Adsorption and Equilibrium Metal-Ceramic Orientation Relationships

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Metal-ceramic interfaces determine the mechanical and functional properties of many technologically important material systems, and thin metal films on ceramic substrates have an important role in technological applications and in fundamental science. Often, the orientation relationship (OR) of a polycrystalline metal film on a ceramic substrate influences the properties, and understanding why specific orientation relationships develop is thus important.

While the details of metastable ORs depend on the kinetics of the specific deposition process, equilibrium (minimal energy) ORs define the driving force for microstructural evolution during annealing of thin films. As such, this study examines equilibrium ORs of metals on α-Al_2O_3 and yttrium stabilized zirconia (YSZ) [1, 2, 3]. Equilibrium conditions were reached by dewetting the thin films in the solid-state (annealing until the film ruptures and forms single crystal particles). The influence of dopants and impurities on the equilibrium crystal shape of the metal, the low-energy OR of the metal with the substrate, and the interface energy, was assessed. Orientation relationships for specific single crystalline particles which had reached the equilibrium crystal shape were determined using electron backscattered diffraction [4]. The solid-solid interface energy was determined using Winterbottom analysis from cross-section TEM samples [5], and the amount of interface adsorption was determined from energy dispersive spectroscopy using the spatial difference technique and fully standardized k-factors [2]. This presentation will show that while specific low-index low-energy ORs often exist, adsorption to the same metal-ceramic interfaces can lower high-energy ORs, resulting in a more isotropic distribution at equilibrium accompanied by diffuse interface states [6].

References

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