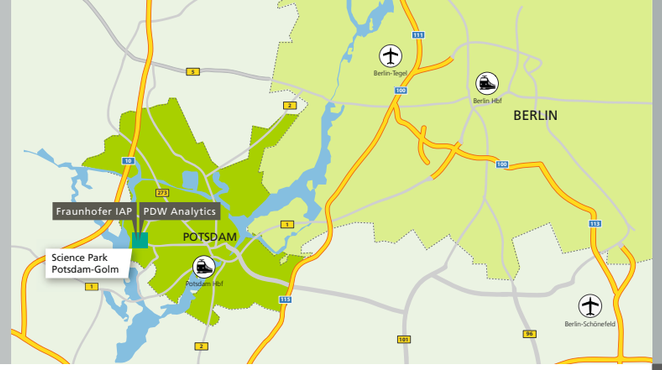
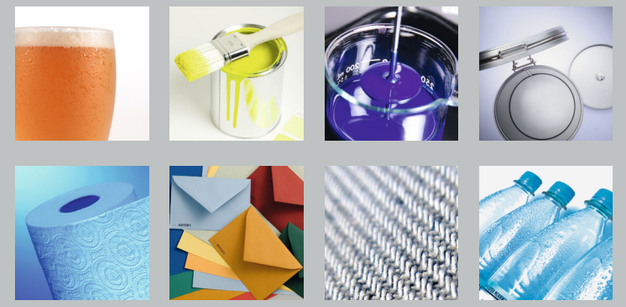


Fraunhofer IAP

FRAUNHOFER INSTITUTE FOR APPLIED POLYMER RESEARCH IAP



HIGHLIGHTS

The Fraunhofer Institute for Applied Polymer Research IAP and PDW Analytics GmbH in Potsdam-Golm have collectively extended the possibilities for particle detection and process development.

This has resulted in a globally unique process analysis platform in which particles between 50 nm and 2 mm can be directly detected inline and on a continuous basis at high concentrations.

Highlights:
- Continuous inline process monitoring
- Detection of particles from 50 nm to 2 mm
- No sample taking necessary
- Undistorted particle size distribution
- Measuring methods that don't require calibration

Potential:
- Tracking and understanding the course of the polymerization
- Increased process reliability
- Efficient process designs
- Recognizing and understanding coagulation phenomena
- Development of feedback strategies

PARTNERS

Fraunhofer Institute for Applied Polymer Research IAP

The Polymer Synthesis Department has many years of in-depth experience in the area of synthesis and polymer dispersions using emulsion, suspension, dispersion, mini-emulsions and inverse emulsion polymerization, as well as in the area of polyaddition reactions in non-aqueous heterophase systems.

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PDW Analytics GmbH

PDW Analytics GmbH is a young innovative company that was created through an academic spin-off of the University of Potsdam. The managing shareholders have more than 10 years of academic and industrial experience in the areas of process analytics and particle characterization.

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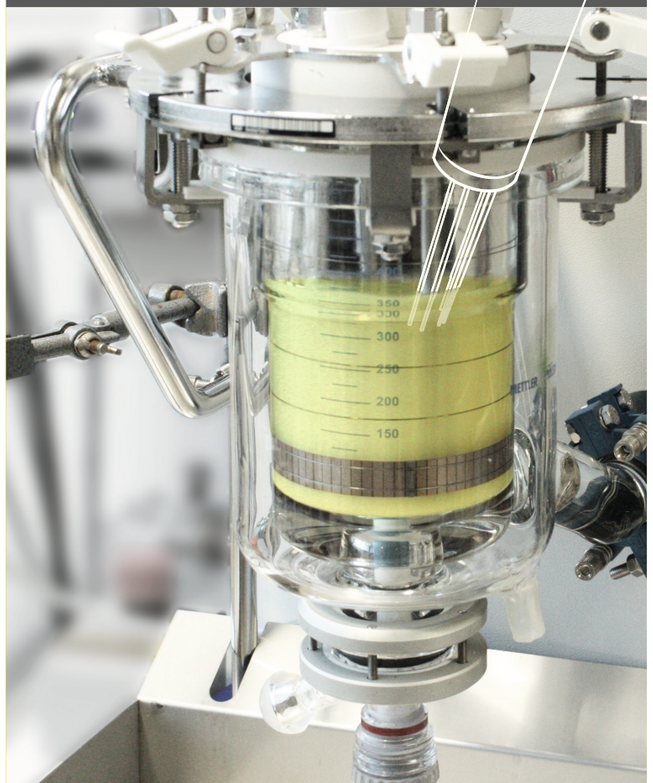
Fraunhofer IAP

PDW ANALYTICS

Process Development for Polymer Dispersions

Continuous inline measurement
of particle sizes from 50 nm to 2 mm

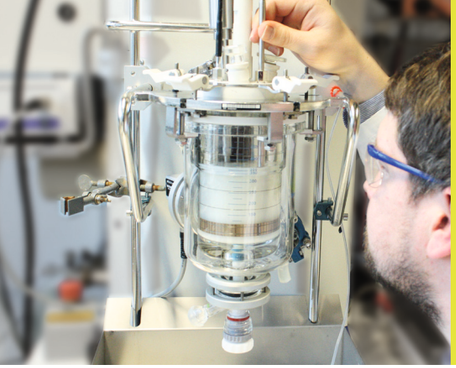


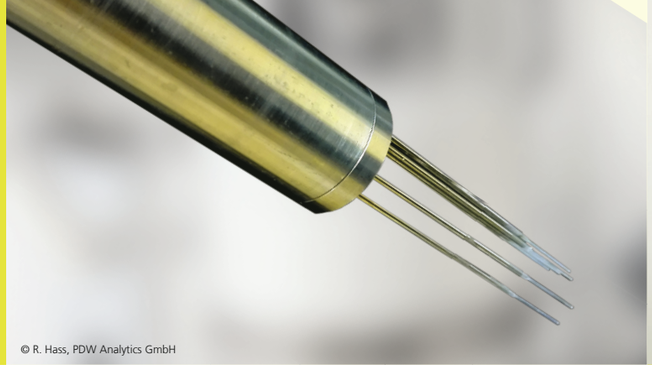
CHALLENGES

Polymer dispersions represent a large proportion of the global polymer market. They are used either directly, for instance as coatings or adhesives, or are intermediate products in the plastics industry, for example in PVC or ABS.

