Supporting Information for

Synthesis of azole-functionalized microspheres and its adsorption properties for gold(I) thiosulfate complex

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CONTENT

1. Pre-processing steps of gold-containing samples.

Before testing, the residual solution containing gold after adsorption need some pretreatment process, which are as follows.

(a) Taking two 3 mL parallel solution after adsorption, and add appropriate amount of deionized water to dilute;

(b) Then 3 mL H_2O_2 with 30% concentration is added drop by drop, oxidizing for 30 min;

(c) After oxidation, 2 mL hydrochloric acid with a volume ratio of 1:3 (v/v) was added;

(d) Put the oxidized solution on the electric heating plate and heat it until it is nearly dry, during the heating process, add 2 drops of 10% KCl solution;

(e) Finally, dissolving with 5% aqua regia and fill in a 25 mL volumetric bottle, AAS were used to analyze the concentration of gold.

Table S1. R_d values of different initial gold concentration.

		Initial gold Concentration (mg/L)			
		20	30	40	50
R_d (L/g)	2 h	1.01±0.03	0.48±0.02	0.19±0.005	0.004±0.002
	4 h	1.62±0.03	1.01±0.03	0.54±0.006	0.14±0.002
	6 h	2.33±0.08	1.50±0.06	0.93±0.01	0.26±0.003
	8 h	3.46±0.29	2.26±0.09	1.47±0.04	0.66±0.01
	10 h	4.62±0.31	3.50±0.19	2.14±0.02	0.88±0.01
	12 h	7.03±0.53	4.65±0.24	2.50±0.03	0.99±0.005
	24 h	43.03±0	8.8±0.77	2.98±0.04	1.22±0.02
	36 h	-	8.9±0.64	3.24±0.05	1.23±0.01
	48 h	-	8.93±0.87	3.26±0.02	1.23±0
	60 h	-	8.93±0.15	3.27±0.06	1.23±0.001
	72 h	-	8.93±2.03	3.27±0	1.23±0
	84 h	-	8.93±0.74	3.27±0	1.23±0

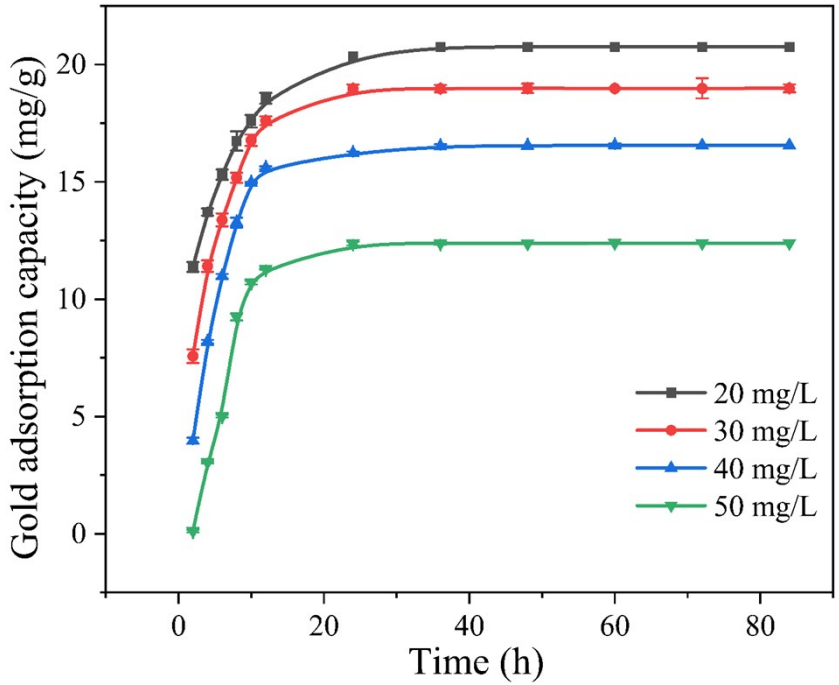

Fig. S1. Gold adsorption capacity of PS-3-AT for Au(Ⅰ) in different initial gold concentrations.
($m_{PS\text{-}3\text{-}AT}$=0.2 g, c_{S2O3}^{2-}=0.01 mol/L, pH=9)

Table S2. Residual Au(Ⅰ) concentration in solution after PS-3-AT adsorption for $Au(S_2O_3)_2^{3-}$ under different initial gold concentration.

