

Biocompatible D-Penicillamine-Conjugated Au Nanoparticles: Targeting Intracellular Free Copper Ions for Detoxification

Murthi S. Kandanapitiye, Chamila Gunathilake, Mietek Jaroniec and Songping D. Huang*

Department of Chemistry and Biochemistry, Kent State University, Kent, OH 44240, USA

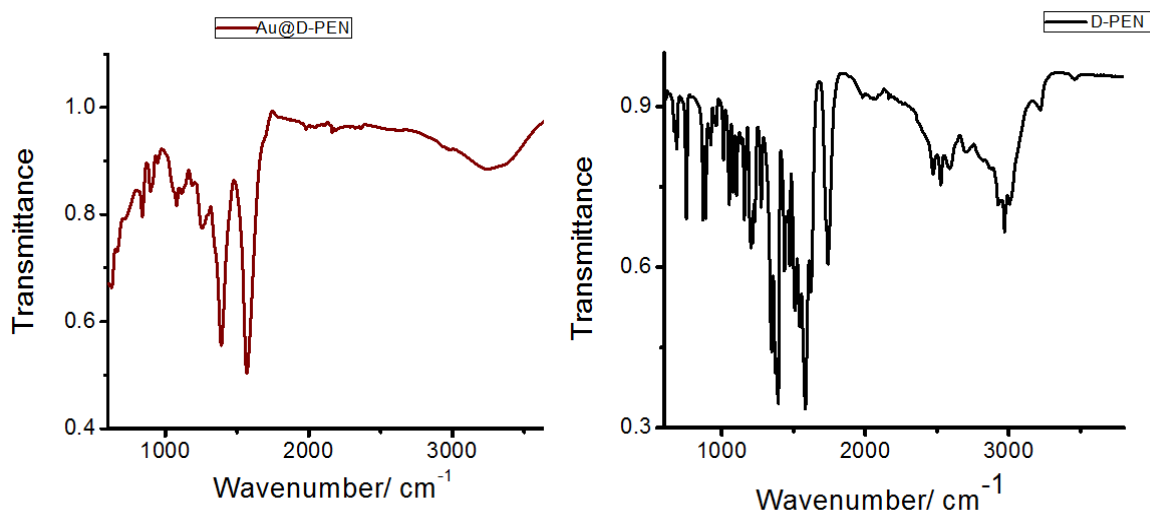


Fig. S1 Fourier transform infrared (FT-IR) spectra of Au@D-PEN NPs (left) and free D-PEN molecules (right).

