Synthesis of spherical nanosized copper powder by ultrasonic spray pyrolysis

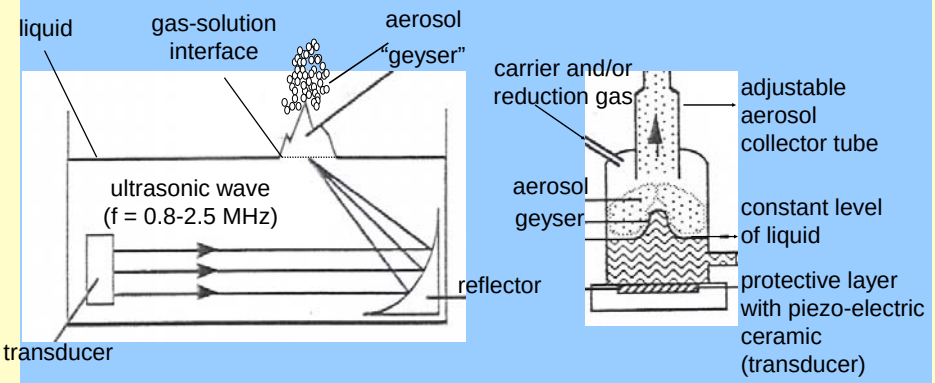
Target: Synthesis of spherical nanosized Cu-powder

- very fine grain size, high uniformity and big specific surface
- better in many applications than commonly used Cu-powders (not possible to produce with electrolytic or hydrogen reduction of $CuSO_4$ in an autoclave)

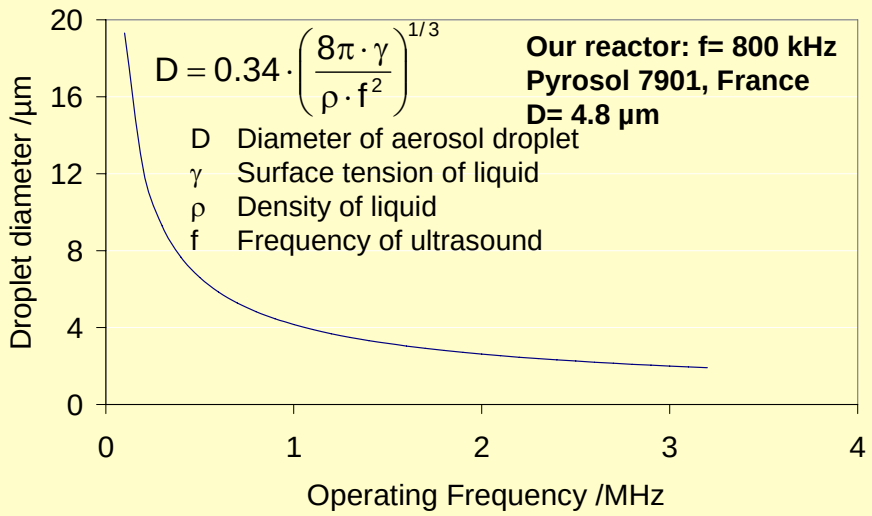
Idea and method

- Ultrasonic spray of Cu-sulfate-solutions (aerosol formation)
- hydrogen gas reduction pyrolysis
- Use of copper acetate $(CH_3COO)_2Cu$ instead of CuSO4
- Use of HCOOH instead of hydrogen gas for reduction

Principle of ultrasonic spray pyrolysis



Calculation of aerosol droplet size



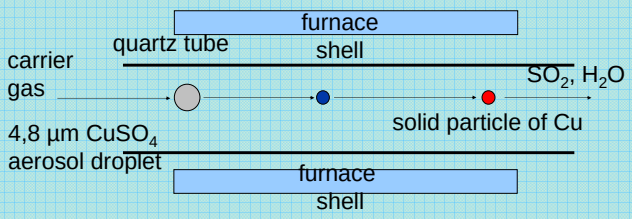
$$D = 0.34 \cdot \left(\frac{8\pi \cdot \gamma}{\rho \cdot f^2} \right)^{1/3}$$

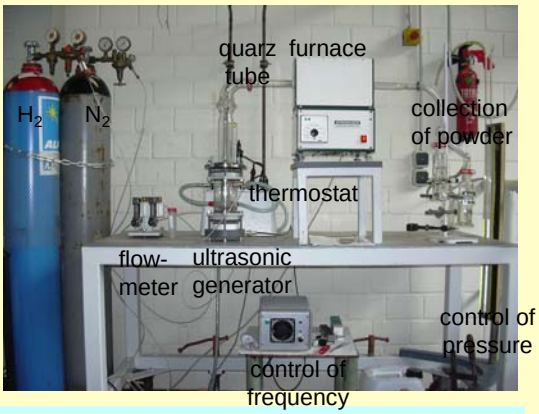
Our reactor: f= 800 kHz
Pyrosol 7901, France
D= 4.8 µm

D Diameter of aerosol droplet
γ Surface tension of liquid
ρ Density of liquid
f Frequency of ultrasound

Transformation of aerosol droplets into particles

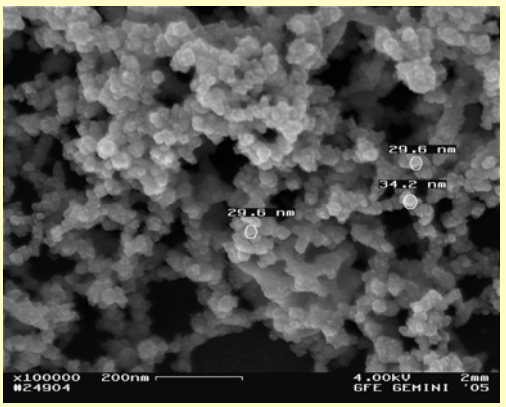
1. Evaporation 2. Precipitation 3. Drying 4. Reduction





Reaktion parameters

- temperature (800°C – 1000°C)
- concentration of $CuSO_4$ and CuAc (0.05 - 0.2 mol/l)
- concenration of HCOOH (3-6 mol/l)
- flow rate of hydrogen (1l/min)



SEM micrograph of Cu- Powder (T=1000°C, c_{CuSO4} =0.05 mol/l)

SEM micrograph of Cu-Powder (T=1000°C, C_{HCOOH} = 0.2 mol/l)

Ultrasonic spray of $CuSO_4$ and $(CH3COO)_2Cu$ solutions followed by hydrogen reduction pyrolysis is suitable for the synthesis of spherical non-agglomerated particles of Cu-nanopowder.

Contact: nanoworld@ime-aachen.de
Prof. Dr.-Ing. B. Friedrich
IME Metallurgische Prozesstechnik und Metallrecycling
RWTH Aachen