Initial gold Concentration (mg/L)	Residual Au(Ⅰ) concentration(mg/L)											
	2 h	4 h	6 h	8 h	10 h	12 h	24 h	36 h	48 h	60 h	72 h	84 h
20	1.382	1.005	0.767	0.624	0.487	0.294	0.057	0	0	0	0	0
	1.339	1.037	0.812	0.539	0.431	0.314	0.057	0	0	0	0	0
30	1.883	1.381	1.098	0.787	0.602	0.437	0.276	0.273	0.235	0.26	0.212	0.273
	1.943	1.331	1.041	0.831	0.552	0.475	0.239	0.241	0.276	0.252	0.3	0.238
40	2.449	1.815	1.429	1.065	0.835	0.755	0.649	0.605	0.614	0.6	0.609	0.609
	2.423	1.831	1.409	1.108	0.844	0.742	0.662	0.622	0.608	0.617	0.609	0.609
50	2.989	2.564	2.29	1.654	1.466	1.370	1.207	1.221	1.216	1.213	1.213	1.213
	3.001	2.574	2.278	1.685	1.45	1.377	1.224	1.208	1.216	1.212	1.213	1.213

Table S3. Linear fitting parameters of the adsorption kinetics of PS-3-AT.

Model	Parameters	Concentration (mg/L)			
		20	30	40	50
Weber-Morris model	First Stage	y=1.5438x+10.3152	y=2.2175x+6.2094	y=2.706x+2.1538	y=2.7356x-2.5809
	Second Stage	y=0.2996x+16.7612	y=0.2273x+16.2445	y=0.1068x+14.9495	y=0.1814x+10.1961
	Third Stage	y=20.75	y=0.0197x+18.9781	y=0.0011x+16.5112	y=0.1405x+12.2709
	k_1 (mg g^{-1} $h^{-1/2}$)	1.5438	2.2175	2.706	2.7356
	k_2 (mg g^{-1} $h^{-1/2}$)	0.2996	0.2273	0.1068	0.1814
	k_3 (mg g^{-1} $h^{-1/2}$)	0	0.0197	0.0011	0.1405

Table S4. R_d values of different thiosulfate concentration.

		Initial gold Concentration (mg/L)					
		0.01	0.05	0.1	0.15	0.2	0.25
R_d (L/g)	2 h	1.04±0.02	0.82±0.04	0.50±0.004	0.33±0.009	0.31±0.007	0.25±0.01
	4 h	1.96±0.23	1.08±0.07	0.70±0.04	0.45±0.004	0.37±0.003	0.31±0.008
	6 h	3.45±0.03	1.42±0.11	0.85±0.08	0.54±0.04	0.46±0.001	0.41±0.006
	8 h	7.94±0.12	1.66±0.02	1.21±0.02	0.78±0.04	0.52±0.1	0.45±0.002
	10 h	24.81±5.79	2.42±0.09	1.58±0.09	1.03±0.01	0.59±0.007	0.54±0.02
	12 h	-	3.36±0.13	2.1±0	1.22±0.04	0.69±0.005	0.62±0.004
	24 h	-	6.84±1.67	2.65±0.08	1.40±0.02	0.88±0.001	0.77±0.01
	36 h	-	6.86±0.09	2.65±0.09	1.42±0.003	0.88±0.001	0.77±0.003
	48 h	-	6.86±0.07	2.65±0.07	1.42±0.001	0.88±0.0006	0.77±0.004
	60 h	-	6.86±0	2.65±0.09	1.43±0.003	0.88±0.0006	0.77±0.004
	72 h	-	6.86±0	2.65±0.09	1.42±0	0.88±0.0005	0.77±0.003

Table S5. Residual Au(Ⅰ) concentration in solution after PS-3-AT adsorption for $Au(S_2O_3)_2^{3-}$ under different thiosulfate concentration.

