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APPENDIX

Table A1 The absorbance at 618 nm of various concentration ratio of modifier onto AgNPls surface based colorimetric detection of 70 ppb Ni(II).

GSH : Cys concentration (μM)	Absorbance at 618 nm			Average	SD
	1	2	3		
0.1 : 0.1	0.0763	0.0760	0.0761	0.0762	0.0002
0.5 : 0.1	0.0934	0.0930	0.0931	0.0932	0.0002
1 : 0.1	0.0944	0.0990	0.0969	0.0967	0.0023
5 : 0.1	0.0805	0.0782	0.0755	0.0781	0.0025
0.1 : 0.5	0.0841	0.0898	0.0889	0.0876	0.0030
0.5 : 0.5	0.1245	0.1254	0.1253	0.1251	0.0005
1 : 0.5	0.1030	0.1014	0.1037	0 1027	0.0012
5 : 0.5	0.0914	0.0901	0.0888	0 0901	0.0013
0.1 : 1	0.1044	0.1073	0.1074	0.1064	0.0017
0.5 : 1	0.1040	0.1044	0.1038	0.1041	0.0003
1 : 1	0.1028	0.1018	0.1018	0.1021	0.0006
5 : 1	0.1034	0.1027	0.0996	0.1019	0.0020
0.1 : 5	0.1693	0.1702	0.1688	0.1694	0.0008
0.5 : 5	0.1690	0.1762	0.1831	0.1761	0.0070
1 : 5	0.2274	0.2290	0.2256	0.2273	0.0017
5 : 5	0.2193	0.2187	0.2187	0.2189	0.0004

Table A2 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) at different pH.

pH	Absorbance at 618 nm			Average	SD
	1	2	3		
2.5	0.1069	0.1076	0.1109	0.1085	0.0021
5	0.1095	0.1099	0.1099	0.1098	0.0002

pH	Absorbance at 618 nm			Average	SD
	1	2	3		
6	0.1685	0.1694	0.1702	0.1694	0.0009
7	0.2111	0.2088	0.2104	0.2101	0.0012
8	0.1845	0.1863	0.1947	0.1885	0.0055
9	0.1390	0.1323	0.1327	0.1347	0.0037
10	0.1118	0.1019	0.1040	0.1059	0.0052
11	0.0823	0.0826	0.0827	0.0825	0.0002

Table A3 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) and other metals at pH 7.

Metal	Absorbance at 618 nm			Average	SD
	1	2	3		
Ni(II)	0.2159	0.2137	0.2168	0.2155	0.0016
Fe(III)	0.1193	0.1317	0.1330	0.1280	0.0075
Fe(II)	0.1245	0.1279	0.1279	0.1268	0.0020
As(III)	0.1305	0.1350	0.1370	0.1342	0.0033
Co(II)	0.1439	0.1478	0.1432	0.1450	0.0025
Cu(II)	0.1415	0.1436	0.1447	0.1433	0.0016
Cd(II)	0.1510	0.1429	0.1486	0.1475	0.0042
Pb(II)	0.1660	0.1695	0.1743	0.1699	0.0042
Zn(II)	0.1629	0.1674	0.1721	0.1674	0.0046
Hg(II)	0.1739	0.1783	0.1808	0.1777	0.0035
Au(III)	0.1777	0.1827	0.1864	0.1823	0.0044
Rh(II)	0.1470	0.1500	0.1518	0.1496	0.0024
Pt(II)	0.1299	0.1338	0.1346	0.1328	0.0025
Ag(I)	0.1571	0.1599	0.1649	0.1606	0.0040

Metal	Absorbance at 618 nm			Average	SD
	1	2	3		
Na(I)	0.1750	0.1784	0.1817	0.1783	0.0034
K(I)	0.1722	0.1805	0.1820	0.1782	0.0053
Ca(II)	0.1730	0.1795	0.1836	0.1787	0.0053
Mg(II)	0.1825	0.1856	0.1873	0.1851	0.0024

Table A4 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) and other metals at pH 8.

Metal	Absorbance at 618 nm			Average	SD
	1	2	3		
Ni(II)	0.1983	0.2000	0.2021	0.2001	0.0019
Fe(III)	0.0911	0.0957	0.0966	0.0945	0.0029
Fe(II)	0.0993	0.0997	0.1015	0.1002	0.0012
As(III)	0.0966	0.0955	0.0973	0.0965	0.0009
Co(II)	0.1003	0.1000	0.1002	0.1002	0.0002
Cu(II)	0.1046	0.1078	0.1171	0.1099	0.0065
Cd(II)	0.0975	0.0992	0.1004	0.0990	0.0015
Pb(II)	0.0971	0.0972	0.0976	0.0973	0.0003
Zn(II)	0.1001	0.0992	0.1003	0.0998	0.0006
Hg(II)	0.0973	0.0966	0.0969	0.0969	0.0004
Au(III)	0.1039	0.1044	0.1060	0.1048	0.0011
Rh(II)	0.0932	0.0939	0.0939	0.0937	0.0004
Pt(II)	0.0945	0.0932	0.0933	0.0937	0.0007
Ag(I)	0.0953	0.0910	0.0949	0.0937	0.0024
Na(I)	0.0957	0.0961	0.0973	0.0964	0.0008
K(I)	0.0972	0.0978	0.0995	0.0982	0.0012

Metal	Absorbance at 618 nm			Average	SD
	1	2	3		
Ca(II)	0.0998	0.0991	0.1027	0.1005	0.0019
Mg(II)	0.0963	0.0982	0.0981	0.0975	0.0010

Table A5 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) and other metals at pH 9.

