Supporting Information to:

High effectiveness of pure polydopamine in extraction of uranium and plutonium from groundwater and seawater

Valery N. Bliznyuk[1], Kamila Kołacińska[2], Alexander A. Pud[3], Nikolay A. Ogurtsov[3], Yuriy V. Noskov[3], Brian A. Powell[1,4], Timothy A. DeVol[1]

1) Department of Environmental Engineering and Earth Sciences, Clemson University, Anderon, SC 29625 USA

2) Institute of Nuclear Chemistry and Technology in Warsaw, Poland

3) V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry, NAS of Ukraine, 50 Kharkivske shose, Kyiv 02160, Ukraine

4) Department of Chemistry, Clemson University, Clemson, SC 29631 USA

5) Nuclear Environmental Engineering Sciences and Radioactive Waste Management (NEESRWM) Center, Clemson University, Clemson, SC 29634-0942 USA

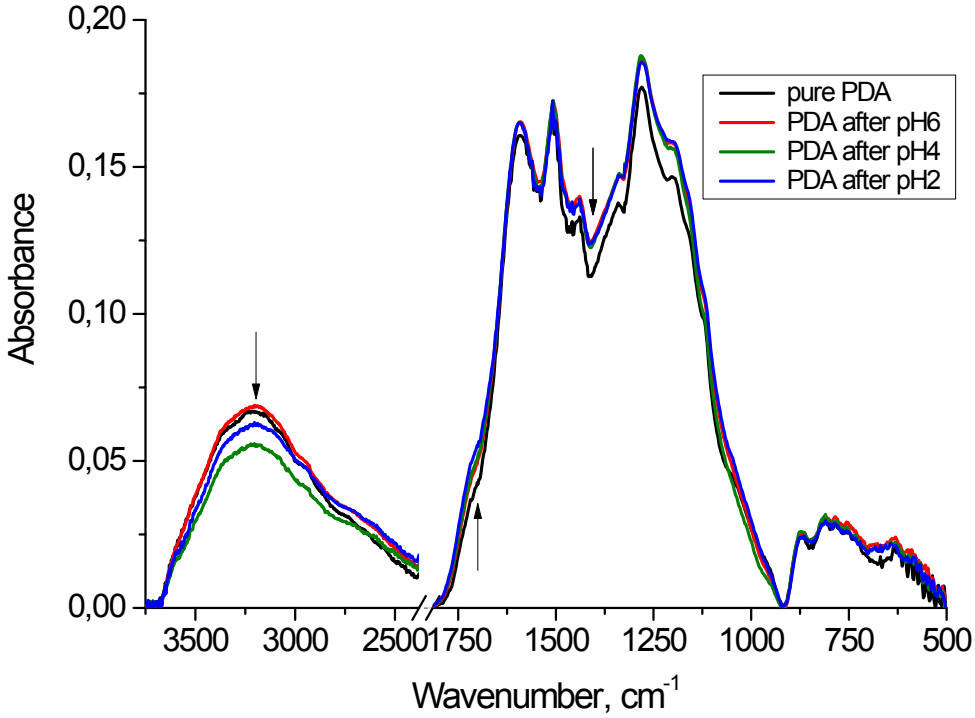

Figure S1. FTIR spectra of PDA powders after treatment in HNO_3 solutions at pH 2, 4 and 6.5 for 16 days

Sorption data created by sequential additions of uranium to a PDA suspension were modeled using a linear and Freundlich isotherm. The Freundlich isotherm yields corresponding constants of K_f = 1,418; n = 0.52. The Freundlich isotherm fit indicates a high degree of non-linearity (n = 0.52). However, in all sampling events greater than 99% sorption occurred. Thus, the data generally represent the linear range of a sorption isotherm. The R^2 values for the linear and Freundlich approximations are 0.93 and 0.92, respectively.

