SOLID CONDUCTION

Solid thermal conductivity can be explained in terms of the apparent density and the degree of contact between the particles forming solid skeleton according to the following relationship given in equation (A):

$$k_s = k_{s,s} \frac{\rho v}{\rho_s v_s} \qquad \text{(A)}$$

In equation (A), $k_{s,s}$ is the solid thermal conductivity for the basic materials, v is the velocity of phonon, v_s is the velocity of phonon for the basic materials. ρ is a term related to the portion of solid skeleton in a whole sample and ρ_s is the value estimated by the vibration of the phonon in solid skeleton for heat transfer, which is determined by the degree of contact between the primary particles or clusters formed by the primary particles as a pathway for conduction. For silica aerogels, the relation is simplified as $k_s \propto \rho^{\alpha}$, where $\alpha \approx 1.5$ in the density range of 70 to 230 kg/m^3. It indicates that the solid thermal conductivity component of aerogel material will decrease as its density decreases in almost a linear fashion. However, due to the extensive tortuosity of solid connectivity in amorphous silica aerogels, they exhibit extraordinarily low solid thermal conductivity values beyond the effect of simple density reduction compared to a solid material of the same composition.

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