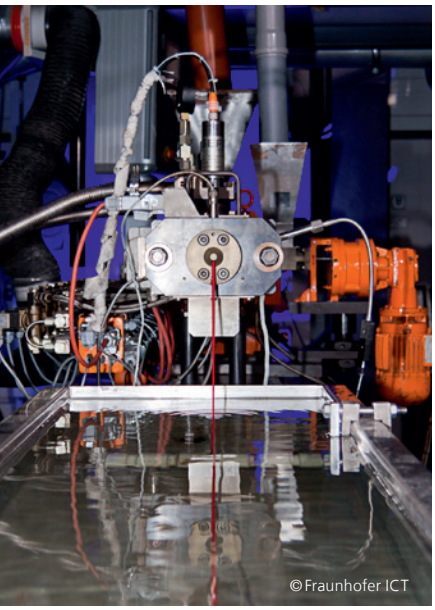
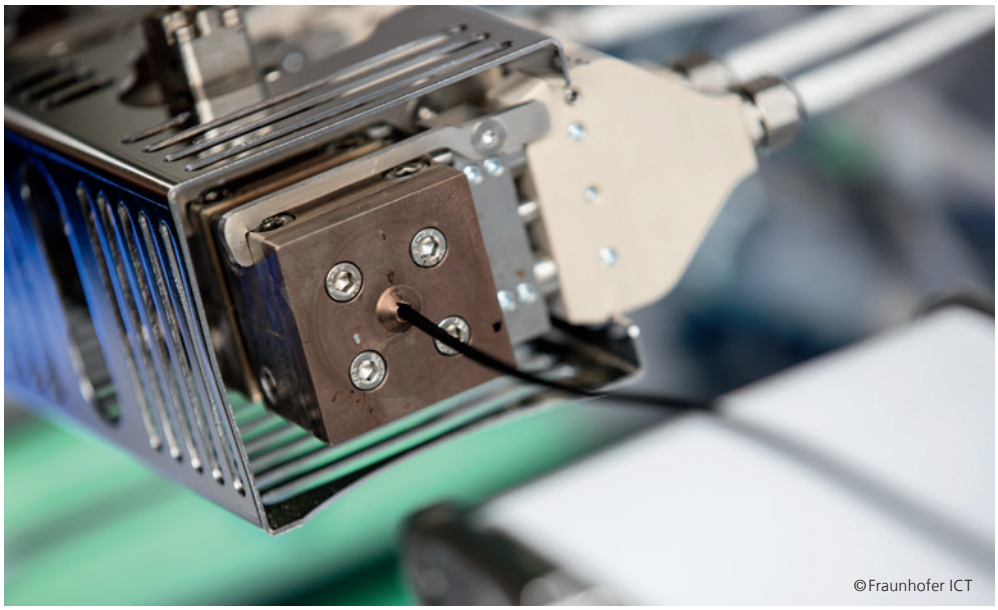
Hybrid Backward Computing for the Plastics Industry

In the Fraunhofer-internal project HyTwin, the ITWM team around Dr. Alex Sarishvili is developing a hybrid digital twin together with researchers from the Fraunhofer Institute for Chemical Technology ICT. Using machine learning (ML) methods, this twin supports companies in the optimization and control of their plastics processing, more precisely their extrusion processes.





A test setup based on real production processes and equipped with extensive measurement technology is being created in the Fraunhofer ICT laboratory.

Extruder, additives, twin screw, nozzle – these are all technical terms from the world of plastics processing, although there are of course many complex variants of production. However, the extrusion process is common to all of them. Here, plastic is pressed as a tough mass under high pressure and high temperature through a shaping opening. At the end, the company receives as a product, for example, thermal insulation panels or plastic granulate for further processing into PET bottles or plastic pipes. "Extrusion is a highly complex physical-chemical process in which hundreds of parameters play a role and which is accordingly difficult to model and optimize," explains Sarishvili. Almost all plastics processed into a product pass through such a step in the process chain.

In the plastics industry, optimizing this still often means using "trial and error" to test how the quality of a product can be improved and optimized by varying individual parameters. Necessary material parameters are determined and tested anew for each material mixture of the real process. This is time-consuming and cost-intensive.

Fraunhofer ICT has a modern pilot plant with twin-screw extruders from 16 to 43 mm as well as versatile metering options at its disposal.

Smart modeled and calculated backwards

Computer simulations or digital twins offer the possibility of optimizing almost the entire extrusion process based on simulation. The project team is taking a hybrid approach: They are developing a digital twin that is both data-based and model-based, which uses AI to predict and optimize. In the best case, the digital twin thinks about the end first and calculates backwards: What product properties or quality do I want and what parameters do I have to set for this? Machine learning processes need masses of data if they are to function properly. At the beginning of the project, therefore, real test data was initially generated at Fraunhofer ICT. They are adapted to a physical-chemical process model and a data cloud of measurement and simulation data is generated. The AI then learns from this.

The expertise of the researchers at Fraunhofer ITWM lies particularly in mathematical modeling and simulation of technical processes. "For many years, (deep) machine learning methods have also been developed at our institute. We are responsible for smart algorithms," says Sarishvili. This has resulted, for example, in the Design for Quality Prediction software tool, which provides essential functions for creating simple data-based models for extrusion processes. As a result, the digital twin should then make it possible to achieve, among other things, higher production speeds, greater flexibility and higher product quality at the lowest possible cost. And not only that, at the end of the project, the goal is an easy-to-use software platform that can also be used by small and medium-sized enterprises (SMEs).

The team also has new projects lined up already: The ENERDIG project, promoted by the Federal State of Rhineland-Palatinate with funds from the European Fund for Regional Development (EFRE), just for starters. The focus here is on determining and optimizing the energy flexibility of extrusion processes.

More information on process analysis using machine learning at www.itwm.fraunhofer.de/process-analysis

Contact

Dr. Alex Sarishvili
Department "System Analysis, Prognosis and Control"
Phone +49 631 31600-4683
alex.sarishvili@itwm.fraunhofer.de