Suppression of interfacial heat transport between silica nanoparicles by silane coupling method

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Silica-based thermal insulating materials are of particular interest in the industry due to the low thermal conductivity and its application for the vacuum insulation. Since the solid thermal conduction is dominated by the thermal boundary conduction (TBC) between silica nanoparticles, reduction of the TBC is significant for the improvement of the material performance. Here we investigated the TBC between silica nanoparticles with a non-equilibrium molecular dynamics simulation. The results indicate that the hydrogen bonding via water molecules between -OH groups at the silica surface works for the enhancement of the TBC. Further, we fabricated the silica-based thermal insulating materials by mold-pressing the silica nanoparticles and the silica surface was modified with the hydrophobic groups in order to remove the surface -OH groups. The thermal conductivity of materials was measured with the steady-state heat flux method. Present experimental results have revealed that the surface modification on the silica nanoparticles with hydrophobic groups is effective for the reduction of the thermal conductivity.