The particle size distribution of polymer dispersions is a crucial performance characteristic in regard to their application. Established measuring methods provide reliable results only when the dispersions are heavily diluted. This means it is always necessary to take samples. However, particle and droplet systems often react extremely sensitively to changes in the system – particularly during the polymerization reaction. Therefore, the offline measurement of diluted samples is frequently not representative of the actual state of the reaction. Furthermore, time delays, until analysis results become available, are counter-productive for the development of optimum process control.

Industrial practice is, therefore, dependent on long-term experience and trial and error approaches when it comes to optimizing processes. The resulting process frequently does not achieve its optimum efficiency in terms of product properties and production costs. This is particularly critical in the case of new developments that need to enter the market quickly.





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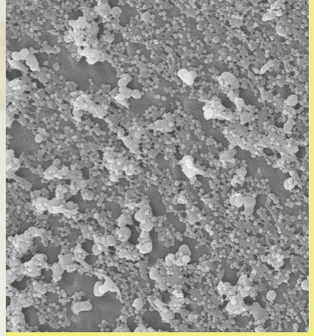

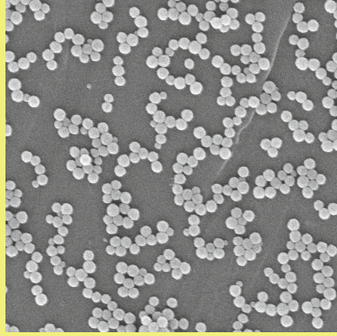

before process optimization

after process optimization

HARDWARE MEETS KNOW-HOW

PDW Analytics GmbH in Potsdam has developed a method of inline measurement of particle sizes between 50 nm and 500 µm that uses **photon density wave spectroscopy**. This innovative technology was integrated into the process development station at the Fraunhofer IAP. The latter is based on an **automated reaction calorimeter RC1e** which regulates reaction conditions and records essential parameters, such as reactor and jacket temperature, heat flow, metered flows, pH value and dispersion viscosity.

Other inline sensors are installed alongside the PDW sensor, which simultaneously determine chemical changes in the system and provide additional measurement values in terms of the size distribution and shape of larger particles over 1 µm. This enables **major process steps**, such as the emulsification of the monomers, particle formation and colloidal stability to be **tracked** during the actual process so that a basic understanding of the processes taking place can be developed.

All of the data obtained from the inline analysis can simultaneously be used to **control the process**. The unique **technical equipment**, combined with the know-how of the Fraunhofer IAP in the area of polymer processes, enables a more effective process design and the development of feedback strategies.

OUR EQUIPMENT

The RC1e work station for process development | Heat flows and real-time calorimetry | 100 mL to 1.5 L | –10 °C to 200 °C | –1 to 60 bar | Glass and stainless steel reactors, variable stirring elements | Intelligent control through reaction parameters

In situ PDW sensor | Characterization of particles, droplets or biological cells in highly concentrated liquid media (> 40 vol%) | Quantitative separation of absorption and scattering: calibration-free, independent, double process tracking

In situ FBRM sensor | Detection of particles ≥ 1 µm through the measurement of focused laser backscattering | Changes in the size distribution, shape and number of particles in real time

In situ PVM sensor | Video microscopy: Visualization of particles ≥ 2 µm | Relative backscatter index (RBI trend)

In situ FTIR sensor | Changes in the concentrations of reactive and transient species | Measurement in the liquid and gaseous phase

Scale-up | 25 L enamel reactor | Variable stainless steel pressure reactor systems between 1.5 L and 40 L | –1 to 60 bars | Up to 300 °C | Inline sensors can be implemented

Reference analysis

APPLICATIONS

Inks and coatings

Adhesives
e. g. for packaging, wood adhesion, binder for cement

Paper and cardboard
e. g. laminates, moisture resistance, adhesion

Textiles and nonwovens
e. g. for coatings: protective clothing (fire brigade), rainwear, car seat covers, underside of carpeting

Leather refining

Printing inks
e. g. flexographic printing inks for printing on packaging

Immunoassays

The platform can also be used in the areas of cosmetics, the food industry and biotechnology
e. g. creams, lotions, PIT emulsions, juices, milk, fermentation processes, algae cultivation, wet grinding

WE OFFER YOU

- A complete range of R&D services for polymer dispersions
- Investigation and improvement of synthesis processes in terms of their ability to achieve product properties, robustness and efficiency
- Improvement of uncertain sub-steps within an existing process
- The development of completely new heterophase processes and process steps
- A determination of critical process parameters and parameter windows/safety considerations
- The customer-specific development of polymerization processes on a lab to mini-plant scale
- Inline measurements in the course of scaling up/on-site implementation of in situ measuring technology

Potential aspects
- Monitoring of particle size distribution
- Optimization of polymer composition and structure
- Achievement of specific particle morphologies
- A selection of suitable surfactant mixtures
- Synthesis of hybrid materials