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Study of diamond+SiC composite material wetting by melted metals

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Results of theoretical and experimental studies of the diamond+SiC composite material surface wetting by metal melts forming the base of commercial solders are presented. The adhesion-active additive of Ti has been established to enhance considerably the material surface wetting. The presence of SiC phase in the composite material samples deteriorates the wetting as compared to that of natural diamond crystals.

Изложены результаты теоретических и экспериментальных исследований поверхности композита (алмаз+SiC) металлическими расплавами составляющими основу серийных припоев. Установлено, что добавление в расплав адгезионно-активной добавки Ti вызывает значительное улучшение смачивания поверхности композита. Наличие SiC фазы в образцах композиционного материала ухудшает их смачивание в сравнении с монокристаллами природного алмаза.

The use of cutting tools reinforced by heat-resistant diamond polycrystals provides a substantial improvement of technical and economic performance in gas and oil well drilling as well as in metal machining [1, 2]. Various metal coating application and soldering methods are used when producing the cutting tools using diamond composite materials. Therefore, it is of importance to study the capillary characteristics and contact interaction in the diamond+SiC (D-SiC) surface-metal melt system.

In this connection, it is of interest to investigate the wetting of the diamond composite material by metals and alloys (copper, silver and copper based alloys) inactive at the solid/melt interface at different temperatures (up to 1150°C), the metals and alloys mentioned forming the base of commercial solders. Moreover, it is reasonable to study the changes in capillary characteristics of the D-SiC surface depending on the temperature and composition of Cu- and Ag-based melts containing the adhesion-active Ti additive as well as low-melting additives such as Sn, Pb, etc. To elucidate the diamond component composition and structure on its capillary characteristics at the interface with the melt is also of importance.

The composite material was prepared by silicon impregnation of the pre-compacted diamond powder (ASM 40/28 grade) under high pressure (above 6 GPa) and temperature (1600 to 1800°C). The samples were shaped as cylinders of 8×1.5 mm^2 size. The wetting processes were investigated on the ground surface (R_a = 0.1) of the D-SiC composite material in a vacuum of 10^{-5} to $5{\cdot}10^{-6}$ Torr. The wetting angles were determined for copper- and silver-based alloys as well as for the same provided by Ti additive using the "sessile drop" method [3]. The alloy compositions were similar to those of solders used in the tool production.

The studies have shown that the wetting character of D-SiC (diamond + 15 % vol. SiC)