Thiosulfate Concentration (mg/L)	Residual Au(Ⅰ) concentration(mg/L)										
	2 h	4 h	6 h	8 h	10 h	12 h	24 h	36 h	48 h	60 h	72 h
0.01	1.352	0.975	0.579	0.289	0.069	0	0	0	0	0	0
	1.323	0.814	0.589	0.281	0.071	0	0	0	0	0	0
0.05	1.549	1.259	1.164	0.991	0.791	0.577	0.417	0.329	0.322	0.325	0.325
	1.472	1.364	1.054	1.011	0.744	0.616	0.235	0.321	0.328	0.325	0.325
0.1	1.883	1.591	1.561	1.21	0.994	0.845	0.701	0.735	0.697	0.735	0.698
	1.872	1.67	1.422	1.234	1.074	0.842	0.734	0.698	0.736	0.698	0.735
0.15	2.128	1.947	1.768	1.589	1.331	1.238	1.106	1.109	1.107	1.106	1.107
	2.161	1.935	1.861	1.513	1.352	1.192	1.129	1.106	1.108	1.103	1.107
0.2	2.182	2.092	1.926	1.833	1.751	1.636	1.457	1.458	1.457	1.458	1.457
	2.209	2.081	1.921	1.867	1.768	1.648	1.459	1.456	1.459	1.457	1.458
0.25	2.282	2.196	2.022	1.945	1.785	1.710	1.548	1.563	1.556	1.563	1.557
	2.332	2.167	2.003	1.951	1.844	1.719	1.577	1.557	1.564	1.555	1.563

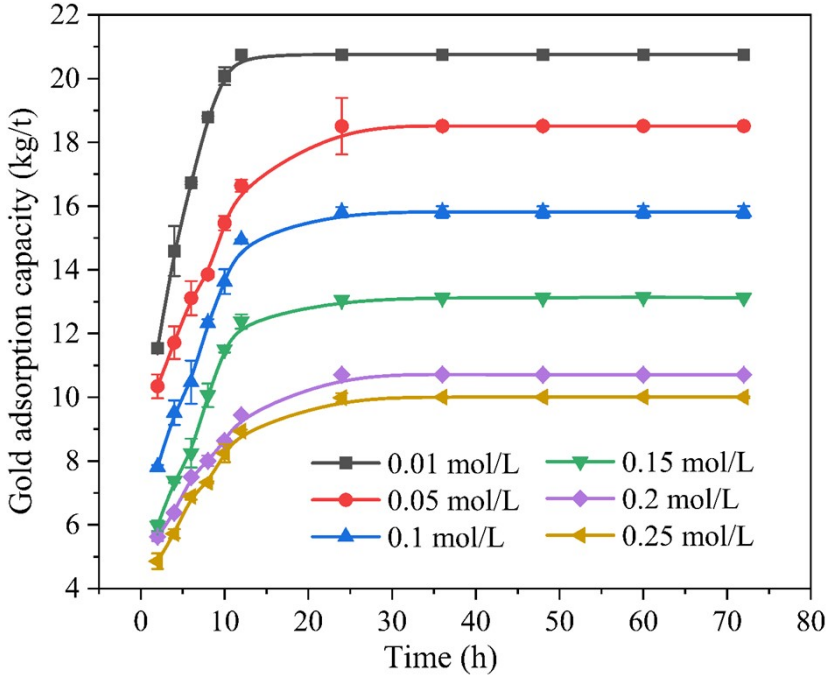

Fig. S2. Gold adsorption capacity of PS-3-AT for Au(Ⅰ) in different thiosulfate concentration.
($m_{PS\text{-}3\text{-}AT}$=0.2 g, $c_{Au(I)}$=25 mg/L, pH=9)

Table S6. R_d values of different temperature.