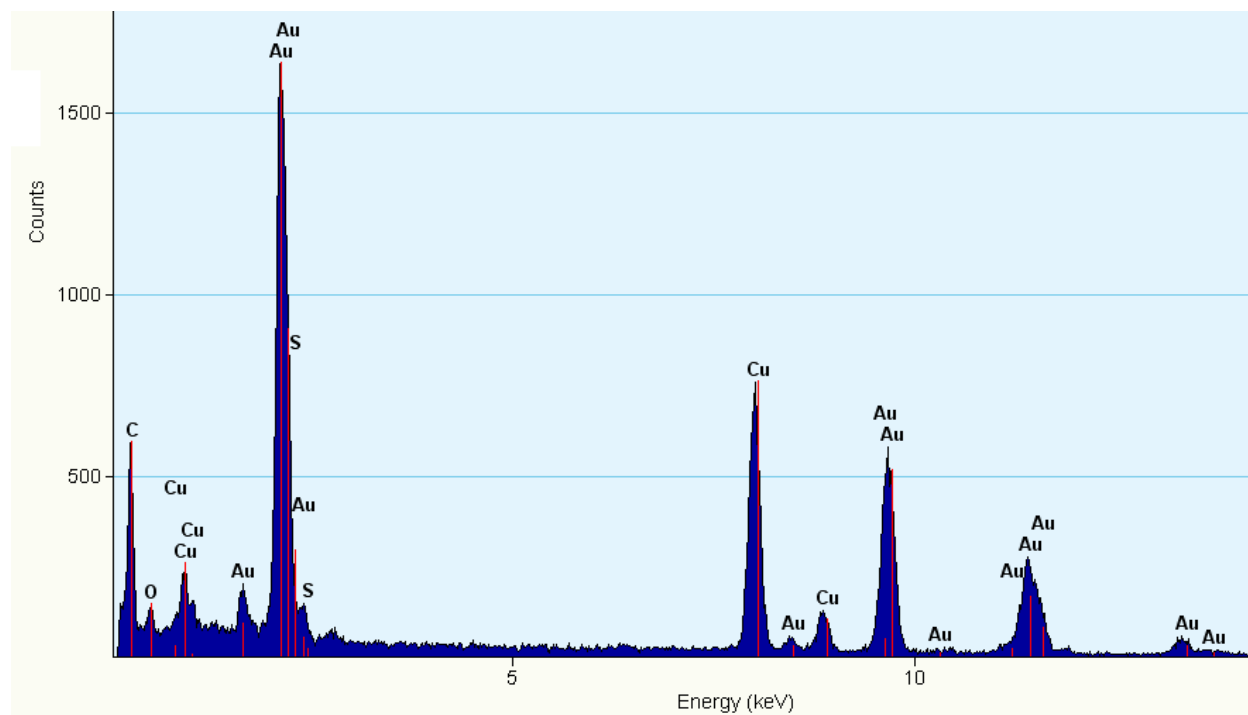


Fig. S2 The EDX spectrum of a typical Au@D-PEN nanoparticle.

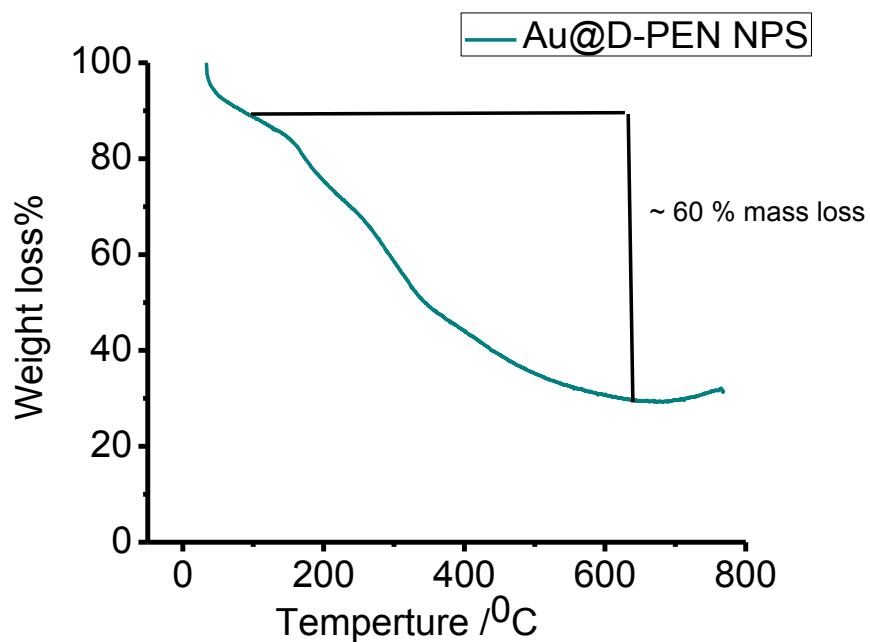


Fig. S3 Thermogravimetric analysis results of the Au@D-PEN NPs.

The processing procedure of kinetic data. The measured kinetic data were found to obey a rate law of first-order reactions. It was found that between zero minute to 54 minutes, the copper binding reaction exhibits a pseudo first-order reaction with $\ln[\text{Cu}]/[\text{Cu}]_0 = -kt$ to give a rate constant of $k_f = 7.0 \times 10^{-5} \text{ s}^{-1}$ or a half-life of $t_{1/2} = 164 \text{ min}$.

