High-resolution Raman microscopic study of C60 fullerite transformation upon HPHT treatment

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For the development of metal-matrix composite materials reinforced by superelastic hard carbon particles [1], the fullerite transformation under pressure has been studied after treatment in the temperature range of the transition from polymerized fullerites to the reinforcing phase. The understanding the fullerite transformation mechanism is important for the control of the structure and properties of the final product. The samples have been prepared from the mixture of iron powder with C_{60} fullerites (10%) at a quasi-hydrostatic pressure of 5 GPa at 600-900°C (3 min). The carbon particles were examined with a CRM-200 confocal high-resolution Raman microscope using green lazer (532 nm) with a power density of approximately 0.1 W/cm2. The low power density ensured that no additional photo-induced polymerization occurred in the samples and minimized sample heating. With increasing treatment temperature, the Raman spectrum taken from a local spot of 1 μm in diameter changes from a mixture of the reflections of three polymers (tetragonal, orthorhombic, and rhombohedral [2, 3]) to a halo in a range of 1100-1600 cm^{-1} typical of the superelastic hard phase. After treatment at intermediate temperatures, the high-resolution method showed the coexistence of three types of polymers and the new superelastic hard phase in submicron-size volumes of the carbon particles.

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