Supporting Information

Shape-stabilized phase change composites enabled by lightweight and bio-inspired interconnecting carbon aerogels for efficient energy storage and photo-thermal conversion

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S1 Adsorption properties of PI/XG/TiO_2 carbon aerogel

Due to their hydrophobicity and adsorption performance, carbon aerogels are considered as highly promising for use as supporting matrix of organic PCMs. Hydrophobicity is typically characterized by measuring the contact angle of water droplets on a surface. The PI/XG/TiO_2-20% carbon aerogel was used as a reference to test the water contact angles on the upper, interior and side surfaces, as shown in **Figure S1 (a)**. The water contact angles of the sample on the upper, interior and side surfaces were 120.70°, 122.13° and 121.73°, respectively, indicating that the sample showed excellent hydrophobicity and oil absorption properties.

Additionally, as shown in **Figure S2 (b)**, samples with 20.1 wt% XG and 20 wt% TiO_2 were used for oil adsorption testing in pure water, peanut oil and oil-water mixed solutions, respectively. The oil adsorption time further evaluated the hydrophobic performance of the PI/XG/TiO_2 carbon aerogel. When we placed the aerogel in water for 12 h, it still floated on the water surface and no water was absorbed. By contrast, peanut oil was completely absorbed by the sample after just 40 s. Emulsion of peanut oil aqueous solution was also used to further reflect the adsorption selectivity of the carbon aerogel. The peanut oil was completely adsorbed and separated from the water within 120 min, indicating that the carbon aerogel has good oil absorption properties and is highly suitable as supporting matrix for the PCMs.

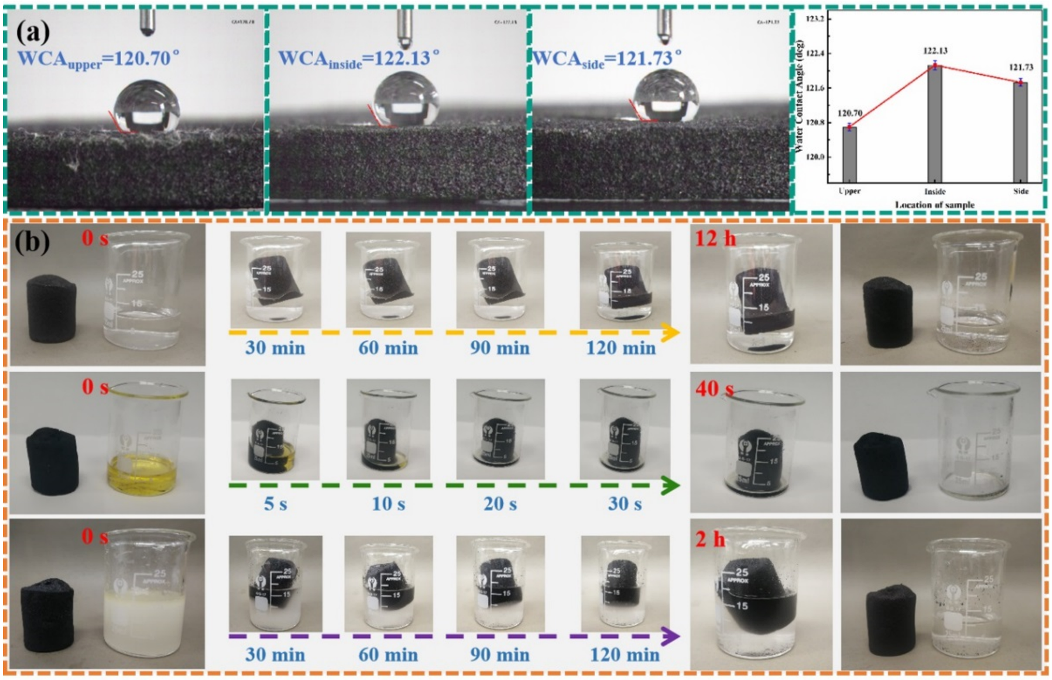

Figure S1 (a) Water contact angle of PI/XG/TiO_2 carbon aerogel of the upper, inside and side surfaces of the representative sample with 20 wt% TiO_2; (b) Simulation experiment of hydrophobic and oil absorption of PI/XG/TiO_2 carbon aerogel in pure water, peanut oil and oil-water mixed solutions.