Table S1 The change of copper concentrations vs. time in the copper binding reaction

Time/ min	Cu concentration/ ppm	Standard deviation
0	53.84509	2.772883
2	53.84509	2.772883
3	54.12122	3.536473
5	51.63606	2.158092
8	51.08381	1.767587
10	49.42703	0.161711
15	49.1509	1.726941
18	48.59865	1.715328
20	47.49413	1.502656
30	46.11349	1.663069
40	44.45672	1.438784
50	43.62833	1.421364
60	43.07607	0.841413
120	41.69543	1.191272
180	39.76253	0.392843
240	40.86704	1.173853
300	39.4864	0.765928
360	39.21027	0.570675
480	40.03866	0.966987
600	39.21027	0.38123
1440	39.4864	0.576482

Table S2 The natural log of copper concentration values at each time point

Time/ sec	ln[Cu]
0	-7.11056
120	-7.11056
180	-7.11566
300	-7.14536
480	-7.15089
600	-7.15677
900	-7.18985
1080	-7.20126
1200	-7.2216
1800	-7.25431
2400	-7.28822
3000	-7.30718
3600	-7.31052
7200	-7.3496

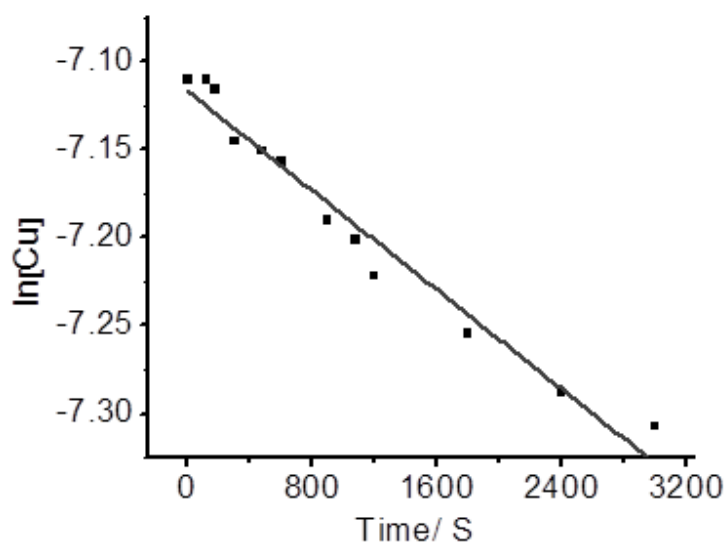


Fig. S4 The kinetic data curve-fitting for time between 0 to 3200 seconds using the data in **Table S2**

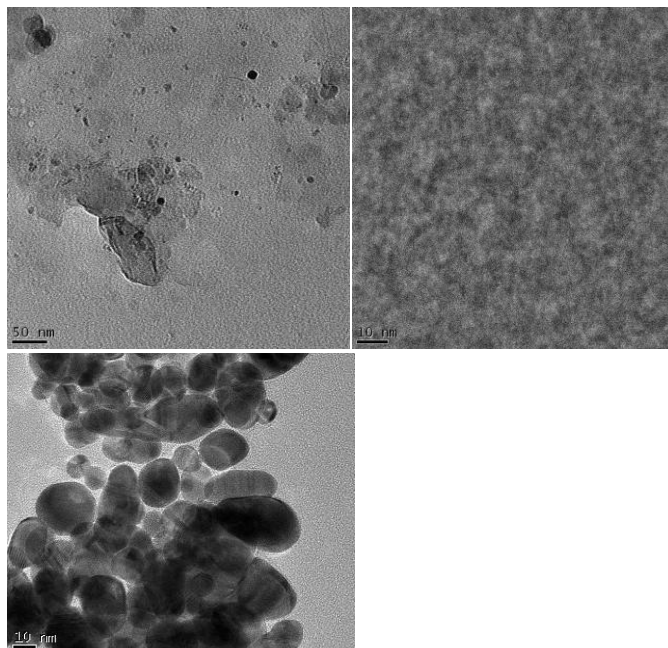


Fig. S5 TEM images of Cu^{2+} exchanged Au@D-PEN NPs.

The upper left panel shows a different type of particulate matter formed around the Au NPs. This new phase has a lower density than the Au NPs that can be occasionally seen in this panel. Under a higher magnification, the newly formed phase appears to be homogeneous and polymeric (see upper right panel), while the Au NPs remain semi-spherical and dense (see lower left panel).

