Glycol-Modified Precursors in the Synthesis of Mesoporous, Monodisperse Particles: Synthesis, Characterization and Catalytic Applications

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The focus of this work lies on the synthesis of mesoporous, high surface area SiO_2- and TiO_2-particles employing ethylene glycol modified precursors (EGMS and EGMT, respectively) and their application as catalyst support. Ethylene glycol modified precursors, such as tetrakis(2-hydroxyethyl)orthosilicate (EGMS) as well as bis(2-hydroxyethyl)titanate (EGMT), have distinct advantages in the synthesis of mesoporous materials compared to commercially available tetraalkoxide precursors, since they have proven to be compatible with lyotropic surfactant mesophases and they allow for a processing in purely aqueous conditions. The latter point, additionally gives access to the controlled formation of particles by applying the miniemulsion technique. For a typical synthesis protocol, a dilute hydrochloric acid solution containing an amphiphilic molecule (CTAB, Brij56, P123) and the respective precursor was homogenized with a lipophilic solvent (e.g. Isopar M, a mixture of alkanes) using ultrasonics. The resulting droplets act as minireactors in which the cooperative self assembly process of the surfactant and condensable precursor proceeds. The hybrid inorganic-organic particles were either calcined or treated by solvent extraction for a complete template removal. The combination of cooperative self-assembly and miniemulsion processing allowed to obtain monodisperse mesoporous and in some cases even mesostructured particles with high specific surface areas. The samples were characterized by XRD, electron microscopy (REM, TEM) and nitrogen porosimetry. The potential of these materials for catalytic applications was tested in the low temperature CO oxidation reaction, using Au/TiO_2 catalysts. The catalysts were prepared by deposition precipitation. Measurements of the CO oxidation kinetics, both in dilute $CO:O_2 = 1:1$ mixtures and in H_2-rich gas mixtures ($CO:O_2:H_2 = 1:1:75$) indeed show a high Au-normalized activity and a higher stability (lower tendency for deactivation) of the mesoporous TiO_2 based catalysts compared to Au/TiO_2 catalysts based on commercial TiO_2 (P25, Degussa).