Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Graphene as a template and structural scaffold for the synthesis of 3D porous bio-adsorbent to remove antibiotics from water

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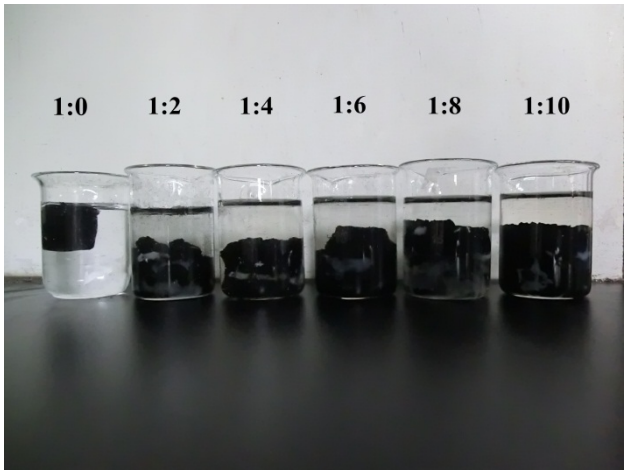

Fig. S1 Digital images of hydrogels with different protein contents.

Digital images of hydrogels with different protein contents are shown in Fig. S1. It can be seen that with the increasing protein content, the hydrogels became looser, which indicates that protein keeps the graphene from agglomeration. Moreover, it also can be seen that graphene hydrogels were floating while the composite hydrogels stayed at the bottom. There may be two reasons. Firstly, with the loose porous structure, composite hydrogels could conserve more water. Secondly, proteins in the composite hydrogels also help absorb more water. Moisture content of hydrogels with different protein contents at room temperature are shown in Fig. S2. The moisture content increased significantly from 4.00 g/g to 16.25 g/g when the mass ratio of graphene to protein increased from 1:0 to 1:2, and the moisture content reached 31.25g /g for the sample 1:10. It was further proved that hydrophilic protein interacted with water molecules strongly, which helped the hydrogel retain more water.

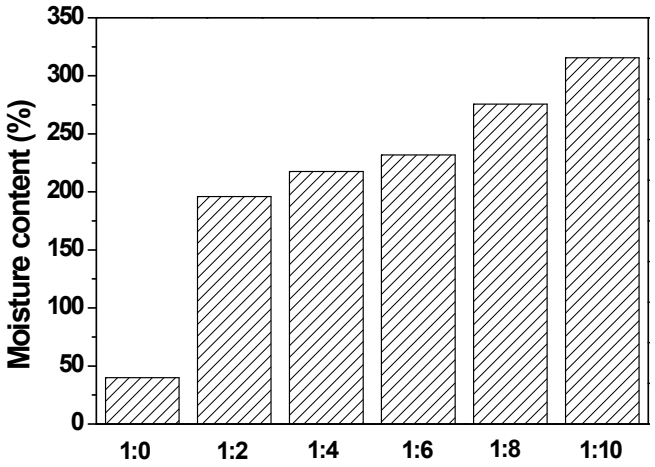

Fig. S2 Moisture content of GS hydrogels with different protein contents.

