Better ceramics through colloid-chemistry

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Ceramic processing received the consideration of a science in the late 70's and early 80's. There was an exponential growth of activity in this field that is still increasing. In addition to the formulation of new materials with enhanced properties, the success for such growth came on the hand of two other sciences that became the basis of the novel processing strategies developed for the production of advanced ceramics: the soft chemistry that allowed the synthesis of purer and better controlled powders and the colloid chemistry that allowed the manipulation of the interparticle forces to achieve ceramics with higher uniformity and reliability. The fundamentals of colloid science apply both in the development of novel synthesis routes of nanopowders and nanostructures and in the shape forming of those powders to produce bulk bodies with complex shapes or tailored micro/nanostructures such as core-shell composites, nanocoatings and layered structures. This work summarizes the basic concepts of colloid science applied to the synthesis and dispersion of diluted and concentrated suspensions, and reports several examples that demonstrate the broad number of possibilities of designing complex shapes and microstructures by manipulation of the colloidal forces operating in the suspensions. On one hand, the production of finer and more controlled powders is possible by techniques such as colloidal sol-gel or the use of microwaves where a diluted suspension is directly obtained and this suspension can be directly shaped using techniques like electrophoretic deposition. On the other hand, the precise control of stability and rheology allows us to obtain concentrated suspensions for direct consolidation using techniques like slip or tape casting, gelcasting, etc. The relationships between suspension parameters and microstructure and properties of the final materials are illustrated with different examples that demonstrate the feasibility of colloidal processing on the design and manufacture of ceramics and ceramic based composites.