A General Multivinyl Polymerization for Transparent, Tough and Functional Aerogel Superinsulators

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Silica aerogels are transparent and thermally super-insulating materials but their application scope has largely hindered by mechanical brittleness.[1] Polymer aerogels are much tougher than silica aerogels, but so far the traditional polymer aerogels are usually non-transparent and requiring complicated process.[2] Inspired by silica chemistry, we developed a brand-new type of polymer aerogels based on multivinyl polymerization. This method is general to most of multivinyl monomers, which are commercially available chemicals widely used in resin industry.[3] The resultant aerogels are tough, transparent and thermally super-insulating. In addition, they can be tailored with multiple functionalities, such as fluorescent, super-hydrophobic properties, and so forth.

As shown in Figure 1a and 1b, divinyl monomer, which has four crosslinking points similar with TEOS, undergoes hyperbranched crosslinking to form nanoporous network upon photo-polymerization. We can further expand the divinyl monomers to trivinyl, tetravinyl or other multivinyl monomers (Figure 1c). The resultant aerogels are highly transparent, as shown in Figure 1d. Mechanical measurements suggest that these aerogels are very tough, which can be compressed to transparent solid disks without breakage. Due to amorphous skeleton and narrow mesoporous structure, the multivinyl aerogels exhibit low thermal conductivities (14~26 $mW \cdot m^{-1}K^{-1}$). We also demonstrated that the multivinyl aerogels can be tailored with multifunctionalities, making our materials one of the most versatile aerogel systems.

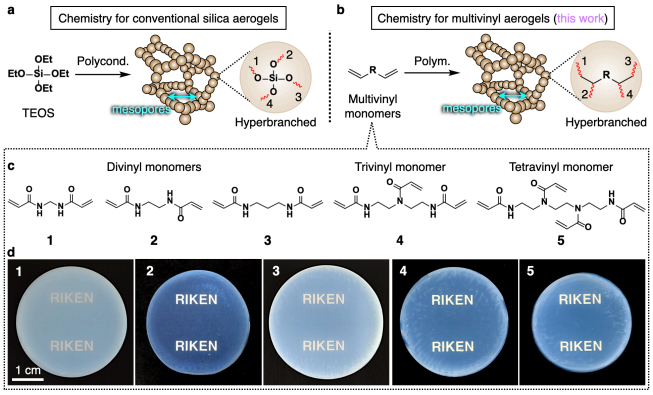

Figure 1. a) Sol-gel chemistry for conventional silica aerogels; b) sol-gel chemistry for multivinyl polymerized aerogels; c) multivinyl monomers in this work; d) aerogel products that obtained from the above monomers.

References:

1) H. Maleki, *J. Non-Cryst. Solids* **2014**, *385*, 55
2) M. Meador, *ACS Appl. Mater. Interfaces* **2015**, *7*, 1240
3) N. Moszner, *Dent. Mater.* **2006**, *22*, 1157