

## Polymer Competence Center Leoben R&D Partner of the Polymer Industry

Polymer Competence Center Leoben GmbH, A - 8700 Leoben



**Bundesministerium** Digitalisierung und Wirtschaftsstandort **Bundesministerium** Climaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie









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## **PCCL** at a Glance

## Leading Austrian Center of Excellence for application-oriented research in the field of polymer technology and polymer science





## PCCL as a link bridging the gap between basic research and competitive industrial R&D





#### From Molecular Structure to Performance of Components



The research program follows the value chain of polymer based products.

#### **Polymer Competence Center Leoben GmbH** *Fields of Expertise*





Chemistry of Functional Polymers Chemistry of Stimuli-Responsive Polymers

Archim Wolfberger

Chemistry of Elastomers and Surfaces Sandra Schlögl

Chemistry of (Nano)Composites Frank Wiesbrock



Simulation and Modeling Simulation Strategies for Polymer and Polymer Composite Designs Peter Fuchs

Material Modeling for Polymer and Polymer Composite Materials Matthias Morak





Surface Testing, Robot Vision and Artificial Intelligence

Al based Testing of visual and haptic Surface Properties Dieter Gruber

Al Tools for Surface Image Processing Matthias Haselmann



Smart Material Testing Aging Behaviour of Polymers Gernot Oreski

Media Resistance of Polymers Sonja Feldbacher



#### Elastomer Technologies and Process Optimization

Polymer Tribology Andreas Hausberger

Material Science and Testing Bernd Schrittesser

Processing Technologies Roman Kerschbaumer



Polymers and Composites for Structural Applications

> Engineering Polymers Michael Berer

> > Polymer Pipes Andreas Frank

Composite Materials Markus Wolfahrt

#### **Circular Economy**





- <u>Ongoing process</u>: How can PCCL 's core competences help to advance sustainable technologies and support circular economy ?
- Core competencences
  - ✓ Polymer chemistry
  - ✓ *Material science of polymers*
  - ✓ Simulation & Modelling
- Expertise also exists with respect to:
  - ✓ *Biopolymers for medical applications*
  - Polymers for renewable energies (Photovoltaics, Hydro-energy)

## **PCCL's competences to increase circularity**



#### **Biopolymers** Synthesis and modification of polymers and fillers from renewable resources

#### Enhanced recycling processes

Use of advanced detection and data processing methods to increase sorting accuracy during mechanical recycling of polymers



#### Ecodesign

Increased recycleability using reversible adhesives

#### **Quality & Reliability testing**

Establishment of structureproperty-processing correlations

#### Lightweight structures

Composite materials

Self healing materials

Reworkable vitrimers

## Increased lifetime of polymeric components

Understanding of interaction of stress factors and material degradation

**Polymer Competence Center Leoben GmbH** *Biopolymers & Biocomposites* 



#### **Eco-Tech: Biopolymers and Biocomposites**

#### Processing of Biopolymers (e.g., PLA)





Structure-property relationships of natural fiber reinforced composites















## Reliability Challenges for New PV Material & Module Developments

Dr. Gernot Oreski

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## Polymers in PV modules





Multi-material composite containing glass, polymers, semiconductors and metal Choice of polymers has distinctive impact on PV modules attributes such as

- 1) Efficiency, as the optical properties of encapsulant (transmittance) and backsheet (reflectance, back scattering) define the number of photons arriving at the solar cell
- 2) Quality, as the main infant failures are caused by bad processing parameters, which are defined by the encapsulant properties, and material incompatibilities
- **3) Reliability,** as most PV module degradation modes are directly linked to polymer degradation and material interactions with polymer components

## Polymers in PV systems





© http://de.cnsolarenergy.com/rews/floating-pv-solar-power-plant-goes-everywhere-18748614.html

## Floating bodies

Balance of System
✓ Cables & Cable ties
✓ Inverter (casings)

#### **PV modules**

- ✓ Encapsulants
- ✓ Backsheets
- ✓ Junction box (casing; mold)
- ✓ Adhesives for frame and Junction Box







Damage analysis

## Main research topic





#### **Challenges for new materials and components**

- Check of compatibility of PV module components will get more and more important in the future, as the variety on materials and components will grow
- Emergence of new degradation modes



- ✓ Delamination
- ✓ Corrosion
- Discoloration



Better understanding of material properties of polymers in PV modules and their influence degradation processes is a precondition for a successful development of new components and reliable PV module designs

https://doi.org/10.1016/B978-0-12-811545-9.00006-9 https://doi.org/10.1002/pip.3323 https://doi.org/10.1016/j.solmat.2018.12.027 https://doi.org/10.1016/j.solmat.2021.110976

## Highlights



#### **Repair solution for cracked backsheets**



 Successful Restoration of electrical insulation properties and prevention of further growth of microcracks
 https://doi.org/10.1016/j.solmat.2019.110194

https://doi.org/10.1016/j.solmat.2019.11019 https://doi.org/10.1002/ese3.118

## Lamination process optimization



https://doi.org/10.1016/j.solmat.2013.04.022 https://doi.org/10.1016/j.solmat.2015.07.0403 https://doi.org/10.1002/app.44912 Investigation of the crosslinking behavior of EVA encapsulant during module lamination

3



Potential for cycle time reduction by 50% revealed



## PV systems designed for specific environmental conditions - Integrated PV

#### **Desert PV**



#### Vehicle integrated PV



© Sono Motors

Agri PV



© Fraunhofer ISE

**Floating PV** 



**Building integrated PV** 

© Ertex Solar

#### PV in transport infrastructure



<sup>©</sup> AIT



## Polymers from renewable ressources





Poly(2-oxazoline)-Based Photoresists from Renewable Resources

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**European Polymer Congress - EPF 2015** 



Competence Centers for Excellent Technologies

## Motivation





# Solvent-free syntheses and halogen-free solvents for resist formulation and development

**Renewable resources** 





Modular adaption to individual requirements

## Water-Developable Photoresists









V. Schenk, L. Ellmaier, E. Rossegger, M. Edler, T. Griesser, G.Weidinger, F.Wiesbrock, *Macromol. Rapid. Commun.* **2012**, *33*, 396-400. Wiesbrock, F.; Stelzer, F.; Schenk, V.; Ellmaier, L.: Fotolack. AT511 707 13.09.11 Wiesbrock, F.; Stelzer, F.; Schenk, V.; Ellmaier, L.: [DE] FOTOLACK; [EN] PHOTORESIST; [FR] LAQUE PHOTOSENSIBLE. WO2013/036979 14.08.12

## Bio-degradable floor sealings



Project ECO-Seal (funded by **FFG**) Dr. Frank Wiesbrock



- Substitution of petrochemical based floor sealings
- Focus on biobased polymers with good degradability
- Free of "microplastics"



**Protection of water and environment** 



#### **Polymer Competence Center Leoben GmbH**



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20

