Colloidal processing of graphene/ceramic composites

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Applications of graphenic compounds have increased significantly in the last few years due to their excellent properties as a reinforcing secondary phase and as a conductive material that make them suitable for both structural and functional applications. The major limitation of carbonaceous materials refers to the difficult dispersion within the ceramic matrix. An effective dispersion can be obtained by colloidal methods so that the control of the colloidal and surface behavior becomes essential to achieve the required uniformity. In this talk, the basics of colloid chemistry are applied to ceramic processing in order to allow the manufacture of complex shaped parts and tailored microstructures of ceramic composites containing graphenic compounds as dispersed phase. The parameters involved in the colloidal processing of graphene/ceramic composites for structural applications are discussed focusing the role of the suspensions stability on the composite performance. On one hand, the preparation of alumina and zirconia monolithic and multilayered composites with graphene oxide by an aqueous tape casting process is described, summarizing also the microstructural features and the mechanical properties of the resulting materials after non-conventional spark plasma sintering. On the other hand, the stabilization of aqueous suspensions of mixtures of manganese dioxide with graphene nanoplatelets is also reported as well as the further manufacture of electrodes onto graphite substrates for applications as supercapacitors. In that case the powder is deposited by an aqueous electrophoretic deposition process without sintering. These examples illustrate the great versatility and reliability of water based shaping methods in the performance of graphene/ceramic composites with multifunctional properties.