Shape Memory Aerogels For Space Applications

Silica-based aerogels are excellent thermal insulators, but do not have mechanical integrity. Efforts to crosslink networks of aerogels by epoxies and polyurethanes have resulted in some success at NASA and other research laboratories, but the compressive strengths of these materials are still poor. We have developed methods by which networks of aerogels can be crosslinked with shape memory polyurethanes to offer desired compressive strength. The research program has led to development for the first time, a low density shape memory aerogel composite material for potential applications in space suit and space shuttle. The study investigates structure properties relationships, manufacturing methods, and the chemistry of crosslinking.

In addition, we are currently working on net-shape manufacturing of aerogel articles. Our current project eliminates the need of batch-type, slow solvent exchange step by directly subjecting the aerogel sleeves to continuous solvent exchange. For this purpose, these aerogels are first strengthened by introducing hybrid particles so as to withstand the hydrodynamic stress arising in reactors. Figure 2 shows an image of POSS-reinforced aerogel.

Figure 2. POSS-reinforced aerogel cylinders with 3 times higher compressive modulus compared to tetraethoxy silane-based aerogels