ParteQ

POWDER FUNCTIONALIZATION

- ☐ HETEROGENEOUS CATALYSTS
- ☐ BATTERY MATERIALS
- ☐ SENSORMATERIALS

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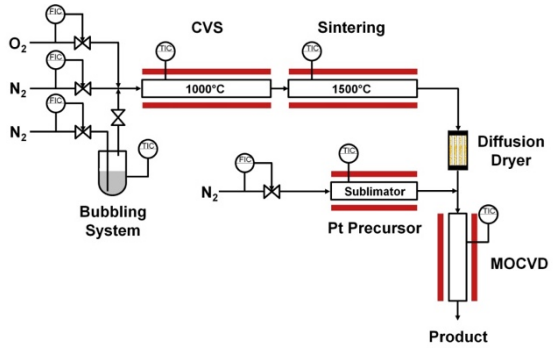
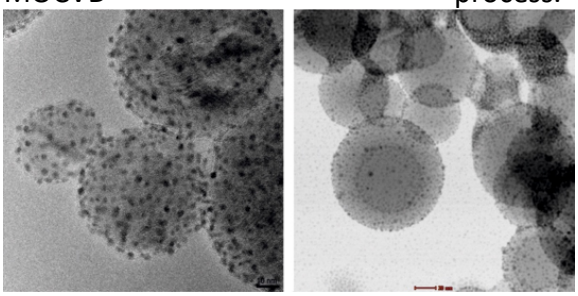
The ParteQ process for particle functionalization is based on the coating of metals or oxides by chemical vapor phase deposition (CVD). The process enables a unique degree of control over structural features such as size and surface texture of support particles and size and number density of supported metal particles or the thickness of oxide shells. We can generate a vast variety of structures, from simple mixed oxides over supported metal islands to core-shell structures and Janus-particles.

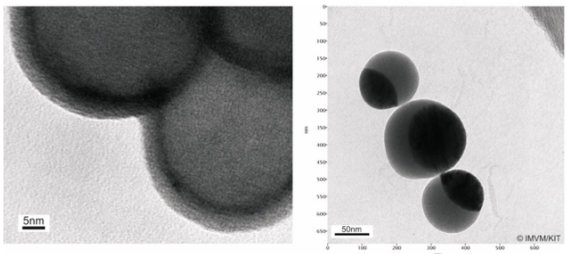
The technique was originally developed as an aerosol process, which allows extreme control but low product yields, and combined the synthesis of the support material by Chemical Vapor Synthesis (CVS) with the coating by CVD in an integrated process. CVS combined with CVD is an attractive process for the synthesis of metal clusters supported on oxide nanoparticles such as SiO_2, TiO_2 and Al_2O_3. Due to solvent free synthesis in the CVS step the nanoscale substrate generated is highly pure and its surface chemistry such as hydroxylation can be controlled. Additionally, the deposition of the metal clusters can be accomplished with high precision regarding particle size and loading independent of each other by the MOCVD process.



The generation of a continuous aerosol stream of Pt/SiO_2 nanoparticles is shown above. After restructuring and sintering of the initially fractal structures, the now spherical SiO_2 aerosol particles were passed through a diffusion dryer to remove water vapor. The aerosol was then mixed with the Pt precursor which was fed from a temperature controlled sublimator and carried by nitrogen. A surface chemical decomposition reaction of the Pt precursor then led to the formation of Pt-islands on the SiO_2 support in the MOCVD furnace Pt/γ-Al2O3 could also be prepared similarly with Aluminum s-butoxide by this process. The size distribution and the number density of noble metal clusters can be controlled by the concentration of the precursor and O_2 in the gas phase in the MOCVD process.



Some examples of structures obtainable with the aerosol process are shown below. The images above show noble metal particles of about 2 nm in diameter on the surface of oxide support particles. The TEM-images below show on the left a multilayer coating of bismuth oxide on a second oxide layer coating a binary oxide core while the right hand side shows a Janus-like particle.



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To increase the product yield and to obtain scalability the process was transformed into a fluidized bed system.

The system allows the functionalization of micropowders on the nanoscale but avoids the necessity of handling nanopowders which is advantageous in further processing but also from an environmental health and safety point of view. Our fluidized bed reactors are heatable up to 200°C allowing thermal CVD processes. They are vacuum tight and can therefore be operated with reactive atmospheres and for the processing of air- or humidity sensitive systems. ParteQ offers systems from the lab-scale (e.g. WSR50) to pilot scale (e.g. WSR160) as complete systems including precursor dosing, and solids handling.

WSR50 with a diffuser diameter of 50 mm for the multigram scale

WSR 160 for the kg scale

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