Phase Evolution and Residual Stress Measurement in Yttria-Stabilized Zirconia Based Composites Prepared by Spark Plasma Sintering Technique

Lukas Bichler[1], Dimitry Sediako[2]

[1] University of British Columbia, Okanagan Campus, School of Engineering, Kelowna, BC, Canada
[2] Canadian Neutron Beam Centre, Chalk River Laboratories, Chalk River, ON, Canada

The activities carried out in this collaborative research project between AECL, UBC and NRC-CNBC involve the fabrication of novel ceramic materials using the Spark Plasma Sintering (SPS) process. During SPS, loose raw powders are placed in a round (20 mm diameter) graphite sintering die and uniaxially pressed, while pulsed DC current is passed through the sintering die to provide heating.

In-depth characterization of the as-sintered microstructure has been carried out using scanning electron microscopy and x-ray diffraction techniques. Neutron diffraction measurements were performed to study the evolution of residual strain in the as-sintered discs as a function of SPS process parameters (i.e., sintering temperature, pressure, time).

The neutron diffraction studies focused on two areas:

1) Level of residual strain in as-sintered materials:

Residual strain measurements in three orthogonal directions were carried out to enable calculation of residual stress in the as-sintered materials. The results suggest that a non-uniform residual strain profile evolved for the different SPS processing parameters. The edges of the specimen had relatively higher / lower compressive strain, depending on the combination of temperature, pressure and sintering time.

2) Texture development in as-sintered materials

As-sintered materials often exhibited non-uniform chemical composition. Further, the grain size of the as-sintered composites was not homogeneous throughout the disc (with a finer grain size near the mold-wall). As a result, texture analysis was carried out at several locations on the as-sintered discs and revealed that preferred crystallographic growth occurred

The ND data for both research areas are currently being analyzed and research publications are in preparation for dissemination with industrial partners, as well as general public.