Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

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Synthesis of Ag nanoparticles encapsulated in hollow silica spheres for efficient and selective removal of low-concentrated sulfur compounds

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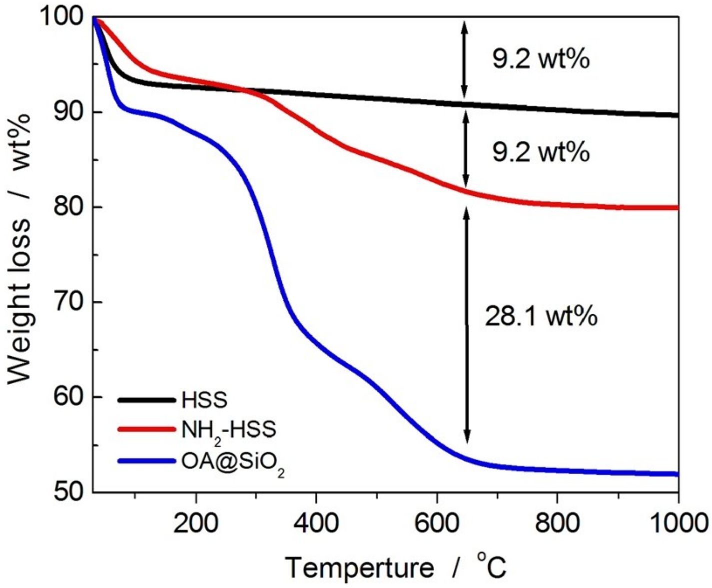

Fig. S1 Weight loss curves of HSS, NH_2-HSS and OA@SiO_2 in a flow of air. The weight loss of HSS seen at 100 °C < T (corresponding to 9.2 wt%) is due to the removal of absorbed water. The NH_2-HSS showed the additional weight loss seen at $T < 650$ °C (corresponding to 9.2 wt%) which is attributed to the breakdown of the amine groups and the alkyl groups of APTES. The OA@SiO_2 shows the further weight loss seen at $T < 650$ °C (corresponding to 21.7 wt%) which is due to combustion of the oleic acid. From these results, it is confirmed that the prepared NH_2-HSS retained the amine groups while the oleic acid was removed.

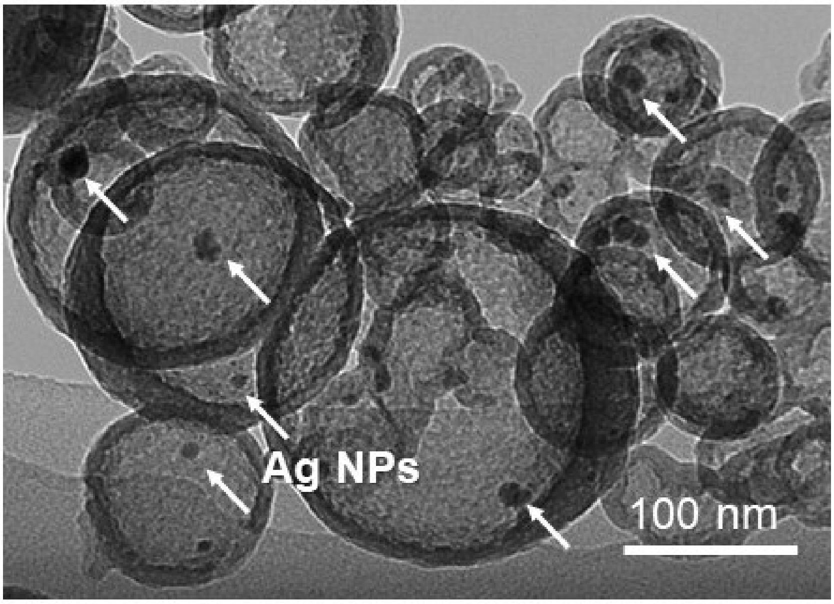

Fig. S2 TEM image of Ag@HSS (wide region).

