



High Power Ultrasonics in Flow Chemistry

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About Hielscher Ultrasonics

- ▶ Manufacturer of ultrasonic homogenizers
- ▶ Family-owned, founded in 1992
- ▶ Headquarter in Teltow (near Berlin)
- ▶ Development and production of all ultrasonic devices in Teltow, Germany
- ▶ Long-time experience in developing ultrasonic systems and processes
- ▶ USA branch: Hielscher USA, Inc. in Ringwood, NJ, USA

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Why Ultrasonics?

- ▶ Innovative process technology
- ▶ Easy feasibility testing
- ▶ Unique results
- ▶ Very interdisciplinary
- ▶ Competitive advantages
- ▶ Real innovations (IP, patents)
- ▶ High energy efficiency
- ▶ Synergies with other technologies



Hielscher Ultrasonics - Product Range

Lab



Feasibility

Bench-top



Optimization

Production



Scale-Up

Industries

- ▶ Nano technology
- ▶ Pigments, paints, inks, coatings
- ▶ Chemistry, biology, food, pharma & cosmetic
- ▶ High performance polymers & coatings
- ▶ Material research & development

Applications

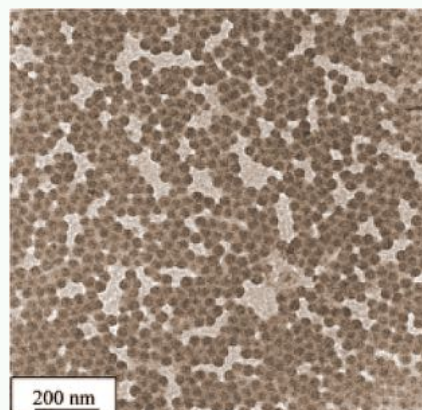
- ▶ Wet-milling, disintegration of primary particles
- ▶ Dispersion & Deagglomeration
- ▶ Emulsification
- ▶ Sono-Catalysis: emulsion chemistry, phase transfer catalysis
- ▶ Sono-Synthesis: precipitation of nanoparticles

Ultrasound in nano technology

- ▶ Nano-emulsione
- ▶ Nano-dispersione
- ▶ Functionalized nanoparticles
- ▶ Synthesis of nanoparticles

Nano-Emulsions

- ▶ efficient, fast emulsification
- ▶ improved emulsion stability



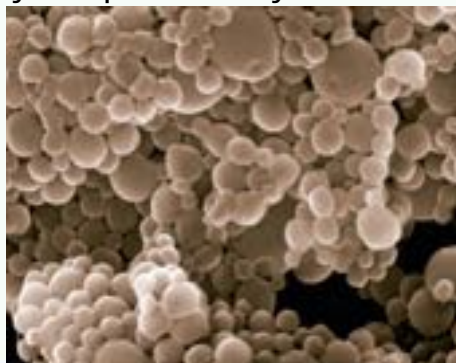
Particles obtained by polyaddition in miniemulsion

Dispersion of nanoparticles

- ▶ for nano und primary particles
- ▶ improved dispersability
- ▶ improved dispersion stability
- ▶ improved hydrophobic properties

Functionalization of nanoparticles

- ▶ improved dispersibility
- ▶ improved dispersion stability
- ▶ improved hydrophobicity



Advantages of ultrasonication

- ▶ Highly efficient milling & dispersing
- ▶ Easy cleaning (no grinding beads)
- ▶ Inline & batch processing
- ▶ User-friendly
- ▶ Linearly scalable
- ▶ No moving parts (no rotors)

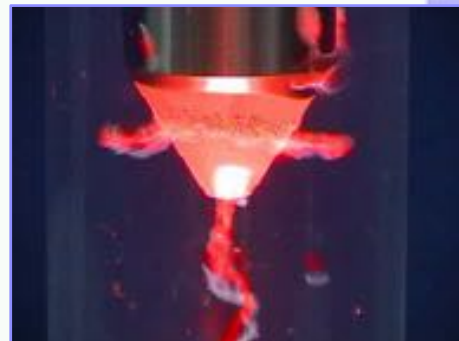
Working principle of ultrasound

- highly intensive ultrasound
 - low liquid volume
 - high amplitude
 - high pressure differentials

