Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

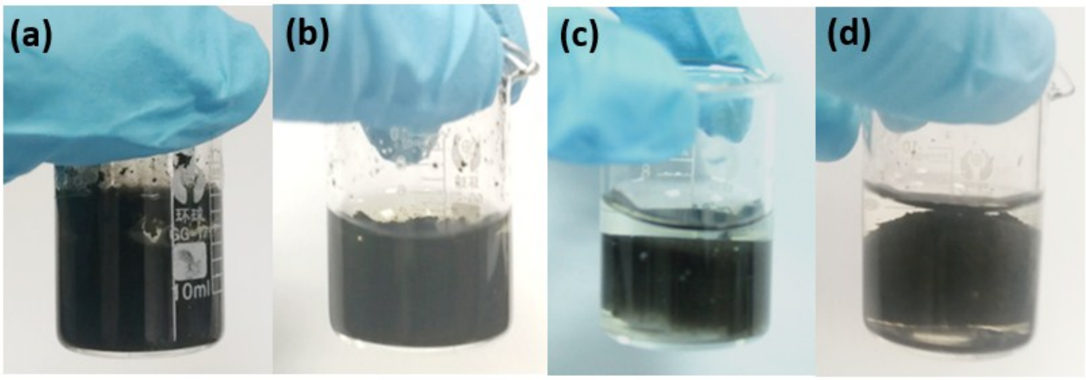


Figure S1 Photographs of samples after freeze-thaw with different ratio between ABA and mPD (a) 0 (b) 1:19 (c) 1:9 (d) 1:4.

Samples with different content of ABA after freeze-thaw are present in figure S1. When the ratio of ABA:mPD is 1:9 or 1:4, the sample can turn into hydrogel. The samples can't form hydrogel when the content of ABA is low and 0. It's obvious that ABA plays an important role in the process of forming hydrogel. On the other hand, high content of ABA increases the cost and reduces the quantity of amino groups and imino groups. Hence, the ratio of 1:9 between ABA and mPD is the optimum value for synthesis.

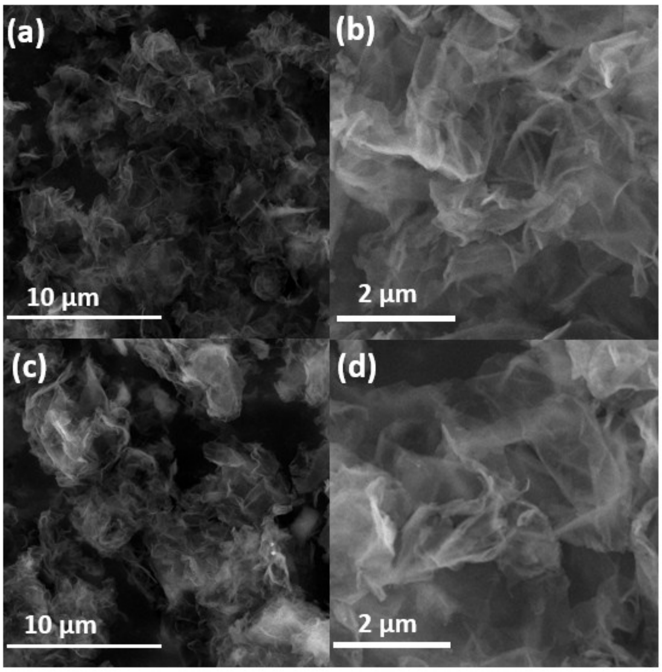
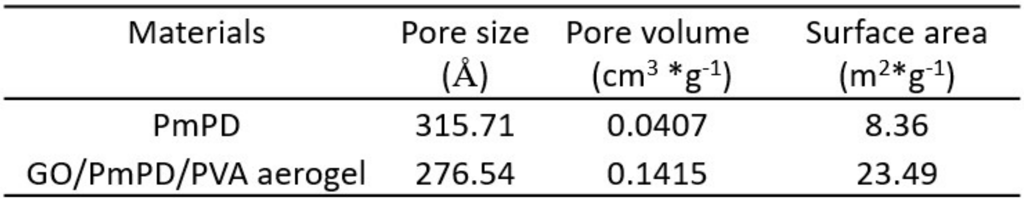


Figure S2 SEM images of GO/PmPD/PVA aerogel in different ratio of materials: (a) and (b) for GO:mPD/ABA: PVA = 1:2:8, (c) and (d) for GO:mPD/ABA: PVA = 1:3:7.

