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Tribological properties of metal-matrix composites reinforced by superelastic hard carbon particles

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The materials combining high wear resistance and low friction include metal matrix composite materials (CM) reinforced by superelastic hard carbon particles obtained from fullerenes under pressure [1,2]. The metal matrix metals were selected to differ in the character of the interaction with carbon. The high-pressure high-temperature synthesis conditions (5-8 GPa, 680-1000ºC) provide the collapse of fullerene molecules and their transformation into superelastic hard carbon particles in the metal powder and simultaneously consolidation of the powders into CM samples of 5-10 mm in diameter and 2-5 mm high. Dry tribological tests were performed with a multifunctional UMT-3MO (CETR) setup at a load of 50 N over a fresh track of a tool steel disk for 2 h. The structure and properties of the resulting carbon phase are determined by the CM synthesis parameters and by the composition (C60 or C60/70) of the starting fullerites and their structure state caused by their pretreatment. The hardness, Young's modulus, and degree of elastic recovery of the reinforcing carbon phase were ranged from 10 to 40 GPa, from 60 GPa to 300 GPa, and from 96 to 77%, respectively. An increase in hardness of the carbon particles increases the abrasive wear resistance of the reinforced CM and simultaneously reduces their friction coefficient. The friction coefficient of CM correlates with that of the matrix metal: the lower is the friction coefficient of the matrix metal, the lower is the friction coefficient of CM: the reinforcement with 10% carbon phase decreases the friction coefficient from 1.12 to 0.74 for Ag, from 0.57 to 0.24 for Fe, from 0.49 to 0.2 for Ni, from 0.48 to 0.17 for Co; and from 0.3 to 0.15 for Cu. Compared with the properties of the matrix metal without reinforcement, the friction coefficient CM is reduced by a factor of 1.6 - 3, and the abrasive wear resistance increases by a factor of 5 - 200.