Thermal Conductivity of a Solid Matrix Unit in Silica Aerogel

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A model of a solid matrix unit obtained from the structure of silica aerogel is developed to calculate the thermal conductivity of the solid matrix unit. According to the kinetic theory and the Matthiessen's rule, three phonon resistances confining the heat flux in the solid matrix unit are transformed respectively to three equivalent phonon mean free paths. The results indicate that the equivalent thermal conductivity of the solid matrix unit is evidently confined by the characteristic length of the solid matrix unit, when it is comparable to, or smaller than, the phonon mean free path of the bulk silica. When the heat flux through the solid matrix unit is longitudinal, the calculation results show that the equivalent thermal conductivity in the solid matrix unit is determined by both the diameter of the particle and the diameter of the cross section of the connected particles. When the heat flux through the solid matrix unit is transverse, the equivalent thermal conductivity in the solid matrix unit is determined by the diameter of the particle.