198c Formation of Spherical Nanosized Semiconducting Particles from the Gas Phase and Deposition of Size-Selected Particle Layers

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The physical properties of nanosized materials in the size regime below 10 nm depend substantially on size and morphology. Within the last years, nanoparticle synthesis from the gas phase has been intensively investigated in our group. Different types of low pressure gas phase reactors like premixed flame-, hot-wall- and microwave plasma-reactors have been developed to characterize the specific conditions that influence particle formation and growth. Flame- and plasma-reactors produce well crystallised, spherical and less agglomerated particles due to high temperature and high temperature gradient. While the flame reactor is suitable for synthesis of oxidic products, the plasma reactor does not have these restrictions.

This contribution focuses on the synthesis and characterisation of nano-sized materials like SnO_x, GeO_x, ZnO, TiO_2, In, Si, and ITO, which are of high interest due to their properties in sensing, catalysis, and electronics. The particle size is an essential factor that influences these properties. The ascendancy of formation conditions on stoichiometry, crystal structure, and size will be illustrated. Process pressure, precursor concentration, and gas composition have been intensively investigated with respect to particle growth and chemical constitution. Particle mass spectrometry has been applied as a useful tool to determine the particle growth in situ. Additionally, this analytical method enables the deposition of size-selected particles with a very small size distribution on any substrate by means of a particle-loaded molecular beam. Sub-monolayer as well as particle multilayer have been deposited for application devices including characterisation, and further processing, e.g. gas sensors, conducting films or catalysis. For example, different samples of SnO_x with mean particle diameter $3\ nm \leq dp \leq 7\ nm$ and stoichiometry $1.4 \leq x \leq 1.8$ were synthesized and intercepted on interdigital capacitors. The sensing properties of the deposited particle films were characterised using impedance spectroscopy.