Study on Thermal Decomposition Processes of Polysiloxane Polymers – from Polymer to Nanosized Silicon Carbide

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Controlled heat treatment of organosilicon polymers leads to formation of various ceramic products, depending on the type of polymeric precursor and conditions of heat treatment. This is the way leading to obtaining materials differing with chemical composition, structure and microstructure (e. g. amorphous, nanocrystalline or crystalline). In the literature exist many information about application of polycarbosilanes, that are used in commercial applications e.g. manufacturing of silicon carbide fibres (Nicalon) or silicon carbide matrix composites. However, these polymers are expensive.

In this work polysiloxanes, as an alternative for currently commercially used polycarbosilanes, were investigated. Four types of cheap commercially available polymethylsiloxanes and polymethylphenylsiloxanes produced by Lucebni zavody (Kolin, Czech Republic) were used. The polymers differed in C/Si molar ratio. Structure, microstructure and phase composition of ceramic products of polymers heat treatment were investigated. Also usefulness of polysiloxanes as substrates of composite ceramic matrices were evaluated.

Curing and heat treatment conditions were determined on the basis of thermogravimetric measurements. Ceramic yield (Y_c) after heat treatment in the temperature range from 20 to 1700 °C was calculated. The ceramic samples obtained by heat treatment of polymers were analysed by means of Fourier transform infrared absorption spectroscopy (FTIR) in the range from 4000 to 400 cm^{-1} with 4 cm^{-1} resolution by means of FTS-60 V Bio-Rad spectrometer. A standard KBr pellet technique was used. The structure of ceramic samples was carried out on XRD diffractometer (Cu K_α radiation, Ni-filtered). The average grain size of ceramic products was calculated by using Scherrer's equation. Microstructure of the materials was examined by scanning electron microscopy JEOL 5400.

It was found that during thermal decomposition of polymers up to the temperature of 1000 °C amorphous inorganic Si-C-O ceramics was formed. Between the temperatures 1000 and 1700 °C nanosized 3C and 2 H types of silicon carbide crystalized.

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