PRESS RELEASE

Making matter talk with "smart rust" - European excellence funding for Fraunhofer ISC scientists

Materials are actually "silent". Although temperature, moisture, chemical influences or mechanical stress leave their mark and have an effect on their strength and service life, they can hardly tell us anything about their history of use. Knowing more about the history of such influences could therefore make a decisive contribution to product quality. However, there is still no solution for making materials talk about their history. The "SmartRust" research project now aims to change this.

The European Research Council (ERC) is a body of the European Union that funds excellent scientific projects by outstanding researchers. The ERC has now awarded an ERC Consolidator Grant to a scientist for a research project that aims to do just that: transform objects into matter that can perceive and communicate environmental influences. Karl Mandel, Professor of Inorganic Chemistry at Friedrich-Alexander-Universität Erlangen and Head of the Particle Technology Group at Fraunhofer Institute for Silicate Research in Würzburg, is convinced: "If materials are enabled to report on their history, this will make a significant contribution to ensuring product safety and reliability, enabling predictive maintenance, making complex recycling states of materials transparent and permitting autonomous, robot-controlled, resilient manufacturing."

Prof. Dr. Mandel wants to achieve this idea with intelligent magnetic particles that are largely based on iron oxide, hence the figurative project name "SmartRust". Micrometre-sized supraparticles are composed of magnetic nanodevices, the "signal converters", which are combined with other, non-magnetic components, the "sensitizers". A toolbox-like approach makes it possible to assemble nanoparticles from signal transducers and sensitizers as desired. The customized SmartRust particles are then integrated into the materials that are to be made to "speak".

SmartRust is thus breaking new ground in research, as Mandel emphasizes. "We suspect that there is an interplay between two magnetic interaction principles." According to this, on hierarchical level I, a triggering event changes the magnetic interactions between the nanoparticles within the individual supraparticles. At hierarchical level II, a triggering event changes the magnetic interactions between the supraparticles, when the matrix of the materials in which these supraparticles are embedded is changed. "The idea is that this magnetic interaction information can be read out quickly, easily, non-destructively and from inside a material." Thanks to the ERC funding, an interdisciplinary team from Prof. Mandel's research groups at the

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Friedrich-Alexander University in Erlangen and Fraunhofer ISC in Würzburg can now work on the scientific principles and technical implementation. "If we succeed in obtaining a meaningful signal-structure-trigger correlation, we could ultimately derive design rules on how to create perceptive matter with SmartRust," Mandel is certain.

About the person

Karl Mandel has been Head of the Particle Technology Group at Fraunhofer Institute for Silicate Research ISC in Würzburg, Germany, since 2014 and Professor of Inorganic Chemistry at Friedrich-Alexander-Universität Erlangen-Nürnberg since 2020. He received his doctorate in chemistry from Julius-Maximilians-Universität Würzburg under Prof. Dr. Gerhard Sextl, holder of the Chair of Chemical Technology of Materials Synthesis (degree: 2013). Prof. Dr. Mandel's specialty is the production of supraparticles - mostly by spray drying - to find new and unexpected properties and use them as smart objects that contribute to sustainability. To date, he has published around 100 papers.

The ERC Consolidator Grant

The European Research Council (ERC), founded by the European Union in 2007, is the most important European funding organization for excellent frontier research. It funds creative researchers of all nationalities and ages who carry out projects throughout Europe. The ERC offers four central funding programs: Starting Grants, Consolidator Grants, Advanced Grants and Synergy Grants. For this year's Consolidator Grants, 308 researchers were selected from 2,130 applicants. "The new winners of the Consolidator Grants represent some of the best European researchers," says ERC President Prof. Maria Leptin.
The Consolidator Grants support excellent scientists at the career stage where they are in the process of consolidating their own independent research teams to pursue their most promising scientific ideas. The grants, worth a total of 627 million Euros, are part of the EU's **Horizon Europe** program.

Image material

Heading with excellence for perceptive matter: Karl Mandel. © K. Selsam, Fraunhofer ISC

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The **Fraunhofer Institute for Silicate Research ISC** (headed by Prof. Dr. Gerhard Sextl) is one of the leading R&D centers for materials-based research and development in the fields of resource efficiency, energy, environment and health. With around 400 scientists and technicians, the institute works to develop innovative functional materials and technologies for more sustainable products that use fewer resources, and to make significant contributions to solving the major global issues and challenges of the future. With its parent institute and the Fraunhofer Translational Center for Regenerative Therapies in Würzburg and the Center for High Temperature Materials and Design HTL in Bayreuth, Fraunhofer ISC combines first-class materials science expertise with many years of experience in materials processing, industrial application and upscaling of production and process technologies to pilot scale, as well as materials analysis and characterization. With a clear focus on sustainability, the institute is a strong R&D partner for industrial partners and supports less resource consumption and responsible production with its developments.

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