PRESS RELEASE

Smart Manufacture – Economic Processing on Lot Size One

Individually manufactured and still suitable for mass production? Cost pressures on the one hand and demand for individualized products on the other require new flexible production processes and materials with individual functionality. The Fraunhofer Institute for Silicate Research ISC is working on sustainable material concepts and processing technologies that are scalable, variable and efficient – in order to meet "mass production with lot size one" and to enable small, variable and efficient manufacturing units. At this year's NANOTECH in Tokyo, examples from three different work areas of the Fraunhofer ISC will be shown.

Stretchable Sensors and Actuators

Integrating sensoric functions into textiles or elastomers is difficult because it requires elastic sensors. The Center Smart Materials CeSMA of the Fraunhofer ISC has developed highly elastic sensors and actuators based on silicone. They provide a wide range of sensoric and active functions for smart electronic textiles (e-textiles) with a broad application potential in medical technology, sports, furniture, or vehicles.

By adding electrically conductive components like silver nanowires, carbon black or metallic particles, silicone can be produced as a stretchable conductive foil, usable e.g. as flexible heating element. If alternating layers of conductive and insulating silicone are coated in a roll-to-roll process, stretchable capacitors are created that can be used to measure strain and pressure. For functional components like stretchable electrodes or heating foils the silicone matrix is filled by conductive particles. Depending on the application, the design and softness of the sensors can be adjusted. This allows tailor-made sensitivity and characteristics of the sensors according to the requirements. The stretchable sensors and actuators can be applied to textiles by printing techniques or simply by ironing. The material and processing concept offers high customizing potential concerning functional properties, shape and application techniques.

Scalable Particle Manufacture and Functionalization

With its unique concept of an open access infrastructure for (nano)particle development and upscaled processing on a pilot line level, Fraunhofer ISC offers profound know-how in particle synthesis and manufacture. The approach enables the pilot production of various particle systems and composites. Essential elements of the pilot line in Wuerzburg are the particle synthesis in batches up to 100 liters, modification and separation methods such as semi-continuous operating centrifuge and in-line analyses and techniques for the uniform and agglomeration free

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incorporation of nanoparticles into composites. Customized particle design and scalable production can provide a new approach to individualized functionalization, adding particles with the required functionalities.

Magnetic (nano)particles are one of the core topics of particle technology in Wuerzburg. Usable as markers as well as smart switching additives or for the waste water treatment, magnetic (nano)particles have high application potential. One of the latest developments is the precise, fast and efficient heating, achieved by magnetic particles exposed in an oscillating magnetic field. This allows simple, cost-effective and automatable industrial processes. For example, very fast curing of resins and silicones or local heating of catalysts or adhesives can be realized. In addition, the bonding/debonding of joined parts is also very attractive for recycling-friendly products.

3D-printed Optics for Individualized Mass Production

In the field of illumination optics, the two Fraunhofer Institutes for Silicate Research ISC and for Optics and Precision Engineering IOF developed new material concepts and processing technology for multifunctional and individualized optical components for "lot size one". High demands are placed on optical systems in the field of lighting. The materials used should be as glass-like as possible, with no yellowing during long term operation and a high transparency in the visible part of the spectrum. Artifacts or inhomogeneities in the printed volume caused by the layer-by-layer processing and not very smooth surfaces due to printing structures on the micrometer scale are unacceptable for use in optical systems. However, with ORMOCER®s – glass-like inorganic-organic hybrid polymers – from the Fraunhofer ISC and an improved printing technology from the Fraunhofer IOF, the optical quality could be accomplished. Specially adjusted optical ORMOCER®s have already been used in the area of optical assembly and connection technology by the Fraunhofer ISC scientists. Due to further development, the initial material was refined for the enhanced 3D printing process, as provided by the Fraunhofer IOF. The combination of material and technology avoids defects on surfaces and in volumes that would otherwise result from 3D printing. In addition, other required functional components such as apertures, electrically conducting tracks or mirrors can be integrated into the printed optical components during the manufacturing process. This simplifies later assembly and enables the manufacture of highly complex optical components. Thus optical systems can be easily created by combining optical ORMOCER®s and digital manufacturing processes.

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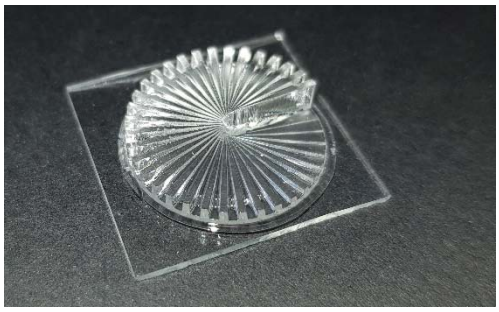
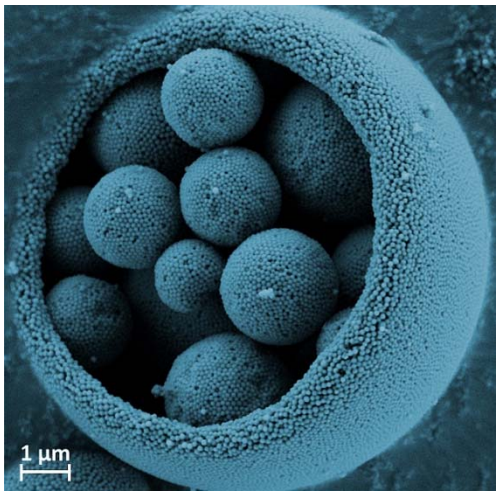
Stretchable sensors – design freedom and customized functionality © Fraunhofer ISC



3D printed optical components © Fraunhofer ISC



Functionalized silica particles © Fraunhofer ISC

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The **Fraunhofer-Gesellschaft** is the leading organization for applied research in Europe. Its research activities are conducted by 72 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 26,600, who work with an annual research budget totaling 2.6 billion euros. Of this sum, 2.2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

The **Fraunhofer Institute for Silicate Research ISC** (director Prof. Dr. Gerhard Sextl) is one of the leading Bavarian R&D centers for material-based research and development in the fields of energy, environment and health. With a permanent staff of about 380 scientists and technicians the Institute works to develop innovative materials and technologies for sustainable products and make essential contributions to solving the major global issues and challenges of the future. With its parent Institute and the Translational Center in Wuerzburg, and its Center for High-Temperature Materials and Design HTL at Bayreuth Fraunhofer ISC combines first-rate expertise in materials science with long-standing experience in materials processing, industrial application and the upscaling of production and process technologies to pilot scale as well as in materials analysis and characterization. With a clear focus on sustainability, the Institute with its project groups is a strong R&D partner for industrial partners.

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