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NUMERICAL STUDY OF RADIATIVE PROPERTIES OF OPACIFIER PARTICLES AND FIBERS DOPED SILICA AEROGEL

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ABSTRACT Silica aerogel is one type of super-insulating material with extraordinary power of thermal insulation. However, the drastically increased radiative heat transfer at high temperature will be much harmful to the insulating performance of the silica aerogel. In practical applications, the silica aerogel is usually doped with various opacifier particles and fibers to suppress radiative transfer. Since the types, sizes, amounts and locations of opacifier particles and fibers doped in silica aerogel have important effects on insulation capacities, this paper aims at optimizing the opacifier doping via numerical analysis for silica aerogel. Firstly, we select the temperature-dependent optimal sizes for single type of opacifier particle and fiber by combining the spectral extinction coefficient with blackbody radiation. Secondly, we obtain the temperature-dependent optimal doping amount for single type of opacifier particles and fibers by evaluating the minimum effective thermal conductivity. Finally, based on the obtained temperature-dependent optimal parameters and the graded temperature distribution in silica aerogel, we design a doping solution of four-layer fiber combined with carbon black and SiC. The results show that insulating capability of silica aerogel is improved effectively.
Keywords: silica aerogel; opacifier particle and fibre; optimal sizes; optimal doping amount; multi-layer; multi-type;