Mechanical properties and fracture of superelastic hard carbon particles produced from fullerenes under pressure

Chernogorova O.P.*, Drozdova E.I., Ovchinnikova I.N., Blinov V.M.

Baikov Institute of Metallurgy and Materials Sciences RAS, Leninskii pr. 49, 119991 Moscow, Russia

**e-mail: tchern@ultra.imet.ac.ru*

Superelastic hard materials with a high hardness-to-elastic modulus ratio are advantageous in terms of wear resistance and tribological properties. Bulk particles and samples of superelastic hard phase (SHP) were obtained from fullerenes at a pressure of 3–8 GPa at temperatures of 800–1200 K. Acording to the microindentation data obtained from the loading-unloading curves treated by the Oliver-Pharr method, the SHP samples are characterized by high hardness (35 GPa), high elastic recovery (85–94%), and low elastic modulus (60–150 GPa). The cracking resistance of the SHP particles was estimated with a Vickers tester at a load of up to 20 kgf. After indentation, no radial cracks have been observed on the particle surface, and the residual deformation limited by the contact area between the particle surface and the diamond indenter was expressed by weak cross-shaped grooves left by the edges of the diamond pyramid and small cracks parallel to the pyramid base in the areas corresponding to the pyramid faces. Such behavior of the SHP particles upon indentation displays their ability to withstand heavy contact loads without any severe residual deformation and without any fracture propagation beyond the contact area.

The fracture surface of the SHP samples obtained from coarse C_{60} crystals demonstrates a terraced cracking through internal interfaces corresponding to the shear planes in the original *fcc* crystal. The SHP particles and samples obtained from the aggregates of fine C_{60} crystals exhibit mixed fracture surfaces containing ductile interlamellar component. The particles obtained from the fullerene soot extract (unresolved mixture of C_{60} and C_{70}) exhibit quasi-brittle river fracture surface typical of amorphous materials.