		Temperature (K)			
		308	318	328	338
R_d (L/g)	0.5 h	0.51±0.01	0.43±0.01	0.31±0.01	0.13±0.006
	1 h	1.37±0.03	0.93±0.02	0.58±0.015	0.25±0.006
	2 h	2.62±0.03	2.49±0.06	1.09±0.05	0.52±0.008
	4 h	5.94±0.24	4.40±0.34	1.74±0.04	0.81±0.013
	6 h	8.8±1.17	5.77±0.35	1.84±0.05	0.91±0.017
	8 h	51.25±11.1	6.19±0.39	1.89±0.06	1.01±0.039
	10 h	-	6.25±0.36	1.91±0.04	1.07±0.017
	12 h	-	6.27±0.33	1.92±0.06	1.06±0.017
	24 h	-	6.29±0.29	1.94±0.003	1.08±0
	36 h	-	6.31±0.25	1.94±0.05	1.08±0
	48 h	-	6.31±0.21	1.95±0.06	1.08±0

Table S7. Residual Au(Ⅰ) concentration in solution after PS-3-AT adsorption for $Au(S_2O_3)_2^{3-}$ under different temperature.

Temperature(K)	Residual Au(Ⅰ) concentration(mg/L)										
	0.5 h	1 h	2 h	4 h	6 h	8 h	10 h	12 h	24 h	36 h	48 h
308	1.848	1.152	0.719	0.355	0.295	0.035	0	0	0	0	0
	1.875	1.119	0.732	0.383	0.222	0.061	0	0	0	0	0
318	1.999	1.403	0.736	0.512	0.359	0.334	0.372	0.334	0.366	0.336	0.361
	1.965	1.440	0.766	0.443	0.400	0.377	0.333	0.369	0.336	0.363	0.339
328	2.214	1.791	1.264	0.987	0.918	0.897	0.898	0.929	0.901	0.886	0.878
	2.171	1.751	1.338	0.953	0.955	0.940	0.928	0.891	0.901	0.921	0.917
338	2.578	2.311	1.840	1.532	1.426	1.387	1.306	1.312	1.308	1.308	1.308
	2.615	2.285	1.861	1.507	1.453	1.331	1.331	1336	1.308	1.308	1.308

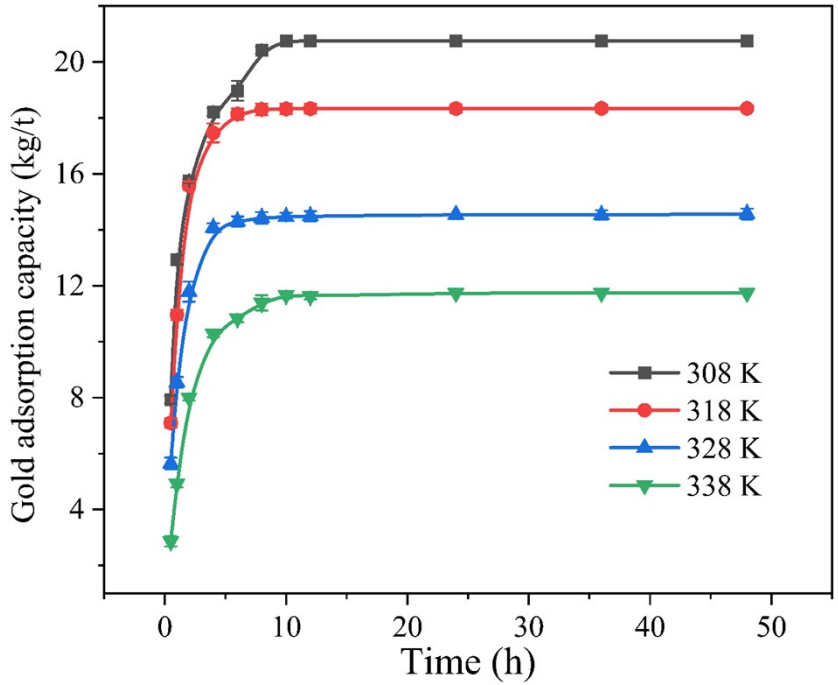

Fig. S3. Gold adsorption capacity of PS-3-AT for Au(Ⅰ) in different temperature.
($m_{PS\text{-}3\text{-}AT}$=0.2 g, $c_{Au(I)}$=25 mg/L, c_{S2O3}^{2-}=0.01 mol/L, pH=9)