-> **strong cavitation**

locally:

- up to 1000bar
- up to 5000K
- liquid jets with up 1000km/h
- hot spots: 150µm



Scalability of ultrasonic processes

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Scale Up



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Sono-Chemistry

Phase transfer catalysis

- ▶ Ultrasonic effects:
- ▶ Improved phase transfer
- ▶ Higher yields
- ▶ Faster reaction rate
- ▶ Less by-products

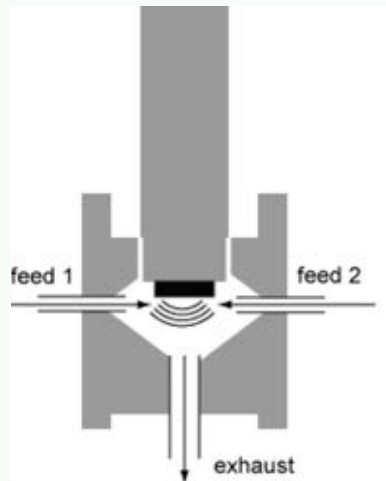
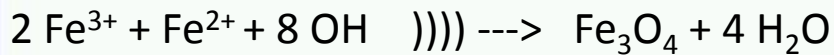
„Ultrasonication promotes phase-transfer kinetics in chemical processes“

Ultrasonically-Assisted Catalysis

- ▶ Ultrasonic flow reactors:
- ▶ Various geometries
- ▶ Special design
- ▶ Easy to clean
- ▶ Easy to operate

Ultrasonic Precipitation of Catalysts

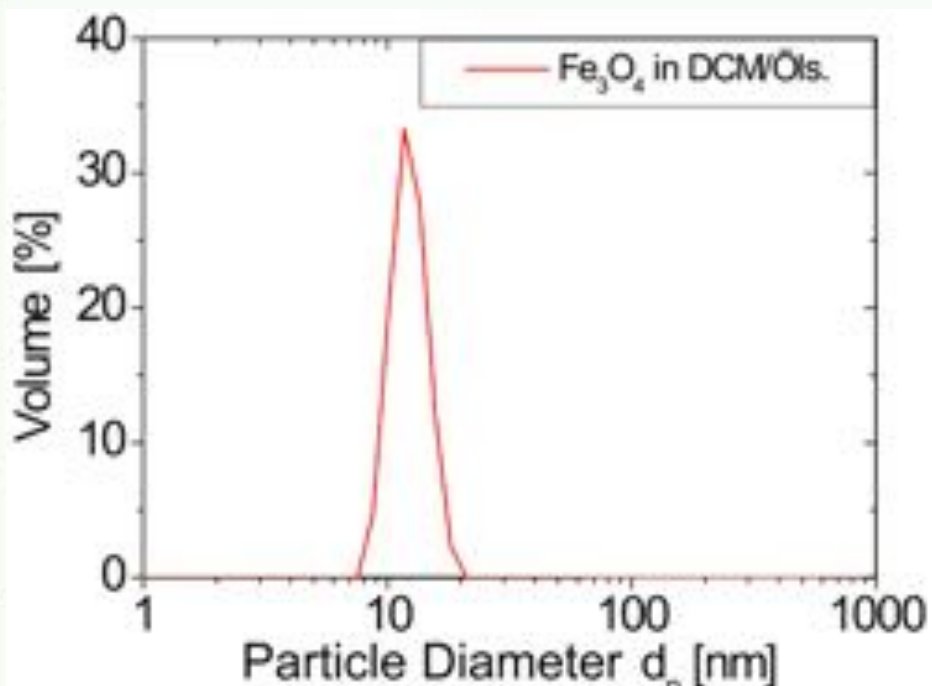
Precipitation of supramagnetic Fe_3O_4 nano particles:



Banert, T., Brenner, G., Peuker, U. A. (2006), Operating parameters of a continuous sono-chemical precipitation reactor, Proc. 5. WCPT, Orlando Fl., 23.-27. April 2006.

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Ultrasonic Precipitated Magnetite



Banert, T., Brenner, G., Peuker, U. A. (2006), Operating parameters of a continuous sono-chemical precipitation reactor, Proc. 5. WCPT, Orlando Fl., 23.-27. April 2006.

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