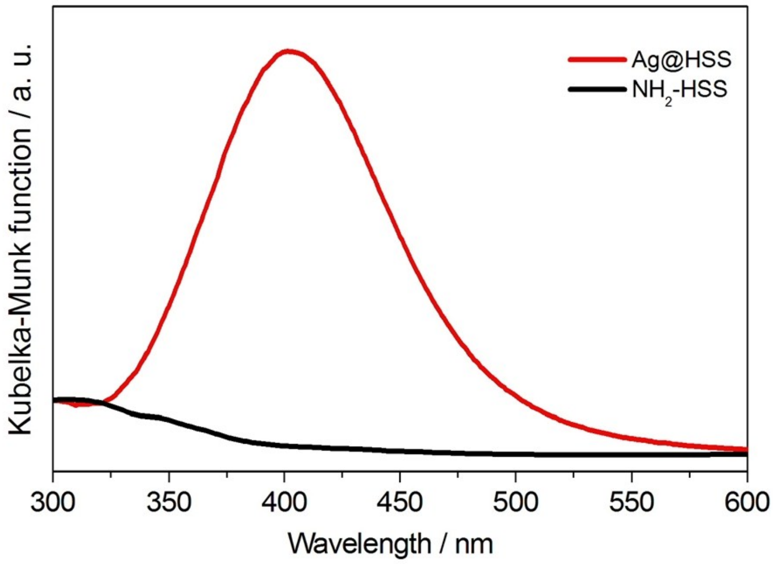

Fig. S3 UV-vis spectra of NH_2-HSS and Ag@HSS. The spectra of Ag@HSS showed the peak at 400 nm derived from AgNPs.

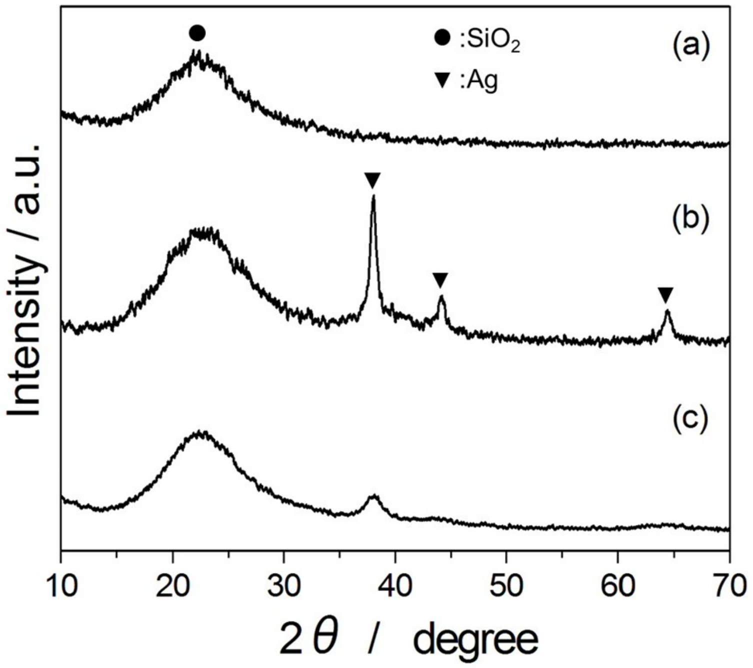

Fig. S4 XRD patterns of (a) NH_2-HSS, (b) Ag/SiO_2 and (c) Ag@HSS. The broad peak seen at 2θ = 15–30° is associated with amorphous nature of silica.

