Thermal Conductivity of Thin Films via the Thermal Comparator Method

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Measurements of the thermal conductivity of thin dielectric films in the last ten years have established that thin film thermal conductivity may be much lower than that of the corresponding bulk solid, by as much as two orders of magnitude, and that significant interfacial thermal resistance may be present along the film/substrate interface.

We review such measurements of thin film thermal conductivity and interfacial thermal resistance, focusing on the thermal comparator method, and discussing its basic assumptions and limitations. We use a microstructural interface model to discuss contributions to the interfacial thermal resistance by the interface diffuse porosity and the varying film microstructure near the interface. Analysis of heat conduction in anisotropic thin films shows that an equivalent isotropic film can be established (whose thickness depends on the degree of thermal anisotropy) and that the presence of large interfacial thermal resistance leads to a strong dependence of film thermal conductivity on film thickness, especially for thin films. Specific data are presented for oxide and other ceramic films on a variety of substrates.