Thermal-Boundary Resistance at Solid-Solid Interfaces Studied by High-Resolution Infrared Imaging

H. Wang and R.B. Dinwiddie
Metals and Ceramics Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6064 USA

F.A. Modine and L.A. Boatner
Solid State Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6030 USA

M. Bartkowiak and G.D. Mahan
Solid State Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6030 USA
and
Department of Physics and Astronomy
University of Tennessee
Knoxville, TN 37996-1200 USA

A high-speed, high-resolution infrared imaging system was used to study the thermal boundary resistance of interfaces between solids. The IR camera operates in a snap-shot mode and is capable of capturing the temperature distribution of the entire *256* x *256* pixel screen. The spatial resolution of the IR camera ranges from infinity to 7.5 μm, and the temperature resolution is 0.015°C. A temperature gradient was established by heating the top of the sample and placing the bottom of the sample in a cold heat sink. Infrared images taken by the camera were analyzed by computer software, and the thermal resistance of the interface was observed as a temperature discontinuity in a line profile. When the thermal conductivity of the sample changed at the interface, a change of slope was also observed in addition to the temperature drop. The high spatial resolution and high temperature sensitivity of the camera were utilized to study thermal resistance on a microscopic scale. Solid-solid interfaces, interfaces between two phases in a solid, and grain boundaries were investigated. Theoretical calculations were carried out to predict the thermal resistance at the interfaces. This new method of measuring temperature gradients across interfaces can provide valuable information in the study of thermal-boundary resistance.

Research sponsored by the Division of Materials Sciences, U.S. D.O.E. under Contract No. DE.A-C05-96O~2464 with Lockheed Martin Energy Research, Inc.