Nanocomposite Powders for Metal-Ceramic and Carbon Nanotube-Ceramic Composites

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Nanometric metal particles are in-situ synthesized in ceramic powders by reduction of oxide solid solutions in H_2, at 1000-1300°C[1,2]. In the composite powders (Fe- or FeCr-Al_2O_3, FeCr- Cr_2O_3, MM'-$MgAl_2O_4$, MM'-MgO with M and M' = Fe, Co or Ni), metal nanoparticles are located either inside the oxide grains or at their surface, and their size, size distribution and composition can be controlled. The mechanical properties of fully densified composites obtained by hot-pressing have been studied. Efficient mechanical reinforcements have been evidenced for alumina- and spinel-matrix composites[2].

Owing to their exceptionnal properties and a very high aspect ratio, the incorporation of carbon nanotubes into polymer, metal- or ceramic-matrix currently involves many research efforts. We have developed new catalytic chemical vapor deposition (CCVD) methods to synthesize single and double-walled CNT *in-situ* inside ceramic powders (Al_2O_3, $MgAl_2O_4$ or MgO)[3]. A very homogeneous dispersion is achieved, the CNT, individual or gathered in small bundles and form a network surrounding all the oxide grains. In dense composites[4-6] obtained by hot-pressing, most CNT are undamaged. They greatly inhibit the grain growth of the matrix and hamper the densification. In spite of some pull-out during the fracture, a real reinforcement has not been evidenced. However, from a percolation threshold smaller than 1 vol. %, the CNT provide to the otherwise insulating material an electrical conductivity. With $MgAl_2O_4$-based materials, the electrical conductivity can be tailored between 0.004 and 10 $S.cm^{-1}$ by the fraction of CNT.

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