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Deposition rate dependent phase/mechanical property evolution in Zirconia and Ceria-Zirconia thin film by EB-PVD Technique

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Abstract:

Pure zirconia (ZrO_2) and ceria (16 mol%) stabilized zirconia (CeSZr) thin films were prepared by electron beam physical vapor deposition with varying deposition rates (1, 4 and 8 Å/s) in order to correlate the phase changes to the mechanical property. X-ray diffraction and Raman spectra results indicate the presence of mixed monoclinic and tetragonal phases in ZrO_2 film, but tetragonal phase dominated at lower deposition rate. However, irrespective of the deposition rate, cerium addition to ZrO_2 resulted in complete stabilization of tetragonal phase. Depending on the presence of dual (ZrO_2) or single (CeSZr) phase either surface cracks or well-connected grain structure, respectively, was observed. However, CeSZr film showed a four-fold increase in hardness in comparison to ZrO_2 which can be attributed to the complete stabilization of tetragonal phase that hinders the crack propagation along the grain. Plastic deformation of CeSZr film was found to be 1.80×10^{-2} GPa, which is about ~55% higher as compared to pure ZrO_2 film (8.04×10^{-3} GPa). Thus, the development of CeSZr based coating may lead to better surface protection of many components.

Key Words: Hardness, Ceria-Zirconia, Thin films, Nanostructure, EB-PVD