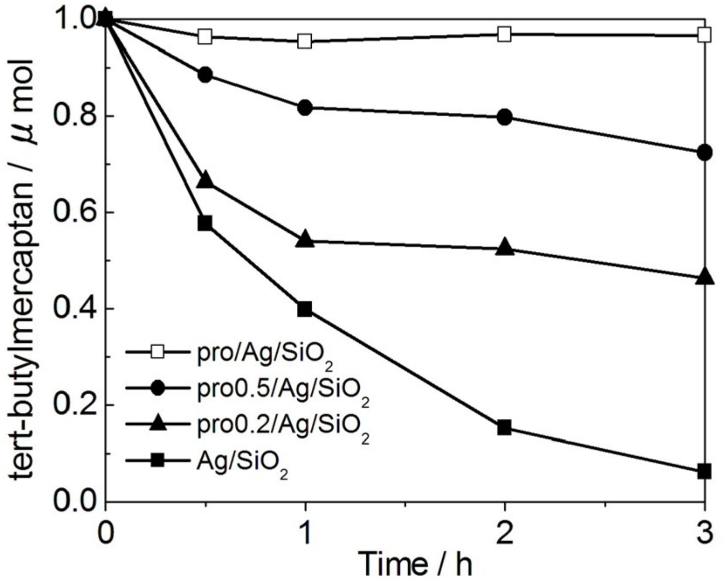

Fig. S5 Adsorption kinetics of TBM (*tert*-buthylmercaptan) over Ag/SiO_2 and protein adsorbed Ag/SiO_2. The amount of adsorbed protein to the surface of 10 mg of Ag/SiO_2 were 2 mg (pro0.2/Ag/SiO_2)), 5 mg (pro0.5/Ag/SiO_2) and 10 mg (pro/Ag/SiO_2).

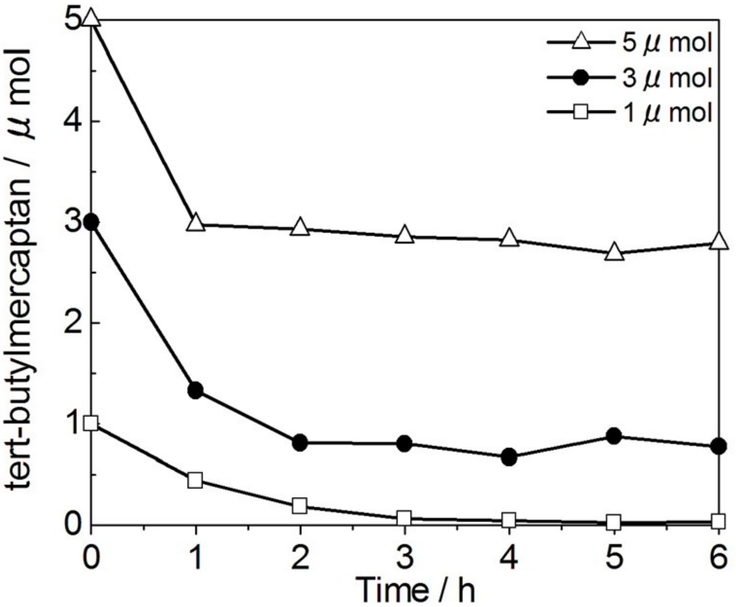

Fig. S6 Adsorption kinetics of 1 μmol, 3 μmol and 5 μmol of TBM (*tert*-buthylmercaptan) over Ag@HSS.

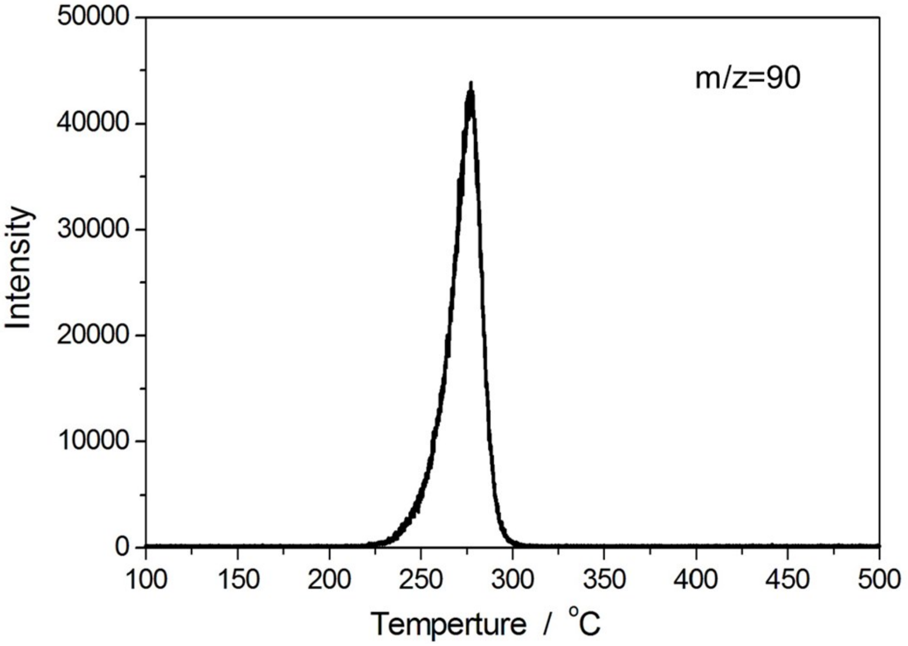

Fig. S7 EGA profile (m/z=90) obtained from TBM (*tert*-buthylmercaptan) adsorbed Ag@HSS. The peak caused by the desorption of TBM is observed around 220-310 °C, confirming that the adsorbed TBM is completely desorbed from Ag/@HSS by heat treatment at 500 °C.

