Carbon nanotubes reinforced alumina composites fabricated by vacuum sintering

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Due to high chemical resistance and perfect mechanical properties carbon nanotubes (CNT) are a promising material for production of composite materials with improved properties. Between the composites based on ceramic matrix the reinforcing of alumina seems to be the moSt promising since this type of ceramics initially possesses a number of attractive properties and it is widely used as a constructional material. The significant increase of fracture toughness and flexure strength after CNT insertion into alumina matrix was demonstrated nowadays only for materials, produced by hot-pressing and spark plasma sintering techniques [1-2].

The present work is devoted to the development of alumina – CNT composite preparation technology using vacuum sintering for the ceramics densification as well as to investigation of CNT concentration and sintering parameters influence on the microstructure of fabricated material.

The initial batch Al_2O_3 (0.25-0.5%MgO) was prepared by solid-phase synthesis at 1100°C. Multi-walled CNT were produced using chemical vapor deposition technique by benzene and ferrocene pyrolysis [3] and then purified by acid treatment.

Various combinations of inserted CNT concentration (up to 2%vol.) and regimes of vacuum sintering for composite samples preparation were used. The samples were heated at residual pressure 10-4 mm Hg up to the temperature 1700-1730°C.

The microstructure of fabricated samples, CNT distribution, mean size of matrix grains, type and value of closed porosity was investigated using optical (POLAM P-211), scanning electron (Jeol JSM-5910LV, QUANTA 3D 200) and atomic-force (Ntegra Aura) microscopy. Fracture toughness and micro-hardness were evaluated according to the indentation results.

In conclusion, the novel composite ceramic material based on alumina reinforced by multiwall carbon nanotubes is developed. The regimes of vacuum sintering and initial batch treatment are developed; the ceramic matrix composition, the CNT concentration, and other technological parameters are optimized. The uniform distribution of CNT in ceramic matrix is achieved. The developed composite possesses the framed network structure of CNT distribution and demonstrates the enhance of fracture toughness in 1.5 - 2 times.

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