X-ray spectroscopy study of the electronic structure peculiarities of silicon nitride nanofibers

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Last years intensive investigations on development and study of reinforced ceramic materials are carried out. Such materials can be applied effectively at high-temperature conditions in oxidizing medium. Whiskers and in last decade nanofibers of refractory compounds such as SiC, Si_3N_4 are used. Si_3N_4 whiskers are promising reinforcing materials for high-temperature ceramic matrixes aimed on increasing their strength and fracture strength

In present work process of synthesis of micro and nanofibers of Si_3N_4 by nitriding of silicon powder was investigated. Results of investigations employing scanning electron microscopy method showed that at 1500 °C and synthesis time of 1 hour some fibers appear among silicon particles. An increase of nanofibers quantity and presence of some microfibers were observed with increasing synthesis temperature to 1530 °C. Further increase of temperature and synthesis time promotes increasing quantity of formed nanofibers, and at synthesis temperature of 1550 °C the only synthesis products were Si_3N_4 nanofibers.

From X-ray photoelectron (XPS) Si 2*p* and N 1*s* core-level spectra it is obvious that values of binding energies of Si 2*p* and N 1*s* core-level electrons of Si_3N_4 nanofibers synthesized by silicon powder nitridation for 2 hours at 1530 and 1550 ^oC coincide within the accuracy of the present XPS measurements with those of the corresponding core-level electrons of the reference Si_3N_4 powder This fact indicates that charge states of the constituent atoms in the Si_3N_4 nanofibers under study correspond to those in the reference Si_3N_4 powder.

It was revealed that maxima of XPS O 1*s* and C 1*s* spectra are at 532.8±0.1 eV and 285.0±0.1 eV, respectively in three samples under investigation and these binding energies refer to oxygen- and carbon-bearing compounds absorbed by surfaces of sample. We did not detected any features on the XPS O 1*s* and C 1*s* core-level spectra that could be attributed to oxygen/carbon atoms being in chemical binding with the material under consideration. It was revealed that XPS valence-band spectra of the Si_3N_4 nanofibers and the reference powder are similar.

The X-ray emission Si Lα bands of reference Si_3N_4 powder and of Si_3N_4 nanofibers synthesized by silicon powder nitridation for 2 hours at 1530 ^oC and 1550 ^oC studied reveal similar elements of fine structure, i.e. their shapes are similar with the exception of insignificant differences.