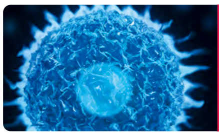


ADVANCED MATERIALS SCIENCE

Fields of Expertise TU Graz

Source: istockphoto.com

This summer, extreme weather events demonstrated the tremendous power of the elements.

Our society faces enormous challenges minimizing and tackling the consequences of global warming and the changing economic landscape. Thus, new materials and concepts are needed for more efficient energy conversion and storage, for lightweight construction, for waste reduction, but also for analytical or biomedical applications. Materials must be designed to maximize their use, re-use and recyclability. More than ever, materials research is a central key to a better sustainable future. Members of the FoE Advanced Materials Science are actively working on these challenges.

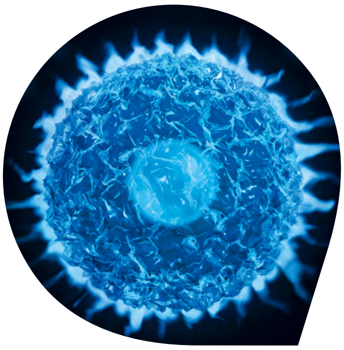
In the 21st call of the initial seed funding of TU Graz, we could finance six innovative project proposals in the areas of physics, chemistry and materials science: Oliver Hofmann, Institute of Solid State Physics; Mohan Tamilselvan, Institute of Chemistry and Technology of Biobased Systems; Anna Galler, Institute of Theoretical and Computational Physics; Francesco Carraro, Institute of Physical and Theoretical Chemistry; Caterina Czibula, Institute of Bioproducts and Paper Technology; and Gean Henrique Marcatto de Oliveira, Institute of Materials Science, Joining and Forming. The project ideas range from density functional theory studies to develop new materials, research on biomedical materials, new innovative analytical tools, organic frameworks, and 3D printing of new composite materials.

We wish all recipients good luck for their proposal submissions, and we look forward to more submissions at the next call. Finally, save the date for **Advanced Materials Poster Day 2025** taking place on **4 February 2025** at Campus Neue Technik, lecture hall H – "Ulrich Santner". We are looking forward to discussing your research with your poster.

Karin Zojer, Gregor Trimmel and Sergio Amancio

Source: Lunghammer – TU Graz

Advanced Materials Science



Thomas Rath

Advancing a Sustainable Future with Research on Emerging Solar Cell Technologies

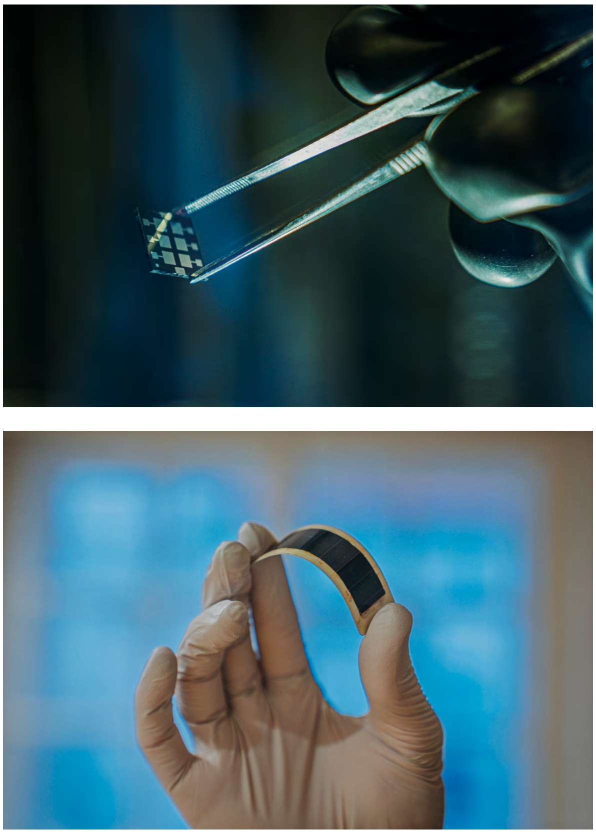
Photovoltaic solar energy conversion holds a central role in a clean and renewable energy supply of the future. While silicon solar cell modules are already well established, emerging solar cell technologies such as perovskite and organic solar cells can significantly broaden the possible applications of photovoltaics due to many advantages, ranging from flexibility, light weight, or semitransparency to a very low carbon footprint. >

Perovskite solar cells are known for their high efficiencies, achieving up to 26%. However, the use of toxic lead in these highly efficient solar cells raises environmental concerns, pushing the need for a more sustainable alternative.

