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Numerical Study of Heat Transfer in Silica Aerogel

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Abstract : Aerogel consists of a ramified and inter-connected solid skeleton enclosing a very important number of nano-sized pores filled with air that occupies most of the volume and makes very low density. The thermal conductivity of this material can reach lower values than those of any other material, and it changes with the type of the aerogel and its composition. So, in order to explain the causes of the super-insulation of our material and to determine the factors in which depends on its conductivity we used a numerical simulation. We have developed a numerical code that generates random fractal structure of silica aerogel with pre-defined concentration, properties of the backbone and the gas in the pores as well as the size of the particles. The calculation of the conductivity at any point of domain shows that it is not constant and that it depends on the pore size and the location in the pore. A numerical method based on resolution by inversion of block tridiagonal matrices is used to calculate the equivalent thermal conductivity of the whole fractal structure. The average conductivity calculated for each concentration is in good agreement with those of typical aerogels. And we found that the equivalent thermal conductivity of a silica aerogel depends strongly not only on the porosity but also on the tortuosity of the solid backbone.

Keywords : aerogel, fractal structure, numerical study, porous media, thermal conductivity
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