Science 4 Technology – Poster Exhibition 2024

Department Polymer Engineering and Science

Chair of Chemistry of Polymeric Materials

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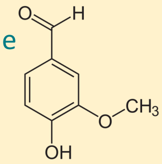
Projekte für eine nachhaltige Zukunft
mit Hilfe von Polymer- und Oberflächenchemie

VANILLA FLOW

Umweltfreundliche Batterie-Systeme & Recycling

- Redox-Flussbatterien auf Basis von erneuerbaren Rohstoffen
  - *Vanillin* und andere Hydroquinone als redox-aktive Moleküle
  - Papier-basierte Membrane
  - Kohlenstoff-Elektroden



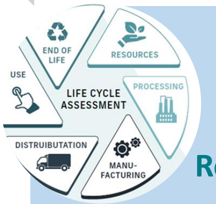
- KI-unterstützte Entwicklung des elektrochemischen Systems

Nachhaltige, rezyklierbare Materialien für den Scheinwerfer der Zukunft

SusMat4CarLight

- Bestimmung von flüchtigen Komponenten aus Rezyklaten mittels GC-MS
- Vermeidung von VOC durch geeignete Additivierung

→ Entwicklung von Rezyklaten mit kontrollierten Eigenschaften



WINTRUST

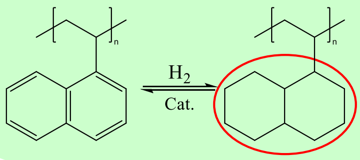
Recycling von Wintersportartikeln

Unsere Beiträge:

- Lösen von Klebeverbindungen mit chemischen Methoden
  → mehr Material für Recycling
- Haftvermittlung zwischen Füllstoffen aus Altmaterial und neuer Polymermatrix

Polymere für die chemische Wasserstoff-Speicherung

- Polymerisation aromatischer Vinylmonomere
- Katalytische Hydrierung und Dehydrierung dieser Polymere



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Neugierig? – Mehr Informationen und tolle Projekte findest du auf unserer Homepage:
https://www.kunststofftechnik.at/lehrstuehle/lehrstuhl-fuer-chemie-der-kunststoffe-1

Smart and Light-Reactive Polymers

In our research group we mainly explore photochemistry as a way to create and modify polymer systems. There are several reasons to use light instead of other triggers (e.g., temperature, pH, magnetic fields):

- temporal control – turning on the light starts the reaction, switching it off usually ends it
- spatial control – in contrast to temperature, reactions can be controlled at high resolutions (nanometer scale)
- applicable for heat sensitive areas (e.g., inside the human body)

Photoreactive systems are already used in coatings, dental fillings, photoresists, and 3D-printing, and there is potential for applications in tissue engineering, customized medical devices or holography.

Wavelength-Orthogonal Photoreactions

Photoreactive molecules and functional groups respond differently depending on the energy input (i.e., the wavelength). Some groups react at relatively high wavelengths (e.g. 450 nm), where others are inert. Wavelength-orthogonality is reached, when two reactions are combined within a system without interfering with each other.

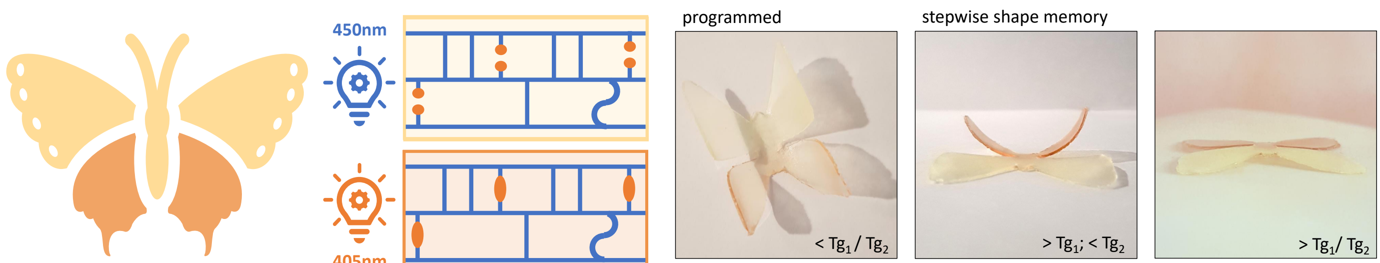

Figure 1 – Shape-memory butterfly

One topic we are exploring is dual-cure photopolymers, where we trigger two curing mechanisms separately with two light colors. Thus, items manufactured from the same resin can exhibit different mechanical properties spatially resolved. In the work depicted in Fig. 1, this system was used to produce a multimaterial butterfly with programmable shape-memory.

