Fabricating eco-friendly nanocomposites of SiC with morphologically-different nano-carbonaceous phases

A route based on aqueous colloidal processing followed by liquid-phase assisted spark-plasma-sintering (SPS) is described for fabricating eco-friendly nanocomposites of SiC with nano-carbonaceous phases (nanotubes, nanoplatelets, or nanoparticles). To this end, the conditions optimizing the aqueous colloidal co-dispersion of SiC nanoparticles, Y$_3$Al$_5$O$_{12}$ nanoparticles (acting as sintering additives), and carbon nanotubes (CNTs), graphene oxide (GO) nanoplatelets, or carbon black (CB) nanoparticles were first identified. Next, homogeneous powder mixtures were prepared by freeze-drying, and densified by liquid-phase assisted SPS, thus obtaining nanocomposites of SiC with CNTs, reduced GO (rGO) nanoplatelets, or pyrolyzed+graphitized CB (p+gCB) nanoparticles. It is also shown that these nanocomposites are dense and have a high hardness of ~20GPa regardless of the nano-carbonaceous phase chosen, but are markedly tougher with CNTs and rGO (i.e., with high aspect ratio nano-carbonaceous phases). Finally, arguments are provided for the appropriate choice of nano-carbonaceous phases for engineering ceramic nanocomposites.
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