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Thermal and Optical Properties of Supercritically Dried Aerogels

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Transparency in thermal insulation systems is of great practical importance since transparent insulation materials would provide efficient insulation that can replace conventional window glazing. Silica aerogels are promising candidates to be used in such insulation systems because they are transparent and have very low thermal conductivity (10-15 mW/m.K). Silica alcogels are synthesized by sol-gel chemistry, gelled in a mold and dried by supercritical extraction with CO_2 to get highly porous (porosity > 90%), low density aerogels. The purpose of this study was to investigate the effects of synthesis parameters such as type and composition of solvents, and type of molds to achieve optimum thermal conductivity and transparency values. Pore diameters, surface areas, and pore size distributions of the synthesized silica aerogels were measured with N_2 adsorption-desorption analysis. Optical properties were determined with using UV-VIS spectrophotometer. Transient Hot-Disk plane source and steady-state Guarded Hot Plate methods were used for analyses of thermal properties. It was found that decreasing the molar ratios of the solvents added in the sol mixture increases transparency. Theoretical calculations on thermal conductivity showed that the lowest values can be reached when the density of the aerogel is between 100-200 kg/m^3. Based on this information, a large scale (30×30×1.2 cm^3) transparent silica aerogel panel was synthesized with density of 180 kg/m^3. Transparency ratio and thermal conductivity of the aerogel were measured as 88% (at 600 nm) and 16 mW/mK, respectively.