaning)

Electromagnetic radiation shielding coatings

Self-repairing coatings

BIOPOLYMER-BASED MATERIALS
MODERN SOLUTIONS FOR INDUSTRY

design of innovative biopolymers with antimicrobial, antifungal and antioxidant properties, with potential application in modern packaging, pharmaceutical and cosmetic materials

creation of active packaging and edible protective coatings that offer a sustainable alternative to traditional materials used in the food industry

advanced modification of biodegradable polymers of natural origin (including chitosan, starch, polyhydroxybutyrate) to improve their durability, elasticity and resistance to environmental conditions

research on innovative deep eutectic liquids (DES) with different compositions (e.g. based on amino acids, sugars, organic acids or polyphenols) and their use as eco-plasticisers, hydrophobicity modifiers, carriers of active substances and functional additives

advanced technologies for the crosslinking of biodegradable polymers – the creation of permanent three-dimensional structures through the reaction of functional groups (e.g. aldehydes with amines), enabling the creation of materials with increased mechanical strength, water resistance and controlled absorption, with potential application in medical, cosmetic and agricultural products

modern methods for the controlled release of active substances – designing systems with optimised kinetics of release of bioactive components from polymer matrices

extraction of active substances from plant waste – development of modern methods for the isolation of valuable bioactive compounds from natural resources, including plant waste

intelligent hydrogels with self-healing properties – development of hydrogels based on biopolymers with self-healing properties

advanced polyhydroxybutyrate (PHB)-based materials for medical applications – development of innovative biocompatible and bioresorbable biomaterials for applications including implants, surgical sutures, drug carriers and advanced dressing materials

PLASTICS PROCESSING AND RECYCLING

technology for the manufacture and modification of polymers – recycling of thermoplastics, including by reactive extrusion

chemical modification of thermoplastics by reactive extrusion

biodegradable polymer composites using raw materials of natural origin

polymer nanocomposites

filling and reinforcement of thermoplastics

modification and processing of engineering plastics, including PPO

SUSTAINABLE AGRICULTURE

organic plant protection products and pesticide minimisation:

- polymeric superabsorbent (SAP) technologies – controlling soil water retention, gradually releasing nutrients, absorbing harmful substances
- natural fertiliser technologies

ADVANCED POLYMERIC MATERIALS FOR SPECIAL APPLICATIONS

synthesis of air-moisture cross-linked polyurethanes and silicone-urethanes

isocyanate modification of asphaltenes, coal tar pitch and hydrocarbon resins

associative polyurethane thickeners

solvent-free and water-dispersion binders for UV-crosslinking coatings

coating materials for special applications, e.g. self-healing polymeric coatings, electromagnetic radiation shielding, etc.

aqueous dispersions of polyurethanes, silicone-urethanes, acrylic-urethanes, silicone-acrylics, acrylic-alkyds, especially for use as coating materials

silicone-urethanes as living-cell scaffolds, solid polymer electrolytes, membranes for the separation of liquid and gaseous mixtures

reticulated glassy carbon

polymeric plasticizers for PVC

polymer nanopowders as impact modifiers for powder coatings and polymer plastics

polymeric consumables used in 3D printers

ageing and application tests on adhesives, coatings, putties and compositions

PVC TECHNOLOGIES

synthesis and modification of vinyl polymers:

- new polymerisation methods: radical (suspension, emulsion), ATRP, RAFT
- design of copolymers and structurally controlled polymers
- chemical modification (e.g. acrylate grafting) to improve resistance to atmospheric, chemical and thermal conditions
- formulation development to improve the physical and chemical properties of PVC and optimisation of production processes

production of dry blends (Dry-Blend)::

- optimisation of formulations and mixing technologies for products with improved mechanical and performance properties
- development of new processing additives and testing of new products
- research into reducing the flammability of PVC products and the development of environmentally compliant compounds

sustainability and recycling:

- recycling of vinyl polymers, search for alternative eco-friendly raw materials
- development of innovative production methods with minimal carbon footprint and less environmental impact

