Nanotechnological Developments in Zirconia Ceramics for sensors

Radu-Robert Piticesdcu, Claude Monty, Barbara Malic, Marija Kosec, Ana Ionascu
IPEE SA - Romanai

Abstract

Yttria-doped zirconia nanopowders have been obtained using the hydrothermal procedure starting from soluble inorganic salts. The mechanisms and kinetics of the process have been studied. TEM images shows that the formation of YTZP powders takes place by the in-situ crystallization of hydrous precursors yielding high purity powders with crystalline size in the range 4 to 22 nm and specific surface in the range 180 - 200 m2/g. Zirconia nanophases were also synthesised by vaporisation-condensation in a solar furnace. The sintering behaviour of nanopowders was studied by electron microscopy using an heating stage and the optimum sintering regime was obtained. Starting from these powders ceramic membranes with controlled thickness and densities over 95% from the theoretical value were produced by the tape casting technique using different organic binders, dispersants and surfactants. The influence of the additives and sintering regime on the density and microstructure of membranes has been studied. Modelling the synthesis and processing of nanopowders allowed for obtaining sintered nanomaterials with controlled different grain sizes in order to establish the grain size dependent properties of YTZP ceramics. The ionic conductivity of the materials was investigated by impedance spectroscopy. A new model based on the brick-layer approach was proposed showing that an increase in the total ionic conductivity of YTZP may be expected when grain sizes are less than 100 nm. These results open the field for nanotechnological development of zirconia materials for mechanical pressure sensors, oxygen sensors and SOFC with enhanced conductivity at low temperatures.