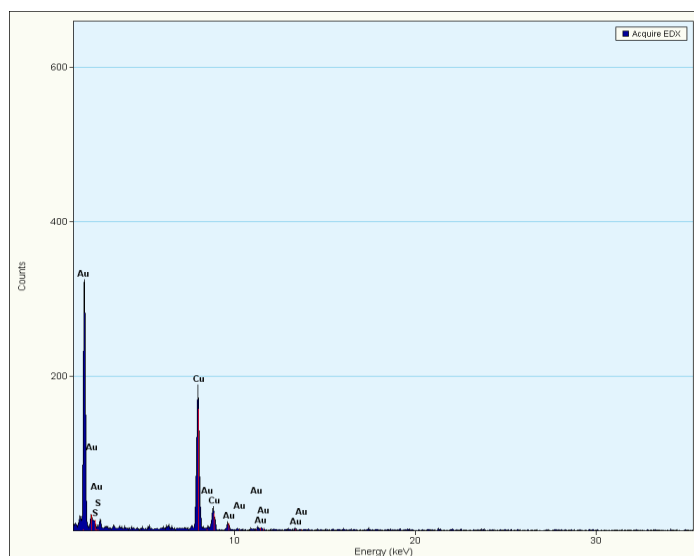


Fig. S6 The EDX spectrum of the newly formed particulate matter, suggesting that D-PEN is detached from the Au surface to bind to the Cu^{2+} ions.

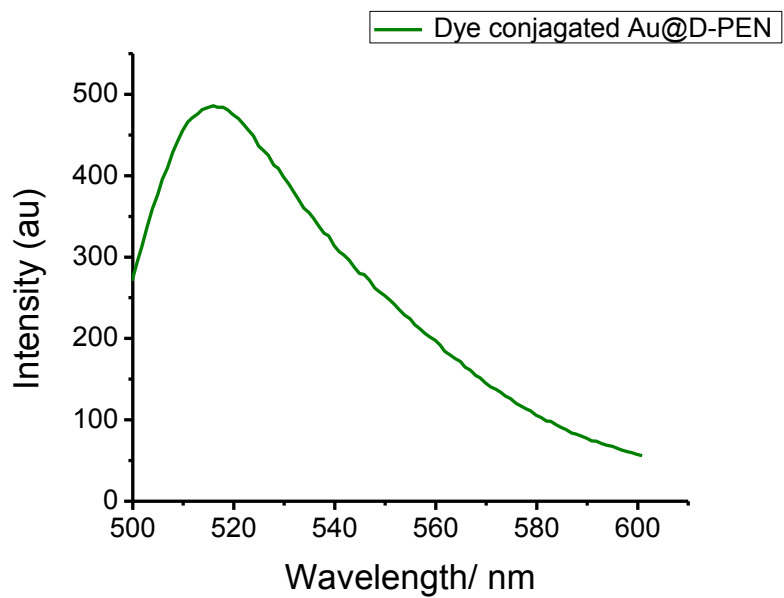


Fig. S7 The fluorescence spectrum of carboxyfluorescein dye-labeled Au@D-PEN nanoparticles.

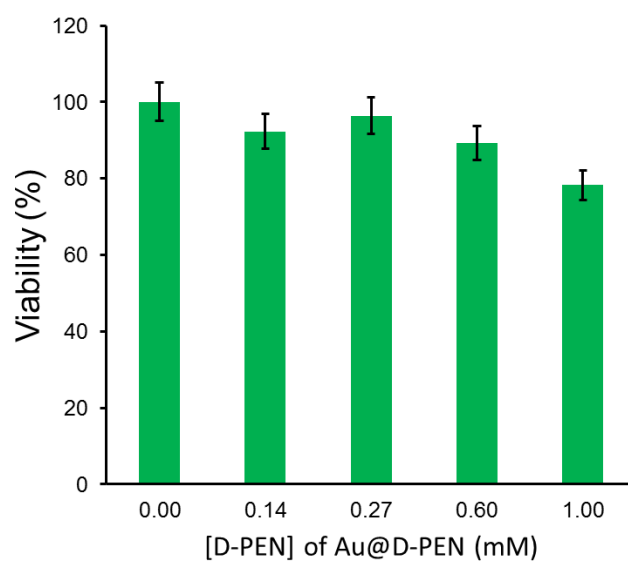


Fig. S8 Cell viability curve of Au@D-PEN as expressed as the concentration of D-PEN on Au NPs in HeLa cells after 24 hours of incubation.