Thomas Rath coordinates the SMARTLINE-PV project, funded by the European Union's Horizon Europe Research and Innovation program. In this project, a consortium of 13 project partners, including universities, research organizations, and companies, develops efficient lead-free perovskite photovoltaics through innovative precursor solutions and a fast plasma-assisted crystallization process (Figure 1). This solar cell technology is targeted for applications in Internet of Things (IoT) devices and building-integrated photovoltaics (BIPV).

Figure 1: Thomas Rath at the Institute for Chemistry and Technology of Materials working in a glovebox, where perovskite solar cells are fabricated and characterized.

Source: Moritz Wehr, Horizon Films



TRANSITIONING TO TIN HALIDE PEROVSKITES

Tin halide perovskite solar cells and modules (Figure 2) offer a promising alternative to their lead-based analogs, but challenges in efficiency, stability and large area fabrication make further research in this field necessary. In SMARTLINE-PV, novel precursor chemistry is used to obtain precise control of the tin perovskite crystallization. Innovative crystallization mediators reduce the tin perovskite crystallization speed, allowing the growth of crystals with less defects in the perovskite films. This is expected to have a positive effect on the efficiency and stability of tin perovskite solar cells.

Furthermore, this approach enables, in combination with a plasma-assisted crystallization technique, to perform the crystallization without the typically used anti-solvent dripping process. Solvent-free crystallization makes the process more sustainable and opens up the possibility of homogeneous large area processing of tin perovskite films.

Figure 2: A tin perovskite solar cell and a flexible perovskite solar cell module.

Source: Moritz Wehr, Horizon Films

To improve the properties of the tin perovskite films, the SMARTLINE-PV team plans to explore non-oxidizing solvents for the tin perovskite precursor solutions as well as the effects of van der Waals interactions. Research on tailored interlayers will also assist the improvement of efficiency and stability.

SELECTABLE COLORS, SUSTAINABILITY AND DEMONSTRATORS

The MorphoColor® technology, inspired by the wings of a butterfly, comprises a photonic structure combining a geometrically structured substrate with an interference layer and offers customizable colors, ideal for BIPV. SMARTLINE-PV aims to achieve power conversion efficiencies above 20%, and by reducing energy consumption and costs in their fabrication through fast low-temperature processes, the tin-based perovskite solar cells will be a competitive alternative to other thin-film technologies.

Moreover, sustainability is at the core of SMARTLINE-PV. Through eco-design and circularity, the entire lifecycle of the solar cells – from production to recycling or disposal – is designed to minimize environmental impact.

In SMARTLINE-PV, BIPV as well as IoT demonstrators are fabricated and tested under real-world conditions. Solar cells embedded directly into building materials, such as facades and roof tiles (Figure 3), combine energy conversion with aesthetics, which well aligns with Europe's green transition goals.

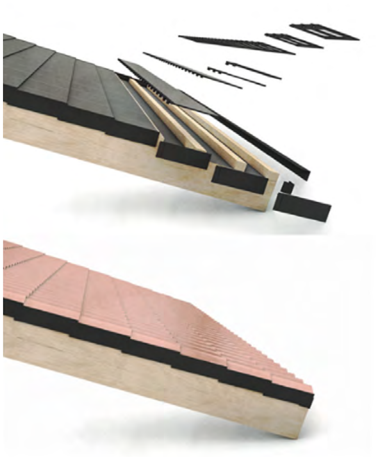


Figure 3: The envisaged application of solar roof tiles with selectable color.

Source: Viktor Karla, Silvester Filkorn, Filbau

A NEW ERA FOR PEROVSKITE SOLAR CELLS

By addressing efficiency, scalability, sustainability, and aesthetics, SMARTLINE-PV paves the way for a new generation of thin-film photovoltaics. These advancements will help Europe strengthen its role in renewable energy and contribute to global efforts to reduce the environmental impact of electricity generation.

Thomas Rath

is a senior scientist at the Institute for Chemistry and Technology of Materials (ICTM) at TU Graz and coordinator of the SMARTLINE-PV project. His research focuses on sustainable concepts for solar energy conversion, in particular materials for organic and lead-free perovskite solar cells. Recently, he received the Zero Emissions Award from the Austrian Science Fund (FWF) for his contributions to renewable energy research.

Source: Sabine Hoffmann, alpha+