# INTERFACIAL EFFECTS AND IONIC TRANSPORT IN YSZ EPITAXIAL THIN FILMS*

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The enhanced ionic transport properties of nanocrystalline ceramics are attributed to the grain boundary and grain size-dependent defect equilibria, which become dominant when the grain size is < 100 nm. Surface and interfacial effects can have significant effects in such nanostructured materials. In the present experiments, we examined their influence by characterizing the effect of the thickness of epitaxial zirconia–10 mol. % yttria (YSZ) films on the ionic conductivity. In this geometry, the fraction of the atoms at the surface and substrate interfaces, versus that within the bulk, varies with the film thickness. The YSZ films were prepared by pulsed laser deposition on (001) MgO single crystal substrates at typical depositions of 0.5 to 1 Å per pulse. The electrical conductivity was measured using two-probe impedance with an electrode configuration to measure current flow parallel to the film and substrate surfaces. The temperature dependent conductivity was correlated with the thickness of the YSZ films, which was varied from < 50 nm to 2000 nm. For film thickness > 50 nm, the conductivity-temperature curves were essentially identical and mimicked those obtained with cubic YSZ single crystals. However, the conductivity increased by one to two orders-of-magnitude when the film thickness was < 50 nm. The associated activation energies below ~ 550°C averaged 1.13 eV for both single crystals and films of every thickness. Above 550°C, the activation energy for films < 50 nm was 0.6 eV as compared to 0.85 to 1 eV for single crystals and films thicker than 50 nm. These findings reveal that conductivity measurements on the thicker epitaxial films reproduce those for single crystals, and that conductivity enhancement similar to that observed for grain sizes < 50 nm can be achieved in epitaxial films of comparable thickness.

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