[P14] Surfactant-free synthesis and characterization of highly dispersible antimony-doped tin oxide nanoparticles

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Antimony-doped tin oxide (ATO) nanoparticles (NPs) are widely utilized in transparent conductive films, solar cells, sensors, and smart coatings due to their excellent electronic conductivity, optical transparency, and chemical stability.[1,2] Although various colloidal synthesis methods for ATO NPs exist, achieving narrow size distribution and good dispersibility remains challenging. Most reported strategies rely on steric stabilization using bulky ligands or surfactants; however, this approach often compromises the electronic conductivity of ATO NPs.[1-5] In the present study, we demonstrate a surfactant-free approach for the hydrothermal synthesis of monodisperse ATO NPs with antimony doping levels ranging from 1% to 13% under alkaline conditions at 150°C in the presence of tetramethylammonium hydroxide (TMAH). Capped by $N(CH_3)_4^+$ cations, the ATO NPs are highly stabilized via electrostatic repulsion, which significantly improves dispersibility and prevents agglomeration of the as-synthesized ATO NPs in water. X-ray diffraction (XRD) analysis on ATO NPs demonstrated that the samples contained SnO_2 with a tetragonal (rutile-like) symmetry, without any antimony-containing side phases. Further, gradual peak broadening was observed with increasing antimony content, indicating incorporation of antimony into the SnO_2 lattice. ATO NPs dispersed in water exhibited high transparency that increased with higher doping levels. The hydrodynamic diameter measured with dynamic light scattering (DLS) decreases from 25 nm for undoped SnO_2 to 5 nm for 13% Sb-doped ATO, accompanied by a narrow size distribution for all ATO NPs. Transmission electron microscopy (TEM) analysis revealed that undoped SnO_2 NPs possessed a cubic morphology, which progressively becomes less defined as antimony content increased. Crystallite sizes obtained from XRD, particle size distributions from DLS, and particle sizes measured by TEM were in close agreement, indicating that the nanoparticles consist of primary crystallites without significant aggregation. *This work has received financial support from the Energy Transition Fund of the Belgian federal government through the ETF project BE-HyFE.*

References

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