Online Characterisation of Nanoparticle Morphology tailored by Gas-dynamically Induced Particle Synthesis

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The variety of processes for gas-phase nanoparticle synthesis can be reduced down to just a small number, if high mass throughputs are desired (flame reactors, hot wall, reactors plasma reactors).

An innovative concept of high throughput gas phase particle reactor has been proposed (Dannehl et al., 2007). Both, initiation of chemical reaction, and quenching of high-temperature gas flow are realized by gas-dynamic shocks in a reactor with two supersonic nozzles. (Fig. 1). The quenching of the high-temperature particle loaded gas flow is achieved by accelerating the flow from subsonic to supersonic speed which decreases the static temperature blow the sinter temperature of the particles.

Because of a homogeneous flow field, an adjustable residence time and high heating and quenching rates tunable size distribution and aggregation is achieved (Grzona *et. al.*, 2009, Goertz et al. 2010). Therefore this method is a potent alternative when nano-scaled mono-dispersed material manufacturing is demanded.

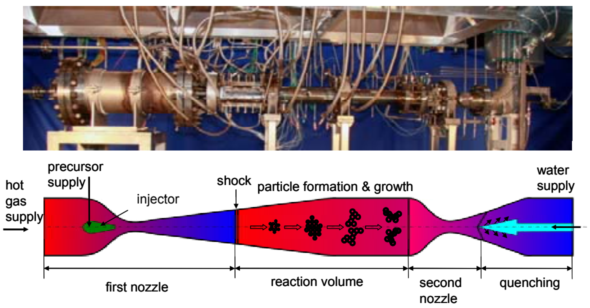

Fig. 1. Gas-dynamically Induced Particle Synthesis

For process control of such a reactor fast and online measurement for nanoparticles, agglomerates, e.g. particle morphology is required. Most of the current aerosol instruments are designed for spherical particles. Therefore, there is a need for instruments capable of fast and online measurement of gas-borne nanoparticle agglomerates.

Recently, a new measurement device for online characterization of gas-borne nanoparticle agglomerates has been developed (Pui et al. 2009). UNPA (Universal Nanoparticle Analyzer) utilizes Differential Mobility Analyzer (DMA), Condensation Particle Counter (CPC) and Nanoparticle Surface Area Monitor (NSAM) to characterize airborne nanoparticle morphology and measure the number, surface area and volume distributions of airborne nanoparticles. The key parameter measured is the UNPA sensitivity, which is defined as the current (fA) measured by the NSAM divided by the number concentration measured (#/cm^3)

$$S = I/N \text{ (fA cm}^3\text{)}.$$

Former experimental data have shown that the UNPA sensitivity S depends on the particle morphology. S is larger for loose agglomerates than for spheres at a fixed mobility diameter.

Experimental UNPA sensitivity measurements in the particles/gas flow behind the quenching show suitable results for the online characterisation of the particle morphology (Fig. 2) under different process conditions.

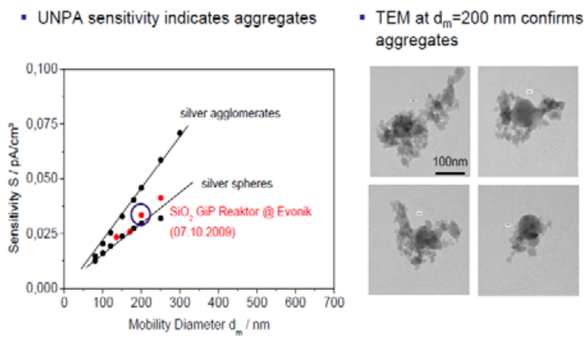

Fig 1. UNPA sensitivity for process parameters A

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