SINTERED EUTECTIC COMPOSITES ON THE BASE OF BORON CARBIDE

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Strengthening of ceramic materials is traditionally achieved by application of different binders and additives, and also using of high-power methods of consolidation. Also one of the most effective ways of strength increasing is the reinforcement by the fibres of refractory compounds realized during the directional crystallization of eutectic alloys of the quasibinary systems. By the directed crystallization of melts it is possible to produce ceramic materials with strength over 4 GPa due to a high purity and perfection of structure, monocrystalline phase components of a composites. But the limited sizes and shape of samples are the basic lacks of this method, and the same as strong anisotropy of properties due to anisotropy of microstructure of directionally reinforced materials. Application of composition powders which had the directionally reinforced structure the same as well as in directionally solidified eutectic alloys can become the decision of this problem. The simplest method of receipt of such powders is the mechanical grinding of directionally solidified eutectic composites. Application of directional crystallization method enables to manage the sizes of eutectic components in the powders and thus, influence on mechanical properties of composites on their basis. Decreasing of sizes of phase components in eutectic powders to the nanosizes opens prospects for the considerable increase of mechanical properties of composites on their basis.

The choice of consolidation method for ceramic eutectic powders is also important, as he must be high-power for activating of diffusion processes in refractory compounds and, at the same time, rapid enough for prevention of degradation of eutectic structure in powders. Last time spark plasma sintering (SPS) becomes one of the most progressive methods for consolidation of ceramics. This method, due to the combined action of temperature, pressure and direct electric current, enables considerably to intensify mass transfer in hard refractory compounds.

Thus by the SPS method eutectic powders of the B_4C-TiB_2 system were consolidated. The microstructure analysis showed that sintered composite represented the polycrystalline material, that consists of eutectic grains chaotically oriented in a volume. The average transversal size of the reinforced inclusions and average distance between them are equal with the same parameters of eutectic structure before sintering and average grain size is equal with the sizes of powder particles after grinding. It is shown that perfection of microstructure of material depends on the sintering temperature and dwell time. The increasing of temperature and dwell time of SPS are led to the increasing of perfection of grain boundary structure and strength of their cohesion. The inclusions of diboride phase grow through the neighbouring grains and thus strengthen the grain boundary contacts.

The bending strength at room temperature of the SPSed eutectic B_4C-TiB_2 alloy was 230 MPa, that insignificantly exceeds the strength of the directionally solidified eutectic alloys of the same composition. Durability at 1600 ^oC was below than that for the directionally reinforced composites, that specifies on the sufficient weakness of grain boundary contacts of the sintered material.

For the increasing of mechanical properties of the SPSed eutectic alloys of the B_4C-TiB_2 system the modification of eutectic powder was conducted. By chemicothermal treatment the powder with original morphology of surface, that is the naked reinforcing TiB_2 inclusion on the surface of particles was obtained. Application of such approach for composites of the (B_4C-TiB_2)-B_4C system on the base of the eutectic B_4C-TiB_2 powder allowed to increase the bending strength almost in 2 times (to 400 MPa) both at a room and at elevated temperature (1600 ^oC).