Nanocomposites and nanomaterials

Structure designing of composite nanoceramics via reaction sintering

O. Popov[1,2], S. Chornobuk[1,2], O. Klepko[1], I. Totsky[1], A. Sivak[1]

[1]*Faculty of Physics, Taras Shevchenko National University of Kyiv, 4 Hlushkov Ave., Kiev 03187, Ukraine*
E-mail:alexey.popov1861@gmail.com

[2]*Science and Research Centre "Synthesis", 16 Karbyshev str., Kiev 02139, Ukraine*

Reaction sintering of ceramic materials can be a way of nanomaterial creation as emerging new phase nuclei actually are nanoparticles.

This work is the experimental investigation of TiB_2-Al_2O_3, TiB_2-Al_2O_3-B_4C and TiB_2-TiC-B_4C-C (graphite) ceramic composites being produced via reaction hot pressing of Ti-B_2O_3-Al, TiB_2-Al-B_2O_3-C and TiC-B_4C precursors correspondingly. It is shown that the three chosen systems can be examples of three different ways of microstructure formation as well as three different approaches to create nanoscale particles inside bulk ceramics.

Titanium diboride nanograins were obtained in TiB_2-Al_2O_3 composite because the densification temperature of 1600°C which was applied during 8 minutes at 30MPa is 1600°C lower than titanium diboride melting point thus TiB_2 nuclei had enough time only for recrystallization to average size of approximately 100nm with considerable amount of nanoparticles.

Nanocrystalline inclusions of boron carbide were obtained in alumina matrix of TiB_2-Al_2O_3-B_4C composite because of B_4C metastability at elevated temperatures. So nanoflakes could be crystallized during the sample cooling from its sintering temperature of 1900°C.

Titanium diboride and graphite nanoinclusions as well as submicron voids inside boron carbide grains were obtained in TiB_2-TiC-B_4C-C materials because of complicated solid and gas phase interaction between titanium and boron carbides at temperatures of 1200 – 1800°C.

So the investigation of different types of ceramic materials showed that *in situ* chemical interaction leads to new phase nanoscale nuclei appearance and accelerates the densification of the charge. Thus at some circumstances the reaction sintering approach both produces nanoparticles and makes it possible to complete consolidation quickly enough to preserve them.

The investigated interaction mechanisms and sintering routs can be expanded to design the structure of other ceramic and metal-ceramic systems.