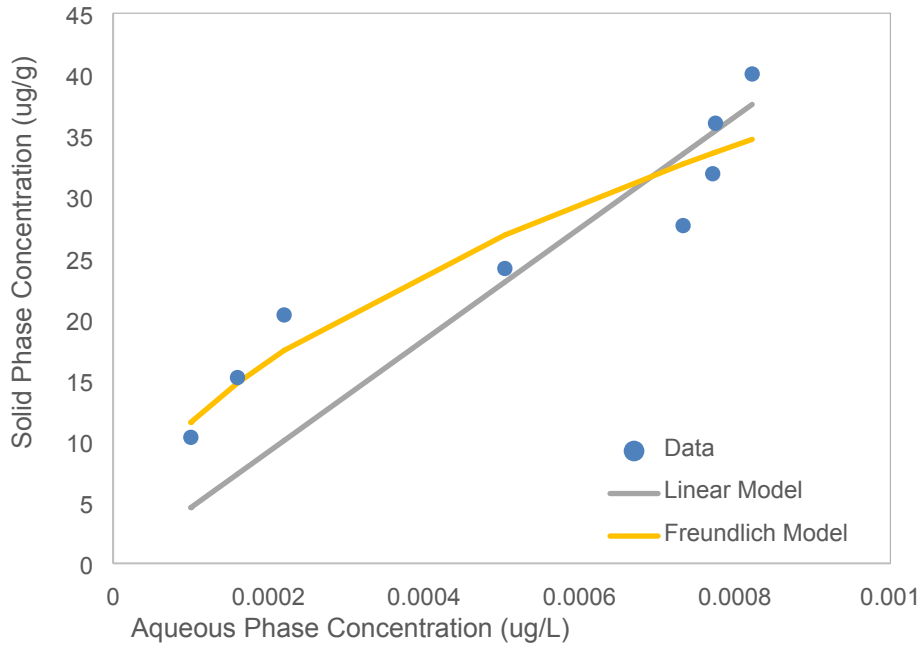

Figure S2: U(VI)-PDA sorption isotherm created by sequential additions of aqueous U(VI). Adsorption of ^{233}U from seawater solution in steps: PDA 6.9 mg; stock solution 0.008 µg of ^{233}U per ml at pH 7. After each adsorption step 5 ml of solution was removed for analysis and 10 ml of fresh solution added.

Uptake of U(VI) to PDA versus time was modeled using a reversible first order approximation (Equations S1 and S2).

Differential equation for first order, reversible sorption kinetics

$$\frac{d[U_{aq}]}{dt} = -k_f[U_{aq}] + k_r[U_{sorbed}]$$

Equation S1

Analytical solution assuming $[U_{aq}](0)$ = initial uranium concentration

$$[U_{aq}](t) = [U_{aq}](eq) + \left([U_{aq}](0) - [U_{aq}](eq)\right)e^{-(k_f + k_r)t}$$

Equation S2

Zero, first, and second order plots assuming a non-reversible reaction were non-linear indicating some degree of reversibility. The forward and reverse rate constants were determined by least squares fitting of the model and data assuming that the aqueous concentration of uranium at equilibrium ([Uaq](eq)) was 0.081 µg/L based on the linear portion of the data. Rapid uptake occurs within the first 100 minutes and these data are not captured by the first order reversible model. However, the long-term equilibration data are adequately approximated using the constants:

k_f = forward sorption rate = 5.9 x 10^{-3} hr^{-1}

k_r = reverse sorption rate = 1.4 x 10^{-3} hr^{-1}

The ratio of the forward and reverse rate constants yields an equilibrium constant of 4.2 which is consistent with the strong uptake of uranium.

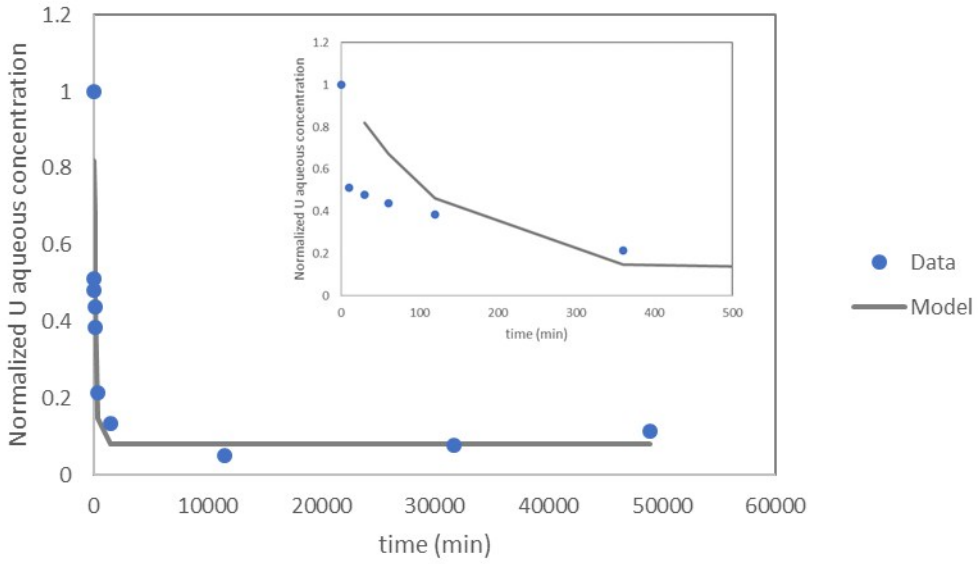

Figure S3: Plot of uranium sorption to PDA versus time and model fit using a first-order reversible reaction.