Additionally, we are investigating antagonistic photochemistry. Much like in muscle pairs in the human body, two contrary actions are combined, yielding new possibilities. As shown in Fig. 2, these contrary actions (curing and inhibition of curing) are initiated by different wavelengths within a single resin system. Using these principles, new additive manufacturing technologies with increased printing speed are anticipated.

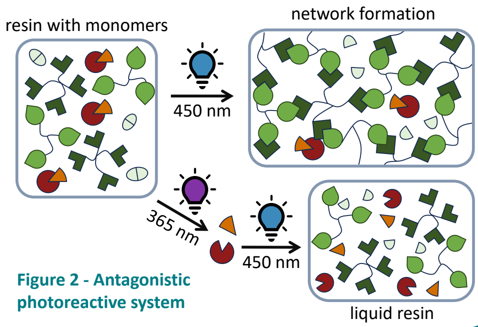

Figure 2 - Antagonistic photoreactive system

Surface Functionalization of Polymers

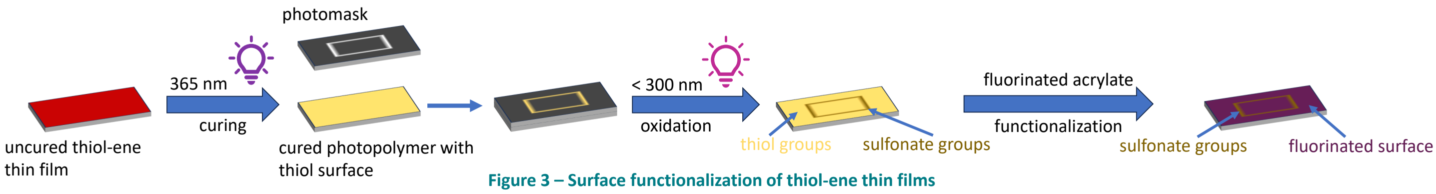

Figure 3 – Surface functionalization of thiol-ene thin films

Surface functionalization is a powerful tool to introduce specific properties to polymeric surfaces such as hydrophilicity, roughness, and the ability to immobilize biomolecules.

In the system shown in Fig. 3, the hydrophilicity of thiol-ene thin films is increased via photo-oxidation of remaining thiol groups to sulfonates. A photomask is employed to spatially control the oxidation reaction. In the next step, the non-oxidized remaining surface areas are functionalized with a highly fluorinated molecule to increase the hydrophobicity. This spatial control of hydrophilicity and hydrophobicity of the surface can be used to guide and manipulate liquid flow in microfluidic systems.

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GRIESSER GROUP

FFG Forschung wirkt.

European Commission

Printed Electronics and Sensors

Using Electrically Conductive Stretchable Inks

The efficient production of electronic circuits and components is one of the most critical areas of the rapidly growing research field of Printed Electronics. The development of stretchable conductor paths opens up the possibility of easily integrating electrical or electronic components into three-dimensional surfaces of machines, human skin or consumer goods. Printed electronics are considered a key technology for the Internet of Things and the car of the future with flexible displays and sensors. One focus of the Institute of Chemistry of Polymeric Materials is to investigate materials and industrializable digital printing techniques for the large-scale production of sensor systems.