Evident lamellar structure with many spaces are observed in various GO/PmPD/PVA aerogel through the SEM images.

Table S1 Pore size, pore volume, and surface area of PmPD and GO/PmPD/PVA aerogel.



Materials	Pore size (Å)	Pore volume (cm^3 *g^{-1})	Surface area (m^2*g^{-1})
PmPD	315.71	0.0407	8.36
GO/PmPD/PVA aerogel	276.54	0.1415	23.49

The surface areas of PmPD and GO/PmPD/PVA aerogel were calculated by the BET method, pore sizes and pore volumes were calculated by the BJH method. The relative parameters were listed in Table S1.

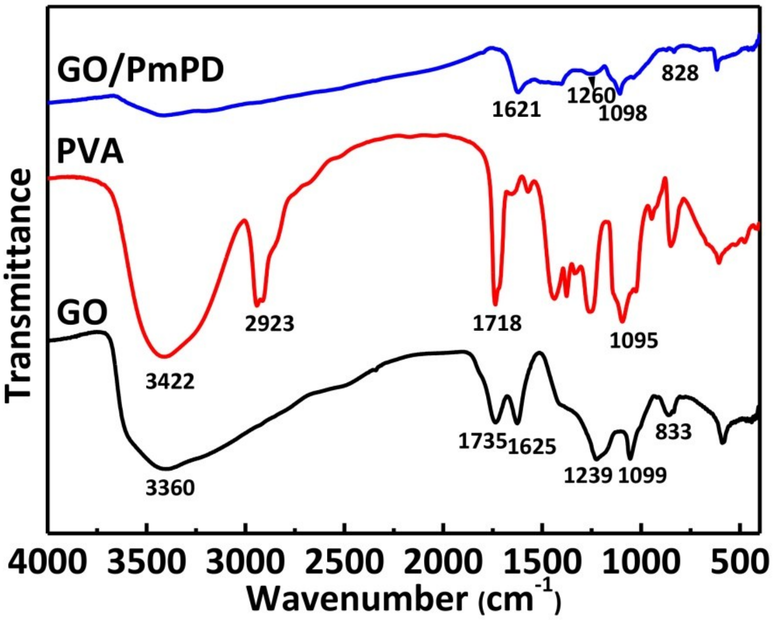


Figure S3 FT-IR spectra of GO, PVA and GO/PmPD.

In the spectrum of GO sheets, a main absorption band appeared at 3340 cm^{-1} can be attributed to the stretching vibration of O-H. The sharp absorption peaks at 1735 cm^{-1} and 1625 cm^{-1} can be associated with C=O stretching vibrations of carboxylic groups or other carbonyl functional groups. And the two peaks at 1239 cm^{-1} and 1099 cm^{-1} correspond to the stretching vibrations of C-O. The peak at 833 cm^{-1} should be assigned the asymmetric stretching vibration of C-O-C.[1] Many oxygen-containing groups observed in GO sheets would promote the composition of GO and PmPD, and be benefit to attract dyes and heavy metal ions in aqueous solution. In the PVA spectrum, the broad adsorption band around 3422 cm^{-1} corresponds to the stretching vibration of O-H, the sharp absorption peak around 2923 cm^{-1} corresponds to C-H stretching vibration, the peak at 1718 cm^{-1} should be assigned to the stretching vibration of C=O, and the peak at 1095 cm^{-1} should be assigned to the stretching vibration of C-O.[2] A large number of hydroxyl functional groups make PVA has excellent hydrophilicity. Through the spectrum of GO/PmPD, peak and 1260 cm^{-1} belongs to PmPD, peaks at 1098 cm^{-1} and 828 cm^{-1} belong to GO, and the at 1621 cm^{-1} should be attributed to the stretching vibration C=O of GO and quinoid imine of PmPD.