Metal	Absorbance at 618 nm			Average	SD
	1	2	3		
Ni(II)	0.0858	0.0863	0.0866	0.0862	0.0004
Fe(III)	0.0858	0.0854	0.0853	0.0855	0.0003
Fe(II)	0.0820	0.0818	0.0833	0.0824	0.0008
As(III)	0.0858	0.0846	0.0843	0.0849	0.0008
Co(II)	0.0847	0.0845	0.0842	0.0845	0.0003
Cu(II)	0.0892	0.0853	0.0877	0.0874	0.0019
Cd(II)	0.0867	0.0871	0.0870	0.0870	0.0002
Pb(II)	0.0863	0.0851	0.0857	0.0857	0.0006
Zn(II)	0.0851	0.0856	0.0864	0.0857	0.0007
Hg(II)	0.0921	0.0928	0.0933	0.0927	0.0006
Au(III)	0.0908	0.0926	0.0897	0.0910	0.0015
Rh(II)	0.0792	0.0791	0.0790	0.0791	0.0001
Pt(II)	0.0778	0.0787	0.0772	0.0779	0.0007
Ag(I)	0.0764	0.0765	0.0767	0.0765	0.0002
Na(I)	0.0908	0.0919	0.0924	0.0917	0.0008
K(I)	0.0912	0.0916	0.0916	0.0915	0.0003
Ca(II)	0.0924	0.0923	0.0933	0.0927	0.0006
Mg(II)	0.0942	0.0957	0.0962	0.0954	0.0011

Table A6 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) (pH 8) at different times.

Time (s)	Absorbance at 618 nm			Average	SD
	1	2	3		
0	0.1267	0.1105	0.1436	0.1269	0.0166
30	0.1469	0.1455	0.1602	0.1509	0.0081
60	0.1596	0.1640	0.1756	0.1664	0.0083
90	0.1688	0.1757	0.1857	0.1767	0.0085
120	0.1759	0.1837	0.1930	0.1842	0.0086
150	0.1814	0.1896	0.1985	0.1898	0.0086
180	0.1863	0.1943	0.2028	0.1945	0.0083
210	0.1895	0.1981	0.2063	0.1980	0.0084
240	0.1924	0.2013	0.2093	0.2010	0.0085
270	0.1966	0.2040	0.2117	0.2041	0.0076
300	0.1995	0.2063	0.2138	0.2065	0.0072
330	0.2018	0.2083	0.2156	0.2086	0.0069
360	0.2043	0.2100	0.2171	0.2105	0.0064
390	0.2069	0.2115	0.2184	0.2123	0.0058
420	0.2077	0.2127	0.2196	0.2133	0.0060
450	0.2067	0.2139	0.2201	0.2136	0.0067
480	0.2090	0.2150	0.2215	0.2152	0.0063
510	0.2114	0.2159	0.2223	0.2165	0.0055
540	0.2123	0.2166	0.2230	0.2173	0.0054
570	0.2128	0.2172	0.2237	0.2179	0.0055

Table A7 $A_{618} - A_0$ of GSH-Cys-AgNPls based on colorimetric detection Ni(II) and other metal under optimal conditions.

Metal	$A_{618} - A_0$			Average	SD
	1	2	3		
Ni(II)	0.0966	0.0992	0.1009	0.0989	0.0022
Fe(III)	-0.0105	-0.0051	-0.0046	-0.0068	0.0033
Fe(II)	-0.0024	-0.0011	0.0003	-0.0010	0.0014
As(III)	-0.0051	-0.0053	-0.0039	-0.0047	0.0007
Co(II)	-0.0013	-0.0008	-0.0010	-0.0010	0.0003
Cu(II)	0.0029	0.0071	0.0159	0.0086	0.0066
Cd(II)	-0.0042	-0.0016	-0.0008	-0.0022	0.0018
Pb(II)	-0.0046	-0.0036	-0.0036	-0.0039	0.0006
Zn(II)	-0.0016	-0.0016	-0.0009	-0.0014	0.0004
Hg(II)	-0.0044	-0.0042	-0.0043	-0.0043	0.0001
Au(III)	0.0073	0.0089	0.0087	0.0083	0.0008
Rh(II)	-0.0085	-0.0069	-0.0073	-0.0075	0.0008
Pt(II)	-0.0072	-0.0076	-0.0079	-0.0075	0.0004
Ag(I)	-0.0064	-0.0098	-0.0063	-0.0075	0.0020
Na(I)	-0.0059	-0.0046	-0.0039	-0.0048	0.0010
K(I)	-0.0045	-0.0030	-0.0017	-0.0031	0.0014
Ca(II)	-0.0019	-0.0016	0.0015	-0.0007	0.0019
Mg(II)	-0.0053	-0.0026	-0.0031	-0.0037	0.0015

Table A8 The absorbance 618 nm of GSH-Cys-AgNPls based on colorimetric detection Ni(II) in different concentration from 10 – 150 ppb.

Ni(II) (ppb)	Absorbance at 618 nm			Average	SD
	1	2	3		
10	0.1078	0.1042	0.1025	0.1048	0.0027
25	0.1145	0.1119	0.1115	0.1126	0.0016
50	0.1358	0.1374	0.1387	0.1373	0.0014
75	0.1621	0.1693	0.1629	0.1648	0.0039
100	0.1893	0.1870	0.1950	0.1904	0.0041
125	0.2120	0.2125	0.2096	0.2114	0.0016
150	0.2332	0.2340	0.2322	0.2332	0.0009

Table A9 The absorbance at 618 nm of GSH-Cys-AgNPls and nickel level in real gold plating solutions.

Sample	Absorbance at 618 nm			Average	SD
	1	2	3		
1	0.1175	0.1244	0.1227	0.1215	0.0036
2	0.1260	0.1253	0.1255	0.1256	0.0004

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