Theory

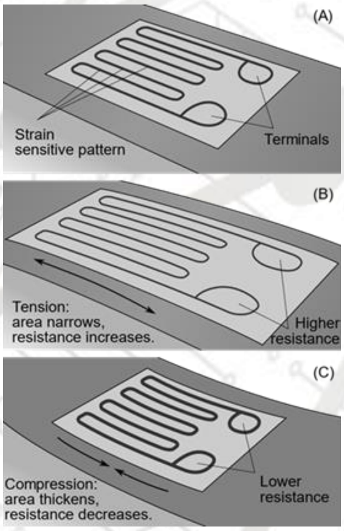

Fig. 1: Principle of a resistance-based strain gauge [1]

The principle of printed electromechanical sensors is based on a change in electrical parameters. They usually consist of conductive materials that can be applied to a substrate by various printing techniques. External stimuli such as pressure, strain (see Fig.1) or changes in temperature, for example, lead to changes in the electrical resistance of these materials that can be easily detected and quantified. Typical conductive inks for the fabrication of such sensors contain silver, copper or carbon particles. In order to protect these devices from environmental influences such as moisture, UV radiation or chemicals, it may be necessary to apply protective layers of barrier materials.

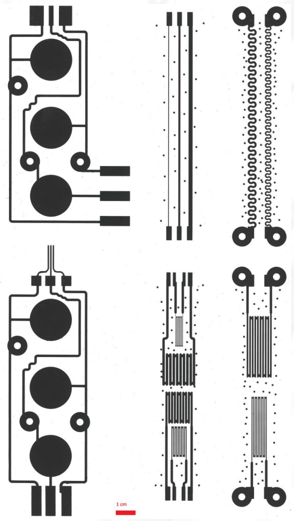

Fig. 2: Different sensor designs fabricated by screen printing using carbon inks

Applications

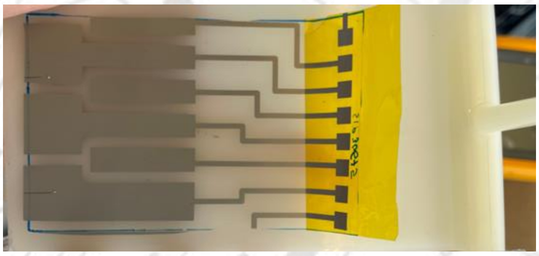

Fig. 3: Example of an in-mold printed sensor

In-mold electronics opens up new possibilities by combining existing injection molding techniques with printed elements such as controls, switches, sensors or antennas. The process is based on the established in-mold decoration technique and can also be applied to thermoforming.

Fig. 4: Rock bolts with printed sensors in a mine

Rock bolts improve the stability of surroundings in mines. Imprinted sensors provide vital information about the condition of rock formations and structures.

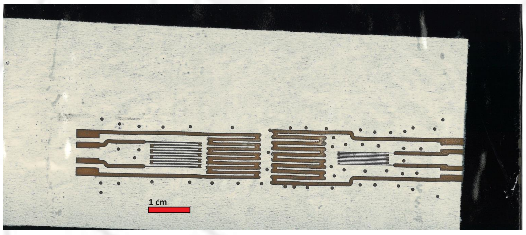

Fig. 5: Printed sensor with an encapsulation barrier

The implementation of strain sensors in conveyor belts allows the investigation of the tension distribution in such devices as well as the simple realization of belt scales.

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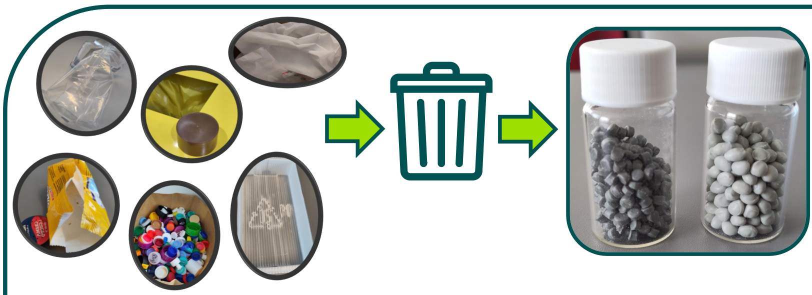
MEG mining engineering mineral economics

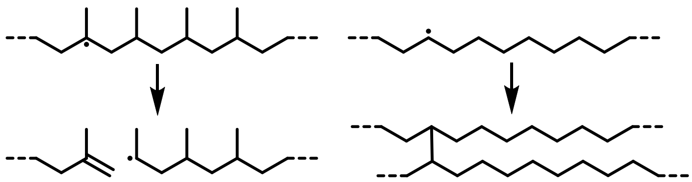
[1] https://upload.wikimedia.org/wikipedia/commons/c/c3/StrainGaugeVisualization.svg, retrieved on 02.04.2024

