

PRESS RELEASE

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New Laboratory Makes Kilogram-Scale Chemical Syntheses of Plastics Possible

When plastics are developed, it's okay to "go a bit over the edge". Because to be able to make reliable statements on the application options for new polymers, excipients, and additives, it is important to be able to process them into components and test specimens, as well as characterize and test them under realistic conditions. However, this requires them to be available in sufficient quantities. For this reason, the Fraunhofer Institute for Structural Durability and System Reliability LBF, based on many years of experience in polymer research, has set up a new kilogram lab that enables laboratory syntheses to be upscaled to kilograms. In reactors and autoclaves with a volume of up to 20 liters, the scientists are capable of carrying out polymerizations and organic syntheses under different conditions. The products obtained can then be examined practically.

When developing new plastics or optimizing existing ones, the process chain frequently begins with the synthesis of new additives, monomers, and excipients, or the polymers themselves. Once the basic proof of concept has been demonstrated in the laboratory, these are processed and tested in the next step under realistic conditions. Generally, only a few grams of a substance can be synthesized in a chemical lab. Usually this is enough to be able to examine the physical, chemical, or thermal properties of the resulting materials.

However, larger quantities are necessary to be able to make reliable statements about the application options for these materials. Practical parameters in particular, such as mechanical properties, durability, look or feel, can only be assessed if the materials are processed under realistic conditions. This applies above all to thermoplastic materials, where the parameters during processing have a significant influence on the final product properties. Processing on practical machines requires at least a few hundred grams, but several kilograms of a material are preferable.

To be able to examine both the institute's own developments as well as those commissioned by industry customers, and at a single location under suitable conditions, Fraunhofer LBF has set up a new kilogram laboratory, which enables the synthesis of a wide variety of substances at a kilogram scale, allowing them to be processed further at the in-house applications laboratory and provided for corresponding testing. Reactors and autoclaves with volumes of up to 20 liters are available in different versions, permitting reactions in temperature ranges from -80° to 250° Celsius, under inert conditions, at pressures of up to 60 bar or in a vacuum. Upscaling a reaction is more than just the multiplication of the reaction volume. Further aspects, such as a

Editorial office

Anke Zeidler-Finsel | Fraunhofer Institute for Structural Durability and System Reliability LBF | Institute Director: Prof. Dr.-Ing. Tobias Melz
Bartningstraße 47 | 64289 Darmstadt | www.lbf.fraunhofer.de | anke.zeidler-finsel@lbf.fraunhofer.de | Telephone +49 6151 705-268

changed thermal transfer, secure handling of larger quantities of reactants and products, as well as preparation and post-processing, must be considered.

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Kilogram laboratory bridges the gap

In the new Fraunhofer LBF kilogram laboratory, reactions such as the synthesis of polymers with special architectures can be carried out, which can be used as coupling agents or compatibilizers in order to improve mechanical properties, transparency, or adhesion to dissimilar materials. The use of gaseous monomers and reactants is also possible. As a result, thermoplastic elastomers made of styrene and butadiene can thus be produced by means of anionic polymerization and subsequent hydrogenation. Further synthesis examples include the production of aqueous polymer dispersions that can serve as binders, additives such as flame retardants or stabilizers, curing agents for epoxy resin, as well as the surface functionalization of fibers or (nano) fillers.

With its kilogram laboratory, Fraunhofer LBF can take its chemical solutions to special customer requests to a higher scale. The resulting products can either be processed further in LBF's own applications laboratory or provided to customers for their own application tests. Customers that have already developed a product at the laboratory scale can then upscale the product to kilograms by the LBF to be able to assess their applicability.

About Fraunhofer LBF's plastics research division

Fraunhofer LBF's plastics research division, which evolved out of the German Plastics Institute [Deutsches Kunststoff-Institut DKI], provides its customers with advice and support along the entire added value chain from polymer synthesis to the material, its processing and product design through to the qualification and verification of complex safety-critical lightweight construction systems. The research division specializes in the management of complete development processes and advises its customers at all stages of development. High-performance thermoplastics and compounds, duromers, duromer composites and duromer compounds as well as thermoplastic elastomers play a key role. The plastics division is an identified skills center for questions regarding additivation, formulation and hybrids. It has extensive expertise in analyzing and characterizing plastics and the changes in their properties during processing and in use, and also in developing methods for time-resolved processes.

FRAUNHOFER INSTITUTE FOR STRUCTURAL DURABILITY AND SYSTEM RELIABILITY LBF



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The new Fraunhofer LBF kilogram laboratory enables laboratory syntheses to be upscaled to kilograms. Picture: Raapke/Fraunhofer LBF.



(Left): With Filtration, products are isolated and purified.

(Right): A 20-liter autoclave enables syntheses under inert conditions as well as in a vacuum or under increased pressures.

Photos: Raapke/Fraunhofer LBF

On behalf of customers, **Fraunhofer LBF** in Darmstadt develops, assesses and implements customized solutions for mechanical engineering components and systems, especially for safety-related components and systems. This is carried out in the performance fields of **Vibration Technology, Lightweight Design, Reliability and Polymer Technology** and includes solutions ranging from product design to verification – customized for you, for each individual client. In addition to the evaluation and optimized design of passive mechanical structures, the Institute designs active, mechatronic-adaptronic functional units and implements them as prototypes. In parallel it develops appropriate forward-looking numerical and experimental methods and testing techniques. Customers come mainly from automotive and commercial vehicle construction, shipbuilding, aviation, machine and plant construction, power engineering, electrical engineering, construction, medical engineering, the chemical industry and other industries. They benefit from the proven expertise of some 400 employees and cutting-edge technology accommodated in more than 11,560 square meters of laboratory and experimental space at locations in Bartningstrasse and Schlossgartenstrasse.

Further press contact:

Peter Steinchen | PR-Agency Solar Consulting GmbH, 79110 Freiburg | Telephone +49 761 38 09 68-27 | steinchen@solar-consulting.de

Scientific contact: Dr. Roland Klein | Telephone +49 6151 705-8611 | roland.klein@lbf.fraunhofer.de