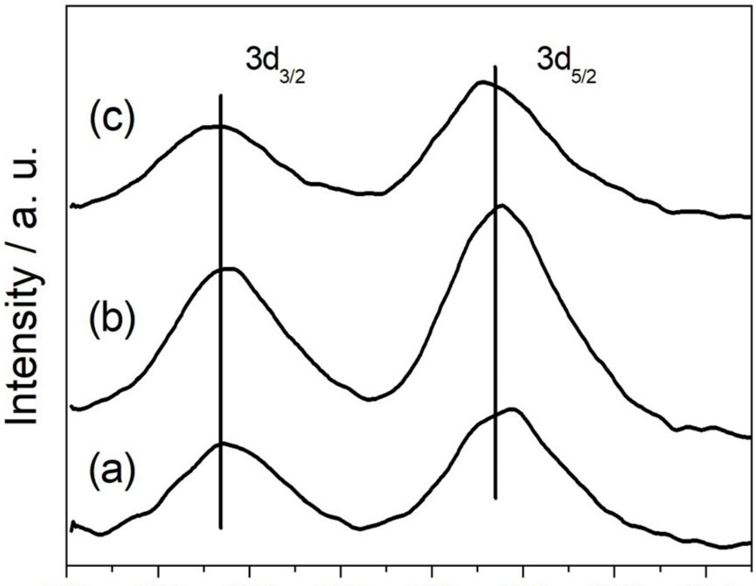

Fig. S8 Ag 3d XPS spectra of Ag@HSS (a) as-synthesized, (b) after adsorption of TBM (*tert*-buthylmercaptan), (c) after regeneration for 2 h at 500 °C.

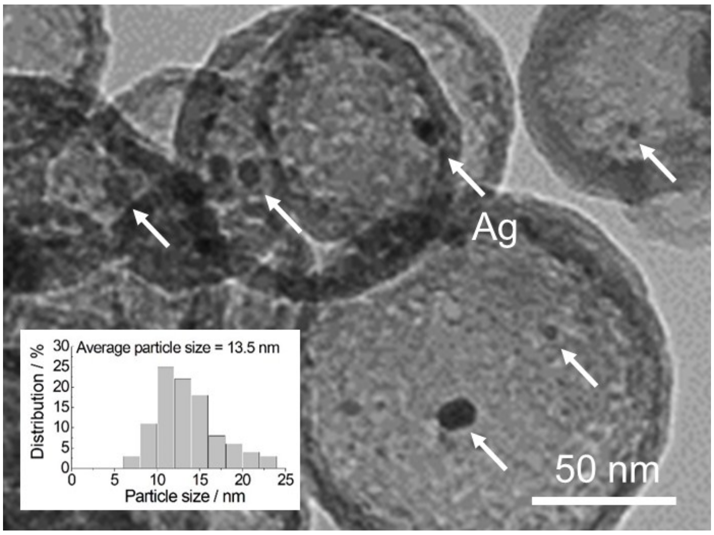

Fig. S9 TEM image of Ag@HSS after regeneration treatment for 2 h at 500 °C. The inset shows the particle size distribution diagram of AgNPs.

Table S1 Adsorption capacities of Ag@HSS and reported samples toward sulfur compounds.

Sample	Adsorbate ^{a}	Support	Adsorption capacity [mol-S / mol-Ag]	Ref.
Ag@HSS	TBM	Hollow silica sphere	0.48	This study
AgNa-Y	TBM	Y-zeolite	0.34	1
AgNa-Y	TBM	Y-zeolite	0.35	2
Ag-X	TBM	X-zeolite	0.62	3
AgSi	TBM	Amorphous silica	1.06	4
Ag-MSN	DBT	Mesoporous silica nanoparticles	0.21	5

^{a} TBM = *tert*-butylmercaptan, DBT = Dibenzothiophen

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