E-Beam Treatment of Post Consumer Polymer Waste

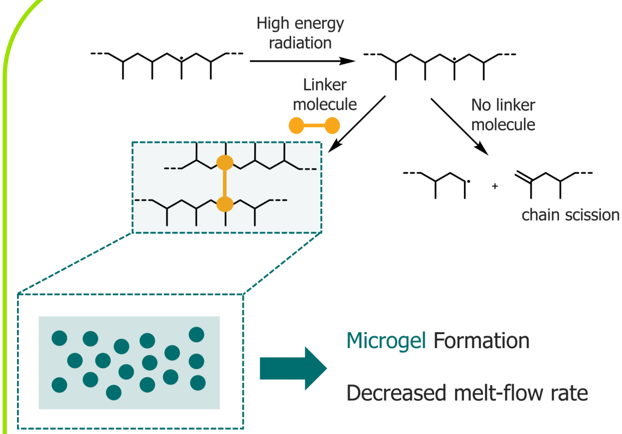
Increasing the melt viscosity of post-consumer polypropylene

For Post Consumer Recycled (PCR) Polypropylene (PP), distributors mostly offer injection type PCR PPs with high melt-flow rates (MFR) and low melt viscosity. This is not favoured for extrusion applications, where low MFR values and sufficiently high melt strengths are required. Irradiation of PCR-PP with e-Beam offers a strategy to decrease the MFR and increase the melt viscosity.

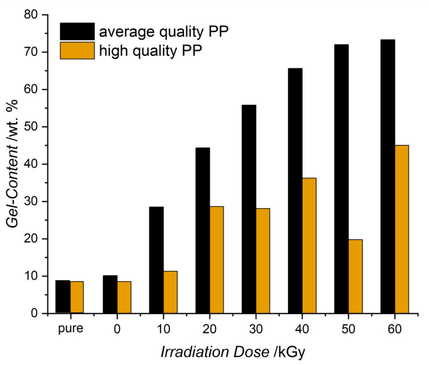


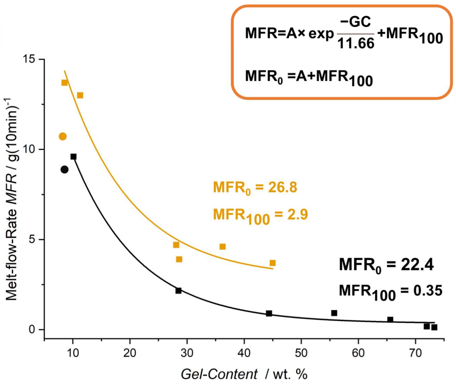


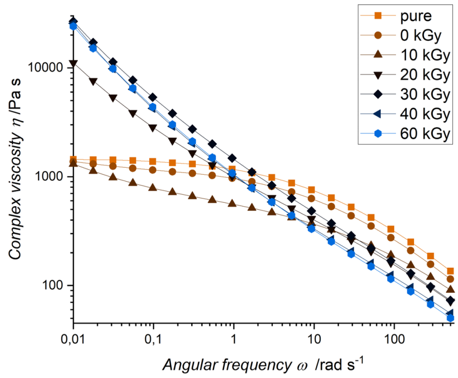
PCR-PPs often contain polyethylene (PE) as impurities. Under irradiation, polypropylene will break via β chain-scission reaction, while polyethylene tends to cross-link



When PCR-PPS are irradiated in presence of linker molecules, the cross-linking reaction dominates over the β chain-scission







Two different grades of PCR-PP were irradiated: The average-quality PP with an estimated amount of 30% PE impurities and the high-quality PP with an estimated amount of 5 % PE. Sample irradiation leads to an increased Gel content – a microgel forms. The presence of PE impurities leads to a faster growth in gel-content. When the Gel-Content increases, the MFR reduces exponentially. Melt rheology shows shear thinning behaviour for all irradiated samples, in here only the viscosity curves for high quality PP are shown.

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