Interface characterization of a W-coated diamond/Al composite for thermal management applications

JI G.[1,2,*], Lu Y. G.[2,3], Schryvers D.[2]

[1]*Unité Matériaux et Transformations, UMR CNRS 8207, Bâtiment C6, Université Lille 1, 59655 Villeneuve d'Ascq, France*
[2]*Electron Microscopy for Materials Science (EMAT), University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium*
[3]*Now at Department of Chemistry and Biochemistry, University of Colorado Boulder, Boulder, Colorado 80309, United States*

A W coated diamond/Al composite has been developed, by a sol-gel followed by an optimized Vacuum Hot Pressing (VHP) processes, for thermal management applications in the microelectronic industry. This composite has demonstrated an excellent combination of a thermal conductivity as high as 600 W/mK and a coefficient of thermal expansion lower than 10 ppm/K, being compatible with that of electronic components. Nanoscale interface characterization has been carried out by Scanning Transmission Electron Microscopy (STEM)/Energy-Dispersive X-ray spectroscopy (EDX) and Precession Electron Diffraction (PED) to shed light on the effect of interface formation, reaction and diffusion on Interfacial Thermal Conductance (ITC). The results show that nanoparticles with a size in the range 30-400 nm, instead of a continuous layer, were deposited by the sol-gel process on the surface of diamond particles. In the VHPed diamond/Al composite, the deposited interfacial particle is rich in W and Al and corresponds to the $Al_{12}W$ phase, while the 'clean' diamond/Al interface in between the particles is tightly-adhered and free of oxygen. Such different chemical nature of the bonds at the interface can have a pronounced effect on the local ITC.