Electronic Supplementary Material (ESI) for Soft Matter

Preparation and characterization of pH- and temperature-responsive hydrogels with surface-functionalized graphene oxide as the crosslinker

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Electronic Supplementary Information

1. Raman analysis

Raman spectroscopy is a non-destructive optical technique. It has been successfully used to characterize graphene and other carbon-based materials. Raman spectra of GO and PNIPAM/SA/GO hydrogels have been shown in Fig. S1.As can be clearly seen, there are two characteristic peaks, namely, D band at 1330 cm^{-1} and G band at 1580 cm^{-1}. The D band is ascribed to edges, other defects, and disordered carbon, whereas the G band arises from the zone center E_{2g} mode, corresponding to ordered sp^2 bonded carbon.[1] R-value (the D-band to the G-band) is a measure of disorder degree and average size of the sp^2 domain.[2] Comparing with GO, R-values of PNIPAM/SA/GO hydrogels slightly increased. This change suggested a decrease in the average size upon chemical functionalization of the exfoliated GO. It is reasonable to consider that the surface-functionalization of GO causes some fragmentation along the reactive sites and yields new graphitic domains, which led to graphenes smaller in size but more numerous in number.[3]

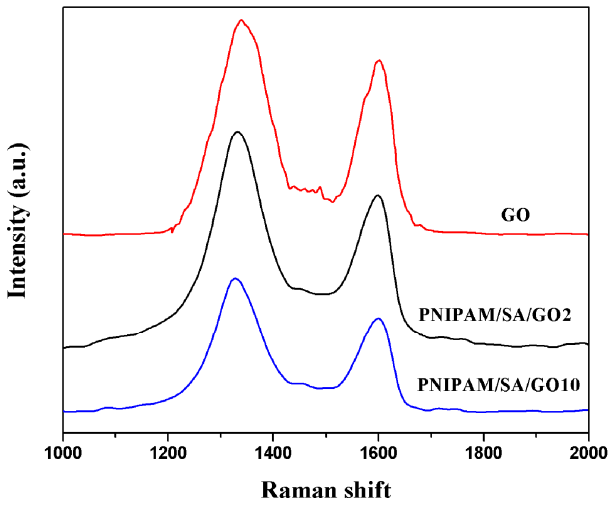

Fig. S1 Raman spectra of GO, PNIPAM/SA5/GO2 and PNIPAM/SA5/GO10 hydrogels.

2. Mechanical properties analysis

The compressive stress-strain of PNIPAM/SA and PNIPAM/SA5/GO6 hydrogels were shown in Fig. S2. The hydrogels prepared by two types of the crosslinkers exhibited completely different mechanical properties. The PNIPAM/SA hydrogel broke at a stress of 0.06 Mpa and a strain of 53.9%. However, the PNIPAM/SA5/GO6 did not break, even at a stress of 34.8 Mpa and a strain of 95.1%. As mentioned above, the average inter-crosslinked distances in the PNIPAM/SA/GO hydrogels network were larger than those in the conventional PNIPAM/SA hydrogel. The PNIPAM chains in the swollen state could be regarded as flexible polymer chains just like those in the rubbery state and thus the large deformation could be realized.

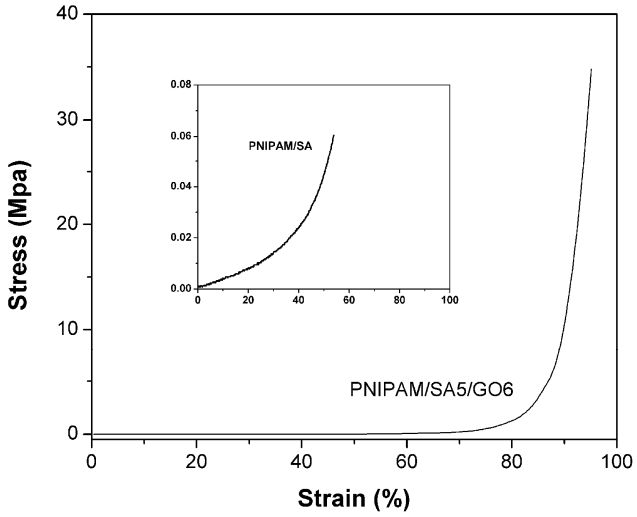

Fig. S2 Compressive stress-strain curves of PNIPAM/SA and PNIPAM/SA5/GO6 hydrogels.

Reference

1 S. T. Sun and P. Y. Wu, *J. Mater. Chem.*, 2011, **21**, 4095-4097.

2 S. Zu and B. Han, *J. Phys. Chem. C* 2009, **113**, 13651-13657.

3 K. Kudin, B. Ozbas, H. Schniepp, R. Prud'Homme, I. Aksay and R. Car, *Nano Lett.*, 2008, **8**, 36-41.