Toward Intrinsic Thermal Conductance of Epitaxial Al/Si Interfaces

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Investigating intrinsic thermal conductance at interface is of great importance for understanding heat transfer in nanostructured materials. To do so, fabricating a high-quality interface and precise measurement of thermal conductance has been challenging for a long time. In this work, we grow a high-quality interface by epitaxially grow Al (111) on Si (111) by molecular beam epitaxy (MBE) method with a controlled interfacial roughness of nanometer scale. The interface thermal conductance of Al/Si is measured by time domain thermoreflectance (TDTR). We demonstrate that thermal conductance of Al/Si is 372 MW $m^{-2}K^{-1}$ at room temperature, in consistent with the highest value measured before. The thermal conductance at Al/Si interface is positively correlated with temperature at 400-600K, where the thermal conductance is expected to be a constant value according to Debye model. The temperature dependency of thermal conductance is attributed to inelastic scattering process by multiple phonons and verified by a molecular dynamics (MD) simulation. The result indicates that inelastic phonon scattering process at Al/Si interface is not eligible as predicted by elastic scattering models.