S2 Mechanical properties of PI/XG-0, PI/XG-20.1% and CA-FSPCMs-3

The mechanical properties of carbon aerogel and composite PCMs have an important influence on their practical applications. Therefore, we firstly take photographs of the PI/XG-20.1% and CA-FSPCMs-3 under different loading power to confirm their mechanical properties, and PI/XG-0 was also used as a comparison (**Figure S2(a)**). It is evident that some crushed debris fell off from under pressure of the 200 g weight, indicating that PI/XG-0 was composed of brittleness carbon materials. As the loading power increased from 200 g to 500 g, the PI/XG-0 carbon aerogel was broken and fell off more crushed pieces. While the PI/XG-20.1% and CA-FSPCMs-3 had no change in the whole process, revealing a good structure and mechanical stability. This result indicates that the mechanical properties of PI/XG-20.1% was significantly improved by the interconnected graphitized structure of the carbon aerogel due to the introduction of XG, indicating the addition of XG not only optimizes the structure of the PI/XG carbon aerogel, but also significantly enhances its mechanical strength.

And the PI/XG-20.1% is a desired supporting matrix for PCMs, which provides the CA-FSPCMs-3 with high shape-stability.

Furthermore, DMA was also used to study the mechanical strength and compressive property of the samples, and the obtained stress-strain curves were depicted in **Figure S2(b)**. Results show that the addition of XG significantly enhances the mechanical strength of the PI/XG carbon aerogel. The compressive strength of the PI/XG-0 and PI/GG-20.1% was about 0.041 MPa and 0.27 MPa, respectively, indicating a high improvement for the PI@XG-20.1% due to the introduction of XG, indicating that the interconnected porous structure of carbon aerogel was successfully constructed and significantly enhanced by the wrapping of soft XG on the surface of PI framework. As a result, the CA-FSPCMs-3 exhibits a high compressive strength of 71.21 MPa, demonstrating that the desirable addition of soft-chain biomass XG significantly improve the mechanical properties of PI/XG carbon aerogels, which ensures the good mechanical stability of the CA-FSPCMs for practical applications.

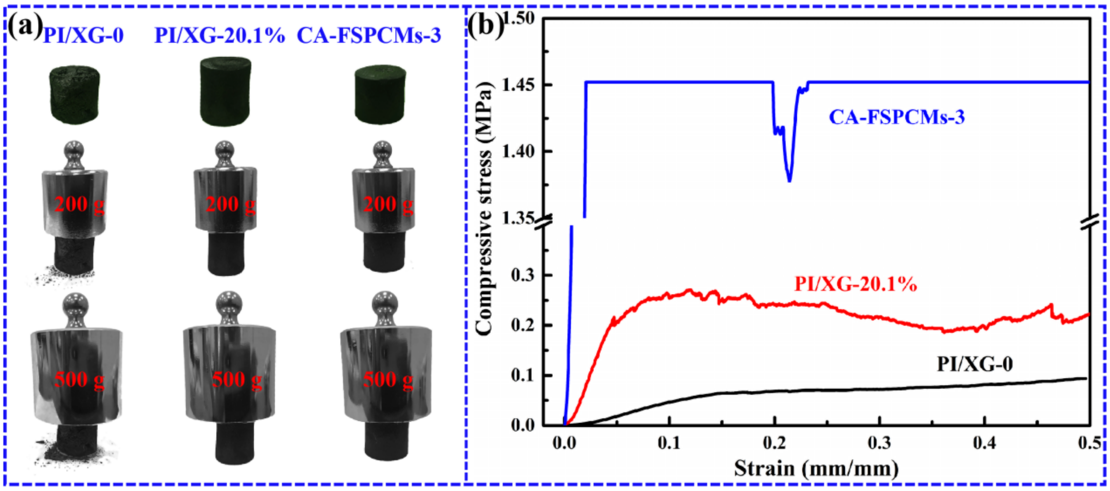

Figure S2 (a) photographs of the PI/XG-0, PI/XG-20.1% and CA-FSPCMs-3 under different loading power; (b) The compressive stress–strain curves of the samples.