Multicore@shell nanoparticles synthesized from a multicomponent target by gas aggregation cluster source

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In nanoscience, the fabrication of multifunctional nanomaterials with unique properties as well as their optimization is an ongoing challenge. The synthesis by gas cluster aggregation source (GAS) offers the opportunity to fabricate a wide range of nanoparticles in terms of particle size, morphology and chemical composition in a single preparation step.
In this work, nanoparticles from titanium oxide (TiOx) and gold (Au) are fabricated by GAS from a single multicomponent target.

The morphology of the resulting particles is analyzed by bright field transmission electron microscopy (TEM) as well as high angle annular dark field (HAADF) scanning TEM (STEM). The crystal structures are determined by selected area electron diffraction (SAED), high resolution TEM (HRTEM) as well as high resolution STEM (HRSTEM). Energy dispersive X-ray spectroscopy (EDX) is combined with STEM to gain local information on the chemistry of the particles. X-ray photoelectron spectroscopy (XPS) as well as X-ray diffraction (XRD) are applied to confirm and complement the results from TEM.

In TEM, the nanoparticles were observed to consist of several Au cores embedded in a TiOx matrix, resulting in a multicore@shell (Au@TiOx) morphology. The Au was present in its standard cubic crystal phase while TiOx was found to be in the amorphous state. Changes in the GAS source pressure were applied to alter the particle size and deposition rate. Upon heat treatment for 1 h at 500 °C in air, the TiOx crystallized to anatase TiO2 while the Au partially formed larger particles and partially diffused to the surface of the nanoparticles.
The preparation of Au@TiOx nanoparticles by GAS gives the possibility to prepare nanoparticles of complex morphology. Heat treatment of the material can be applied to tailor the crystal structure of the TiOx as well as the distribution of the Au. This approach can solve the issue of poor adhesion of Au on TiO2 since Au nanoparticles are mechanically fixed in a TiO2 matrix. The approach of GAS preparation of multicomponent nanoparticles can in principle be applied to a broad variety of materials and material combinations.

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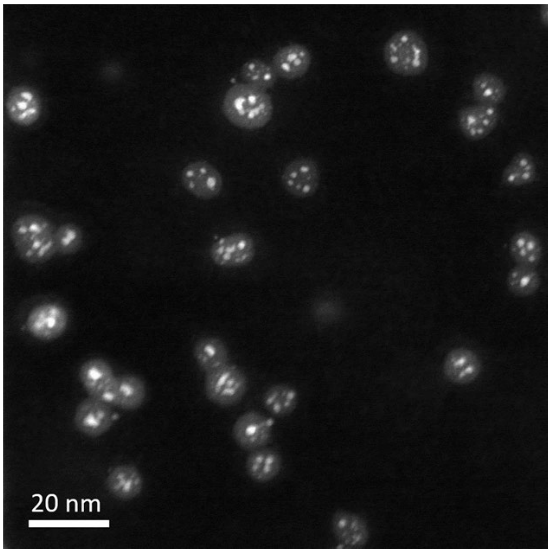
Graphic:



Keywords:

Multicomponent Nanoparticles, TiO2, Au, GAS