

High Hardness Coating on Yttria-Partially Stabilized Zirconia

J. E. Zorzi⁽¹⁾, R. Milani⁽¹⁾, R. F. de L. Lorenzi⁽¹⁾, C. L. G. de Amorim^{(1)*}, C. A. Perottoni⁽¹⁾

(1) PGMAT- CCET, Universidade de Caxias do Sul, e-mail: clgamorim@ucs.br

* Corresponding author.

Abstract – Ceramic parts of a 3 mol% yttria-partially stabilized zirconia (3Y-PSZ) were molded by uniaxial pressing. After sintering, these parts were submitted to a thermal treatment in a low-pressure argon atmosphere at 1600 °C in a carbon bed, resulting in the formation of zirconium carbide (ZrC) in the surface. The samples were characterized by x-ray diffraction, semi-quantitative energy-dispersive electron microprobe analysis (EDS) and nanohardness test. The results clearly point to the formation of a ZrC coating over the 3Y-PSZ substrate with improved hardness.

Coating of zirconia with high hardness materials such as ZrC can lead to high toughness ceramic parts with improved hardness and wear resistance. In this work, substrates were produced from the 3Y-PSZ (Tosoh TZ-3YB), with average grain size of 0.6 µm. The pre-compacted pellets were sintered in air at 1500 °C during 2 h. After sintering the 3Y-PSZ substrates were submitted to a thermal treatment in an amorphous carbon powder bed (Printex, Degussa) at 1600 °C in a graphite resistance furnace (Model 1000-3560 FP20, Thermal Technology) under an argon atmosphere.

The samples were characterized by grazing angle x-ray diffraction, EDS and nanohardness measurements.

The result of grazing angle x-ray diffraction of one of the samples is presented in Fig. 1. The peaks marked with asterisks represent the 3Y-PSZ substrate while the others are due to the ZrC coating. The lattice parameter for the later, 4.691 ± 0.002 Å, is in accordance with the literature for ZrC [1].

Transversal cuts in the samples had shown that the color, initially white, changed to dark gray all over the sample, not only in the surface. This was already observed in a previous work [2] and indicates that carbon migration and/or oxygen disproportionation has occurred in the sample.

The amount of carbon incorporated in the sample was estimated by EDS analysis. Fig. 2 presents the concentration profile of O, Zr and C. One should note a higher concentration of carbon near the surface than that in the interior of the sample.

The results of nanohardness measurements can be seen in Fig. 3. The surface hardness, approximately 20 GPa, is about 25% greater than that of the interior of the substrate. The improved hardness results from carburizing of zirconia and consequent ZrC formation at the surface. Using both EDS and nanohardness results it was possible to estimate a thickness of 1–2 µm for the layer of ZrC formed on the 3Y-PSZ substrate.

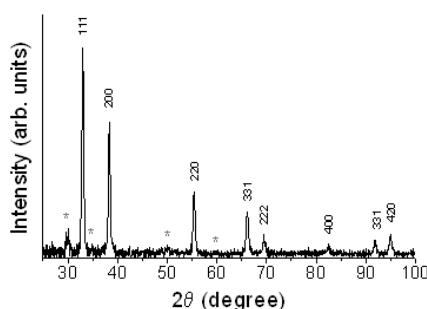


Figure 1: Grazing angle x-ray diffraction of one of the samples. The peaks marked with asterisks represent the 3Y-PSZ substrate and the others are due to ZrC.

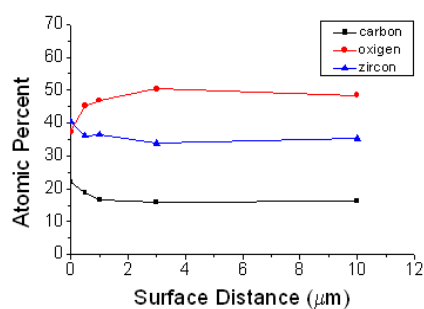


Figure 2: Concentration profile of carbon, oxygen and zircon obtained by semi-quantitative energy-dispersive electron microprobe analysis (EDS).

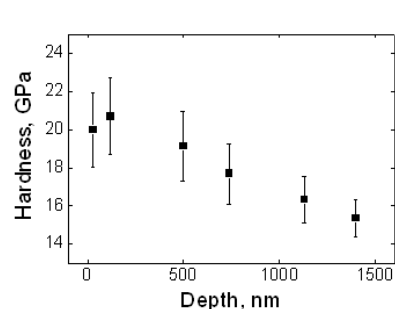


Figure 3: Nanohardness profile starting at sample's surface.

References

- [1] A. Maitre, P. Lefort, Solid State Ionics 104 (1997) 109-122.
- [2] M. M. Lucchese, C. L. Fritzen, A. S. Pereira, J. A. H. da Jornada, N. M. Balzaretti, Diam. Rel. Mater. 14 (2005) 1605 -1610.