Electroconductive properties monitoring after oxidation of a ZrB_2 ceramic material

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Abstract

The electroconductive properties of a ZrB_2 ceramic material were investigated before and after oxidation. This material has recently gained new interest thanks to a combination of attracting properties such as high melting point, high hardness and wear resistance with low electrical resistivity. The latter allows applying electrical discharge machining (EDM) for the production of small precision parts with complex geometry.

A fully dense ZrB_2 was produced by hot pressing at 1700°C with Si_3N_4 as sintering aid. The material was subjected to oxidation in flowing oxygen in the range of temperatures 850-1100°C. The oxidation kinetic changes from logarithmic, at 850°C, to parabolic behavior for temperatures up to 1100°C. At lower temperatures an oxide scale develops, which blocks the oxygen diffusion and prevents further corrosion. At higher temperatures a growing layer of monoclinic Zirconia forms. The parabolic gain due to the formation of ZrO_2 is superimposed to the linear evaporation of boric oxide.

In order to evaluate the change in resistivity of the oxidized material a two-point method was used on bars with the oxide layer removed from the ends.

The change in resistivity of oxidized samples is much higher than predicted from a simple change in cross-section, due to the formation of the corrosion layer. Therefore a zone extending far deeper under the corrosion layer should be responsible for the decrease in conductivity.

Cross sections of the oxidized material were analyzed with scanning electron microscopy (SEM) and Raman spectroscopy to understand the mechanisms connected with changes in electroconductive properties.