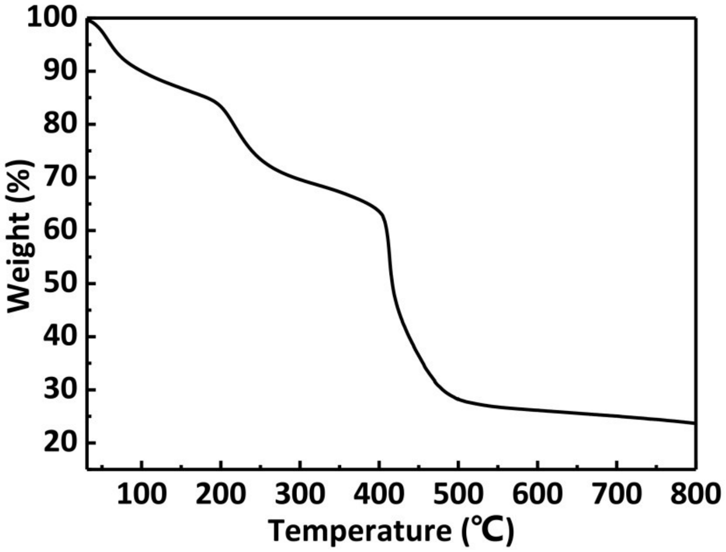


Figure S4 TGA curve of GO/PmPD/PVA aerogel.

As present in figure S4, the initial weight loss below 200 °C can be assigned to the evaporation of water. The second step of weight loss between 200 °C and 400 °C is attributed to the melting of PVA.3 The final weight loss from 400 °C to 800 °C is associated with the main polymer chains' degradation.4

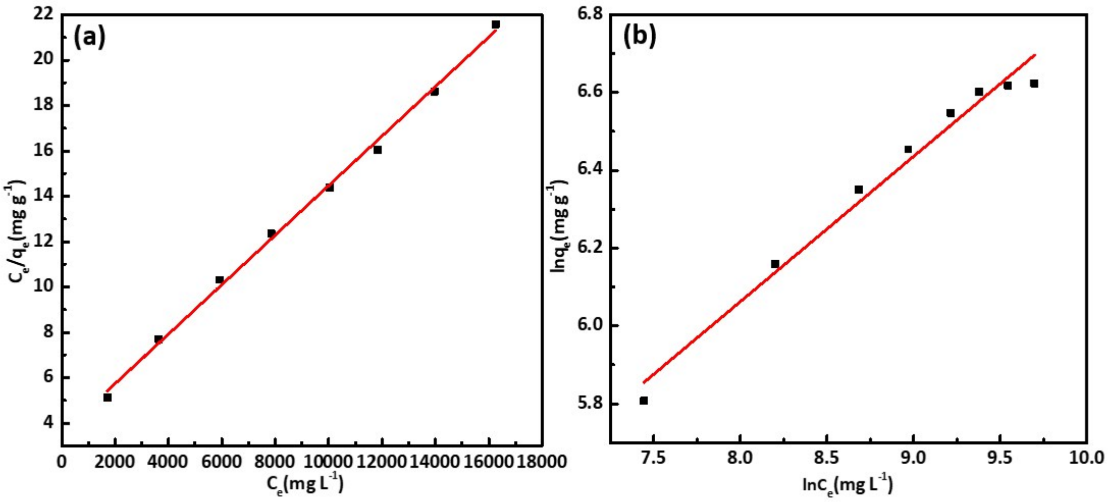


Figure S5 Fitting equilibrium data with (a) Langmuir isotherm model and (b) Freundlich isotherm model.

In order to carry out the maximum adsorption capacity of Ag(Ⅰ) at room temperature and figure out how the adsorbates interact with adsorbents, Langmuir model and Freundlich model were used to fit experimental data and show in figure S4.

$$\frac{C_e}{q_e}=\frac{1}{Kq_m}+\frac{C_e}{q_m} \tag{1}$$

$$\ln q_e=\ln K_f+\frac{1}{n}\ln C_e \tag{2}$$

Where q_e (mg/g) is adsorbed amount of Ag(Ⅰ) at equilibrium time, c_e represents the equilibrium concentration of Ag(Ⅰ), q_m (mg/g) represents the maximum adsorption capacity of GO/PmPD/PVA aerogel, and the Langmuir parameter K correlates to the adsorption energy. Freundlich parameters K_f and n correlate to the adsorption intensity and adsorption capacity.

Table S2 Comparison of the adsorption capacity of Ag(I) between GO/PmPD/PVA aerogel and other various materials.

