Supporting Information

Flexible, Sandwiched High-Performance Super-Insulation Fabric

Fan Bai, Juntao Wu*, Guangming Gong and Lin Guo*

Key Laboratory of Bio-Inspired Smart Interfacial Science and Technology of Ministry of Education, School of Chemistry and Environment, Beihang University, Beijing 100191, P. R. China

* Address correspondence to wijt@buaa.edu.cn, guolin@buaa.edu.cn

Experimental section

Materials. 4,4’-Oxydianilin (purified by sublimation), pyromellitic dianhydride (recrystallized before use), polystyrene (PS; average M_w~192000, from Sigma-Aldrich) and N,N-Dimethylformamide (DMF; ≥99.5%, from Beijing Chemical Co., dehydrated by molecule sieves).

Fabrication of the sandwiched PI fabric. First, 10 wt% poly(amic acid) (PAA, the precursor of PI) solution was synthesized by utilizing a typical polymerization, and a 20wt% PS solution was prepared by dissolving PS in DMF. The two solutions were mixed in equal quality and stirred at room temperature for at least 5 h to yield a homogeneous mixed solution. And a 2wt% mixed solution was prepared via a diluting process. Second, two syringes with the above two different concentration solutions were put in the electrospinning system for 2 h in turns respectively, and a 10×10 cm aluminium foil served as the collection electrode. Third, the as-prepared sandwiched PAA fabric was heated at 120 ºC, 150 ºC, 180 ºC, 250 ºC, 300 ºC, 350 ºC for 0.5 h to go through an imidization process, which could turn PAA into PI.

Characterization. The morphologies of the sandwiched PI fabric were characterized by an environmental scanning electron microscope (ESEM, Quanta 250 FEG), and the bulk density was about 0.21 g/cm³. The thermal conductivities were tested in a multifunction thermal constants
analyser (Hot Disk, TPS-2500). During the testing process, heating power was 1.8 W with a sensor radius of 14.95 mm, and the total time of the transient was 40 seconds. The apparent insulation property was measured by using an electronic thermometer and a heated or cooling aluminum plate, of which the temperature could be stable controlled by fire or liquid nitrogen. The samples were put on the aluminum plate, and temperature changes would be recorded by the electronic thermometer. The mechanical properties were measured by using a Shimadzu AGS-X Tester at a loading of 1 mm min\(^{-1}\) with a gauge of 10 mm. All of the samples were cut into stripes with the length of 20 mm and the width of 5 mm.

**Scheme S1.** Synthetic route of PI. The raw materials, PMDA and ODA, were generated into PAA by a condensation reaction. And after a thermal imidization treatment, the PAA can be turned into PI.
Figure S1. Diameter distributions of (a) the PI porous spheres, (b) nanogrooved fibers and (c) pores.

Figure S2. (a) A strip of sandwiched fabric was prepared to get close to the flame. (b,c) And after contacting with flame, the sandwiched PI fabric would be self-extinction very soon.
Figure S3. Thermogravimetric(TG) curve of the sandwiched PI fabric.

**Movie 1:** The apparent thermal insulation performance of the sandwiched PI fabric.

**Movie 2:** The cryogenic resistance performance in the liquid nitrogen of the sandwiched PI fabric.