POLYMER MATERIALS ANALYTICS

characterisation of polymeric materials: melt mass flow rate MFR (EN ISO 1133); differential scanning calorimetry DSC – temperature of phase transition (melting, crystallisation and glass transition temperature), degree of crystallinity (EN ISO 11357); thermogravimetric analysis TGA – temperature and decomposition rate of polymers, volatile matter content, mixture composition and additive/filler content (ISO 11358); DMTA dynamic mechanical thermal analysis – determination of the viscosity dependence of polymeric materials on shear rate and temperature, loss modulus, conservative modulus, tg (ISO 3219, ISO 6721, PN-EN ISO 14770); permeability to O2, water vapour, CO_2 – barrier properties (DIN 53380/ASTM F2622-08, ASTM F1249-06, ASTM F2476-05); specific and bulk density (PN-EN ISO 1183, PN-EN ISO 60, PN-EN ISO 61)

mechanical properties of polymeric materials: static tensile and flexural mechanical properties assessment (PN-EN ISO 527 and PN-EN ISO 178); impact testing according to Izod and Charpy with and without notching (PN-EN ISO 180, PN-EN ISO 179); heat deflection temperature under HDT load (PN-EN ISO 75); softening temperature according to Vicat (PN-EN ISO 306); Shore hardness A and D scale and Rockwell ball indentation (PN EN – ISO868, PN EN ISO 2039)

comprehensive flammability analysis of materials: oxygen index, vertical and horizontal flammability, cone calorimeter tests, thermogravimetric tests coupled with mass spectrometry and FTIR spectroscopy

research using IR microscopy and Raman microscopy – including microplastics analysis

polymer resin characteristics: viscosity, density, softening point, acid number, hydroxyl number, curing time, temperature peak and others

mechanical strength tests – bending, compression, tension

analysis of hydrogen permeability of polymer films

FTIR spectroscopy – identification of functional groups and intermolecular interactions

UV-Vis spectroscopy – determination of substance concentration and monitoring of photochemical processes

GPC/SEC with quadruple detection, MALDI mass spectrometry – analysis of molecular weight, distribution, and polymer structure

measurement of barrier properties – gas (O_2, CO_2) and water vapor permeability

POLYMER MATERIALS ANALYTICS

determination of antioxidant properties – ability to neutralize free radicals

moisture determination – water and volatile content in samples

density and viscosity testing, thermal analysis (PVC stability), plasticization tests, gelation degree, etc.

tests compliant with international standards (PN-EN ISO, ASTM) ensuring full quality control of materials

testing of selected properties of liquid paints, varnishes and the resulting coatings: viscosity, density, film thickness, hardness (Persoz, Koenig, Pencil), impact resistance, abrasion resistance, scratch resistance, water resistance, adhesion, flexibility, formability

measurements of the rheological properties of polymers: viscosity viscoelasticity, etc.

surface imaging of polymers and plastics (optical profilometer)

determination of transition temperatures, e.g. melting, glass transition (Tg), crystallisation (differential scanning calorimeter DSC)

determination of the dynamic properties of plastic polymers using DMA (Dynamic Mechanical Analysis) – measurement of the mechanical properties of materials as a function of time, temperature and frequency

measurement of surface tension (hanging drop method) and wetting angle (laid drop, static method), Kruss goniometer

determination of film formation temperature and white point of aqueous polymer dispersions

mechanical stability of aqueous dispersions and suspensions

solids content (dry residue)

testing of density, viscosity, thermal analyses (stability of PVC), plasticisation tests, degree of gelation, etc.

tests in accordance with international standards (EN ISO, ASTM) to ensure complete quality control of materials

VALUES

We work with passion, based on:

- Professionalism
- Commitment
- Reliability
- Partnership

POTENTIAL

Product and process innovation

from laboratory scale through pilot scale to production in our own process halls

Completion of technological line distributed on the market

from 'concept to product'

Inventions and know-how

patented solutions and know-how in the field of modern chemical processes that can be commercialised

Development and competence

investment in technology and human resources with more than 170 scientists and specialists for companies investing in innovation

Research platform

implementation of R&D projects

Cooperation with leaders

cooperation with Polish and foreign business and academic partners

Process scaling

scale-up and scale-down of chemical and biotechnological processes

Laboratories and apparatus

developing research facilities with specialised laboratories and modern apparatus.
We have a complete set of processing equipment that constitutes the plastics production sequence.
We have comprehensive, interlinked analytical methods for testing plastics

Łukasiewicz
Industrial Chemistry Institute

We create innovations
that shape a sustainable future.
Trust our knowledge and experience!

LET'S MEET!

Łukasiewicz Research Network –
Industrial Chemistry Institute
8 Rydygiera St.
01-793 Warsaw, Poland
ichp.lukasiewicz.gov.pl/en

Piotr Jankowski, PhD Sc. Eng.
Area Leader, Polymer Technology Research Group
+48 453 056 197
piotr.jankowski@ichp.lukasiewicz.gov.pl

FOLLOW US / / /