

# SAFE PRODUCTION AND PROCESSING OF HAZARDOUS MATERIALS





## **FRAUNHOFER ICT HAS A LONG HISTORY IN THE FIELD OF EXPLOSIVES TECHNOLOGY AS WELL AS SAFETY RESEARCH**

Our comprehensive expertise in the field of explosives technology means that we have advanced competences in the safe design and operation of hazardous processes (explosive, toxic or corrosive). As one of the very few explosives research institutions in Europe we have the authorization and appropriate infrastructure to handle substances that are not usually permitted in standard laboratories.

At Fraunhofer ICT, specially equipped laboratories, explosion-proof facilities and pilot plants are available for the synthesis of explosives and otherwise hazardous substances under safe conditions. Manipulators are used for the handling of highly sensitive materials. For production purposes we develop and employ remotely-controlled or fully automated processes.

Various analytical methods and comprehensive characterization techniques are available to compile all relevant safety and performance data of potentially hazardous materials. These include thermal stability, mechanical stability, friction and impact sensitivity, chemical stability and compatibility, self-heating and autocatalytic decomposition, aging behavior and long-term stability. Knowledge of these data is essential to ensure the safe production and processing of hazardous materials.



## PROCESS DESIGN AND DEVELOPMENT

Continuous processing involving concepts of micro reaction technology is a key element in our development of safe processes.

The advantages of micro process technology are particularly significant when potentially hazardous processes are involved. Strong exothermic reactions are processed almost isothermally due to the outstanding heat exchange characteristics of our micro-structured reactors. This highly effective heat management facilitates the suppression of hotspots, decomposition reactions and labile by-product formation, and enables significantly shorter dosing times. The small reactor hold-up in our continuous processes makes the synthesis and downstream processing of toxic, explosive or otherwise unstable products and intermediates safer than in any conventional batch process. In combination with the short residence time that we can provide, hazardous materials are safely produced at the point of use where they are immediately further processed. Recent processes that we have developed include strong exothermic nitrations, halogenations, sulfonations, ethoxylations, generation of diazomethane and the synthesis of various explosives.

Besides numerous laboratory processes, Fraunhofer ICT has also developed special multipurpose processes on a pilot plant scale, allowing the continuous production of various liquid explosives in relevant production quantities. Typical throughputs are in the range of a few hundred grams per minute.



## SAFETY ANALYSIS

In our microfluidic laboratory processes, we investigate alternative reagents, process conditions and reaction parameters such as temperature, pressure, stoichiometry and dosing time that we are unable to apply on a macroscopic scale. We thus identify both critical process conditions and safe process windows, and analyze the sensitivity of the entire reaction system.

Various calorimetric systems are available to determine thermal safety data, ranging from classical reaction calorimetry to adiabatic calorimetry and continuous reaction calorimeters developed in-house, allowing almost real-time process monitoring.

## FACILITIES

- Chemical plants and synthesis laboratories for explosive and otherwise hazardous materials
- Safety boxes for the remote controlled operation of hazardous processes (at lab and technical scale)
- Testing sites for explosives and safety investigations

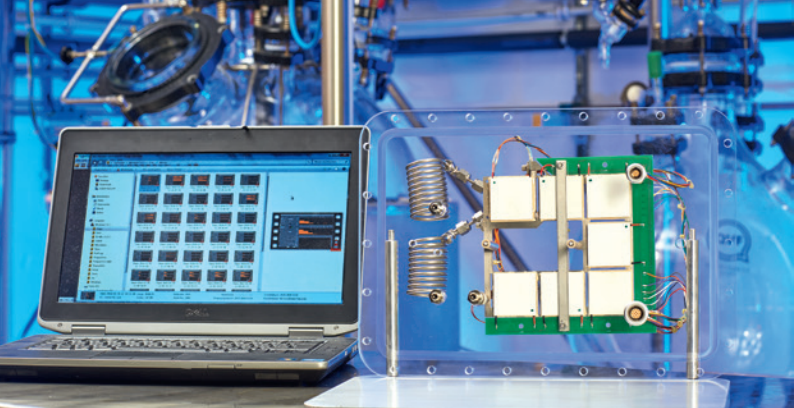


## EQUIPMENT

- Microreactor test stands and synthesis units
- Multipurpose microreactor plants at technical scale for the continuous synthesis and work-up of hazardous materials
- Pilot plant for safe synthesis upscaling up to 50 liters of reaction volume
- Reaction calorimetry (batch and continuous)
- Adiabatic calorimetry (ARC), micro calorimetry (TAM), thermal analysis (DSC, DTA, TGA, SDTA, EGA)
- Test stands for impact and friction sensitivity
- Detonation chamber
- Test stands for thermal stability and aging behavior
- Cutting-edge process spectrometers for inline, online or atline process monitoring (UV/Vis, NIR, IR, Raman)

## OUR OFFER

We provide our customers and project partners with rapid and comprehensive R&D services in the field of chemical process safety. We offer feasibility studies, targeted analysis of individual process steps, process development and process optimization services as well as detailed safety investigations. We develop tailored process safety concepts for customer-specific tasks in all areas from laboratory to production scale.



## **Fraunhofer Institute for Chemical Technology ICT**

Joseph-von-Fraunhofer-Strasse 7  
76327 Pfinztal (Berghausen)  
Germany

### **Contact**

Dr. Dušan Bošković  
Phone +49 7 21 46 40-759  
[dusan.boskovic@ict.fraunhofer.de](mailto:dusan.boskovic@ict.fraunhofer.de)

[www.ict.fraunhofer.de](http://www.ict.fraunhofer.de)