Materials	q_{max} (mg/g)	Ref.
PMPSQ microspheres	1140	5
Ag(I)-imprinted chitosan	199.2	6
Poly(o-phenylenediamine)	533	7
Expanded perlite	8.46	8
Poly(glycidyl methacrylate)	157.05	9
GO/PmPD/PVA aerogel	917.41	This study

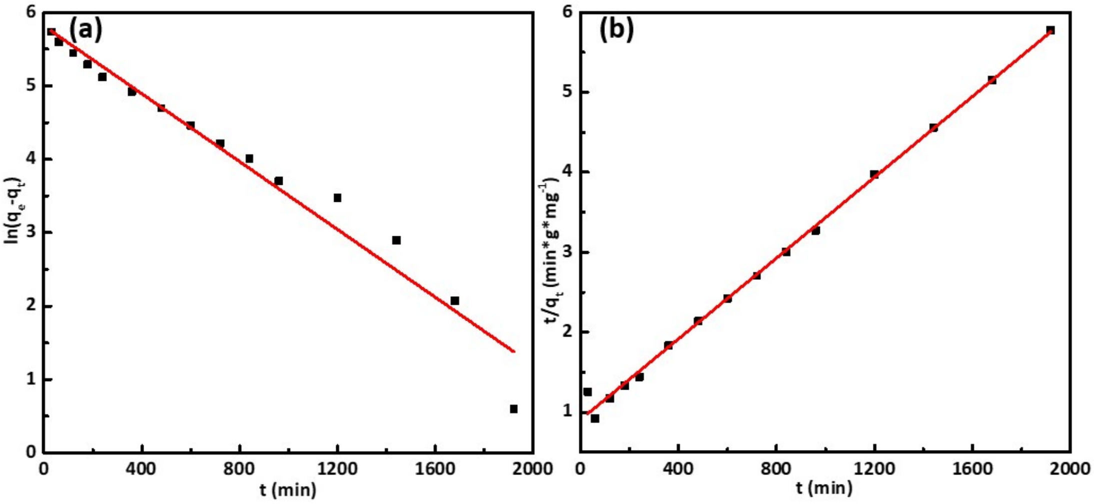


Figure S6 (a) pseudo-first-order model (b) pseudo-second-order model of Ag(Ⅰ) adsorption by

GO/PmPD/PVA aerogel.

The behaviors of Ag(Ⅰ) adsorption on GO/PmPD/PVA aerogel were analyzed by the pseudo-first-order and pseudo-second-order kinetic equations and present in figure S5. These two equations are expressed as follows:

$$\ln(q_e - q_t) = \ln q_e - k_1 t \qquad (3)$$

$$\frac{t}{q_t} = \frac{1}{K_2 {q_e}^2} + \left(\frac{1}{q_e}\right) t \qquad (4)$$

Where q_t and q_e are the adsorption capacities of Ag(Ⅰ) at time t and at equilibrium, respectively; k_1 and k_2 are constants of the pseudo-first-order and pseudo-second-order adsorption reaction, respectively.

Reference

1. Q. Kong, J. Wei, Y. Hu and C. Wei, Journal of Hazardous Materials, 2019, 363, 161-169.
2. I. Saini, A. Sharma, R. Dhiman, S. Aggarwal, S. Ram and P. K. Sharma, Journal of Alloys and Compounds, 2017, 714, 172-180.
3. S. Kumar, B. Krishnakumar, A. Sobral and J. Koh, Carbohyd. Polym., 2019, 205, 559-564.
4. W. Yu, L. Zhang, H. Wang and L. Chai, J. Hazard. Mater., 2013, 260, 789-795
5. X. Lu, Q. Yin, Z. Xin and Z. Zhang, Chem Eng Sci, 2010, 65, 6471-6477
6. H. Huo, H. Su and T. Tan, Chem Eng J, 2009, 150, 139-144.
7. X.-G. Li, X.-L. Ma, J. Sun and M.-R. Huang, Langmuir, 2009, 25, 1675-1684.
8. H. Ghassabzadeh, A. Mohadespour, M. Torab-Mostaedi, P. Zaheri, M. G. Maragheh and H. Taheri, J Hazard Mater, 2010, 177, 950-955.
9. J. Zhao, S. Wang, L. Zhang, C. Wang and B. Zhang, Polymers, 2018, 10.