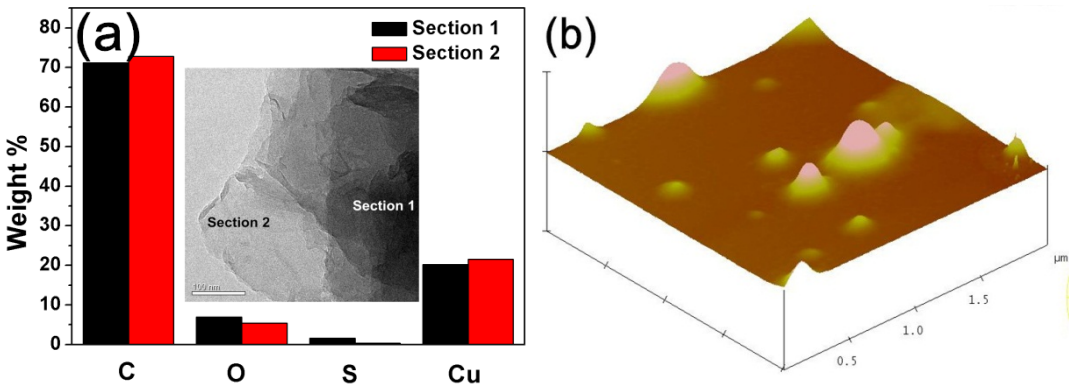

Fig. S3 TEM and EDS of GS

TEM and EDS of GS are shown in Fig. S3a. It can be seen that the section 1 has higher O and S content than section 2, indicating that the protein act as adhesive for graphene sheets, however, in thin edges the S content is lower indicating the low content of protein in Section 2. Thus the graphene were covered and bonded by protein. The AFM of GS as shown in Fig.S3b also confirmed the relationship between graphene and protein.

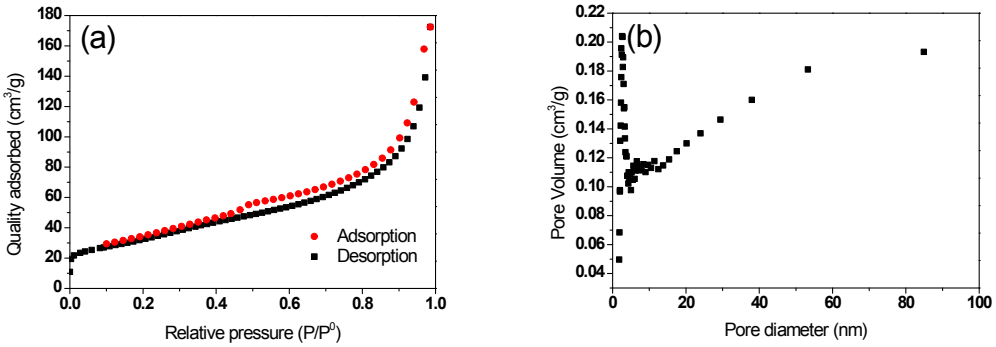

Fig. S4 BET test (a) N_2 adsorption and desorption curves of GN, (b) Pore size distribution of GN.

Tetracycline adsorption on GS aerogels with different protein contents was investigated, as shown in Fig. S2. Since protein has little adsorption capacities and is much cheaper than graphene, we evaluated the adsorption capacities of the aerogels using two approaches: one is the common method used to calculate the adsorption capacity following Equation (1) and the other only uses the mass of graphene as the adsorbent dosage. We used the second approach to select the best mass ratio of graphene to protein for a composite as an adsorbent. Under the second calculation method, with the increasing protein content, the adsorption capacity increased within a certain range and then decreased. The peak of adsorption capacity appeared in the sample 1:6, with an adsorption capacity of 80.26 mg/g. This result occurred because with the increasing protein content, the composite featured higher hydrophilicity and more functional groups that are beneficial for adsorption. However, the protein has fewer pores and has little adsorptivity. As a result, after the protein content increased beyond a certain range, the adsorption capacity of the composite decreased. Therefore, we used the composite aerogel of a mass ratio of graphene to protein 1:6 for the following characterization and adsorption comparison with the graphene aerogels.

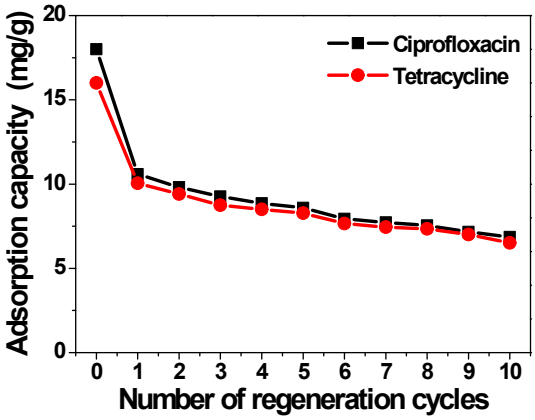

Fig. S5 Regeneration properties of adsorbent