Amphiphiles functionalized colloidal metal-oxide nanoparticles: from design to technological applications

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Colloidal inorganic nanoparticles are among the most widely investigated nanomaterials both from the fundamental point of view and for their exploitation as engineered materials for many technological applications: from nanomedicine to bio/chemo-sensing, from photocatalysis and optoelectronics to environmental and energy fields. Among the large variety of colloidal inorganic nanoparticles, metal oxides are considered as very intriguing material to design and engineer nano-systems exerting favorable chemical and optical performances. Indeed, the physicochemical, bioactive and functional features can be finely tuned by controlling the size, chemical composition, atomic doping and surface characteristics. Hence, the surface functionalization with specific moieties or biomolecules represents a valuable strategy to modulate the bio/eco-compatibility as well as the colloidal stability, together with the definition of functionality, thus favoring the use in certain technological fields. In this contest, amphiphilic molecules are good candidates for the surface functionalization of nanoparticles, guarantying a fine tuning of morphology, size and self-assembly behavior as well as of chemical functionality and colloidal stability. Among them, lipids are amphiphilic biocompatible molecules useful to create nanoparticle surface coatings. Similarly, polyphenols are aromatic compounds also including lipophilic and hydroxyl groups which make them intriguing molecules to be used ligand/stabilizer for the inorganic nanoparticles thus furnishing advanced redox behaviour. Here, an overview of metal oxide nanoparticles, such as Fe3O4, CeO2, ZnO and TiO2, prepared via bottom-up wet-chemical synthesis and engineered through a chemical functionalization at a molecular level with amphiphiles, such as lipids or long-chains fatty acids2,3 and polyphenols4,5 , is proposed. The outstanding combination of microscopy, spectroscopic and scattering analyses results decisive to shed light on the physicochemical features of such modified nanoparticles, thus allowing to define the chemistry-structure-function relationships as a decisive step for the development of functional nanomaterials for advanced technological applications.