Mixed-ligand titanium alkoxides – stability, precursors for complex oxide materials and use as models for interaction between titania and bioactive molecules

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Titania (TiO_2) nanoparticles are of increasing technological interest. They are found in, for instance, dye-sensitized solar cells, medical implants, drug delivery systems[1] and have recently found potential application in wound-healing.[2] Production of titania nanoparticles commonly goes through the solution-gelation (sol-gel) process where titanium(IV) alkoxides usually are employed as starting materials to obtain crystalline nanosized particles after heat-treatment. Metal oxo-alkoxide complexes are formed as intermediates through simultaneous hydrolysis-condensation reactions, acting as nuclei for the emerging metal oxide nanoparticles.[3] There is a current trend of employing "ligand-stabilized" titanium oxo-alkoxy complexes as molecular catalysts in aqueous systems, without assessing the fate of these complexes in water. Recently, however, evidence against the presumed hydrolytic stabilization by introduction of chelating organic ligands has emerged.[4,5,6,7] We have synthesized a series of titanium alkoxide complexes with different types of ligands (carboxylate, phenoxide, phosphonate, β-diketonate) and demonstrated using different microscopy techniques (SEM, AFM, TEM) their facile hydrolytic transformation in contact with water.[4,5,6,7] Interestingly, the hydrolysis of these complexes afforded crystalline (anatase) nanoparticles of narrow size distribution without need for heat-treatment.[6,7] It further proved possible to obtain complex and hierarchical porous materials, using ligand-substituted titanium complexes.[5,6,7] In the view that metal oxo-alkoxide complexes can be regarded as intermediates between the metal alkoxide precursors and metal oxide nanoparticles, they are excellent model systems for studying the interaction between titania surfaces and bioactive molecules, for instance in drug delivery.[8]

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