Size Effects on the Thermal Conductivity of Nano Aerogels

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Size effects of the nanopores and solid nanoparticles of an aerogel (Fig. 1) on its effectivethermal conductivity are modelled and analyzed, as a function of the temperature and pressure. This conductivity consists of the gaseous (molecule) thermal conductivity of the gas inside the aerogel pores,the (phonon) thermal conductivity of the solid backbone, and the (photon) thermal conductivity due to the radiative heat flux through the gas. It is shown that the size effects lower the values of these three heat transport componentsand they strengthenas the pore and/or particle size is scaled down. Furthermore, we have found that the gaseous thermal conductivity can be reduced to values much smaller than that of air in free space, by decreasing the pressure, increasing the temperature, and/or reducing the collision cross section of the nanoparticles. The predictions of the proposed model are in good agreement with experimental data reported for a nano aerogel of silicaand they could be useful for guiding the design of nano aerogels with a tailored thermal performance.

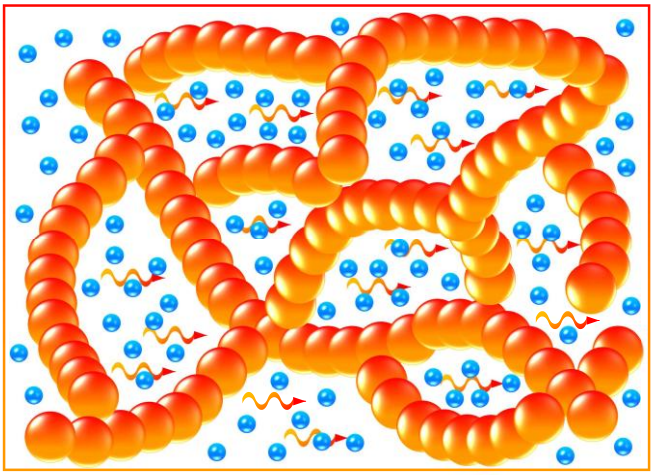

Figure 1: Scheme of an aerogel structurein whichheat is transferred by conduction through the solid backbone (chain of particles) and the porous structure (gas molecules represented by blue dots), and by thermal radiation (wavy arrows).