NANOZIRCONIA

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Nanostructured Zirconia is finding application in engineering materials, barrier coatings, technical ceramics, sensors, catalysts and fuel cells. Elsa Antunes, Nuno Neves and João Calado present InnovNano's Emulsion Detonation Synthesis method.

Zirconia is one of the most important technical ceramic materials; its excellent mechanical properties ensure it has a broad range of applications. The material is found in natural state in the form of baddeleyite (monoclinic phase). Pure undoped zirconia exhibits the following phase transformations: the monoclinic phase, from room temperature to 1175 °C, tetragonal phase, between 1175 and 2370 °C and cubic phase from 2370 °C to its melting point (2750 °C). Zirconia also has another two phases: orthorhombic I and II at low temperatures and high pressures (above 4 GPa), which is being investigated as a possible candidate for a super hard material.

However, the sintering temperature of zirconia, 1400 to 1500 °C, means that it is difficult to produce ceramic parts with undoped zirconia; during the cooling a volume change (4-5 %) occurs, inherent in tetragonal-monoclinic transformation, which leads to the formation of some cracks on the final pieces. To produce fired ceramic pieces, zirconia material must be stabilised with several oxides (dopants): MgO, CeO2; CaO, Y2O3, etc., the most prevalent stabiliser being Y2O3.

The common method used for the industrial production of yttria doped zirconia powder is the simultaneous hydroxide co-precipitation of zirconia and yttria salts. The hydroxide is then filtered, washed, calcined and milled to the required final narrow size distribution.

It is well known that dynamic shock induces chemical reactions. Emulsion Detonation Synthesis (EDS) is an industrial process patented by INNOVNANO, where material synthesis occurs at very high pressures (1-10 GPa). High pressures are commonly used to modify phase diagrams, and produce novel micro and nanocrystalline structures with different proper-