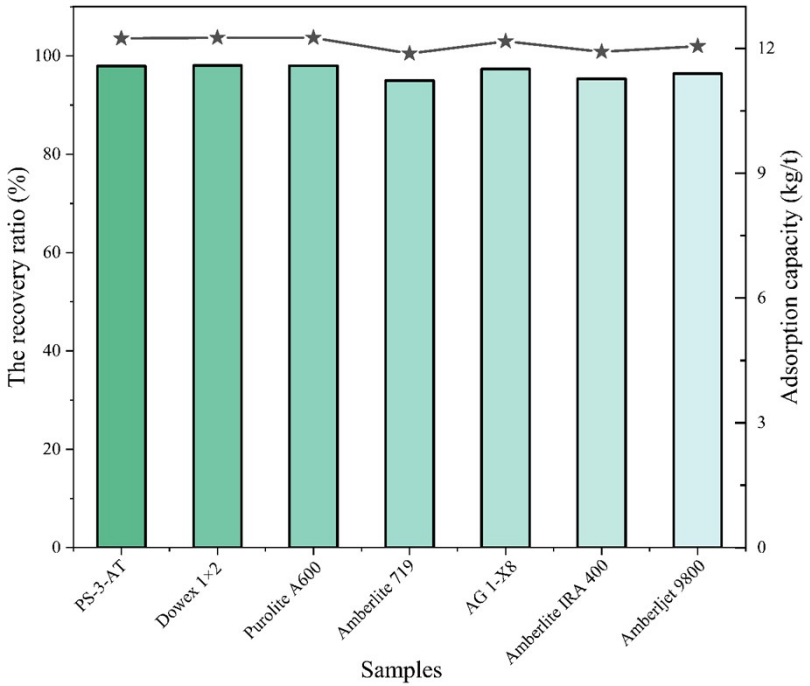

Fig. S4. Comparison of adsorption ability of PS-3-AT with other resins.
($m_{adsorbent}$=0.2 g, c_{S2O3}^{2-}=0.01 mol/L, pH=9)

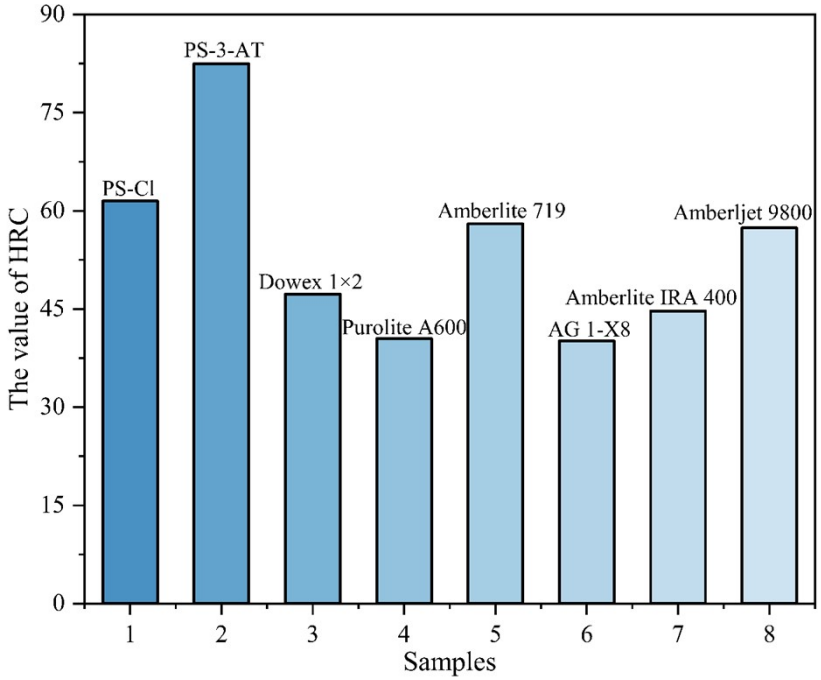

Fig. S5. Comparison of hardness of PS-3-AT with other resins.

Table S8. Comparison of the price of PS-3-AT with other resins.

Samples	Weight/g	Mesh	Price/CNY
PS-Cl	100	12.5-37.5	18.5
Dowex 1×2	100	100-200	1988
Purolite A600	100	50-100	160
Amberlite 719	100	50-100	180
AG 1-X8	100	50-100	1060
Amberlite IRA-400	100	50-100	200
Amberjet 9800	100	50-100	300