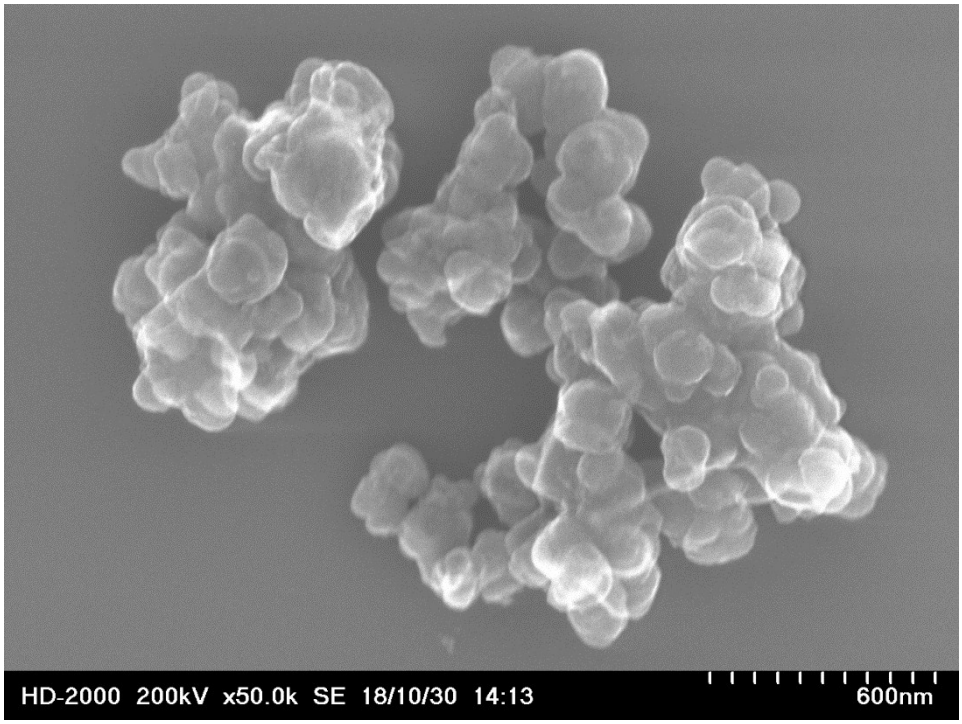

Figure S4. STEM image of agglomerates formed by pure PDA particles

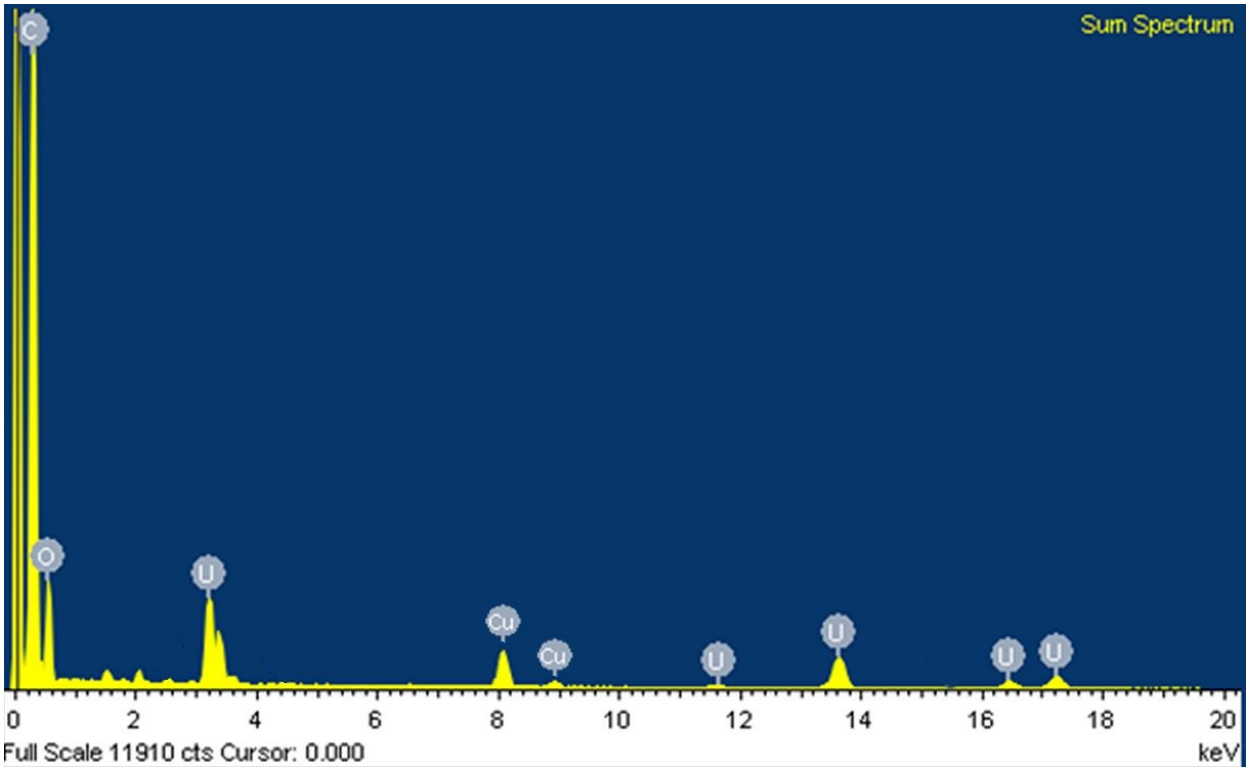

Figure S5. EDX spectrum of the PDA sample with adsorbed uranium.

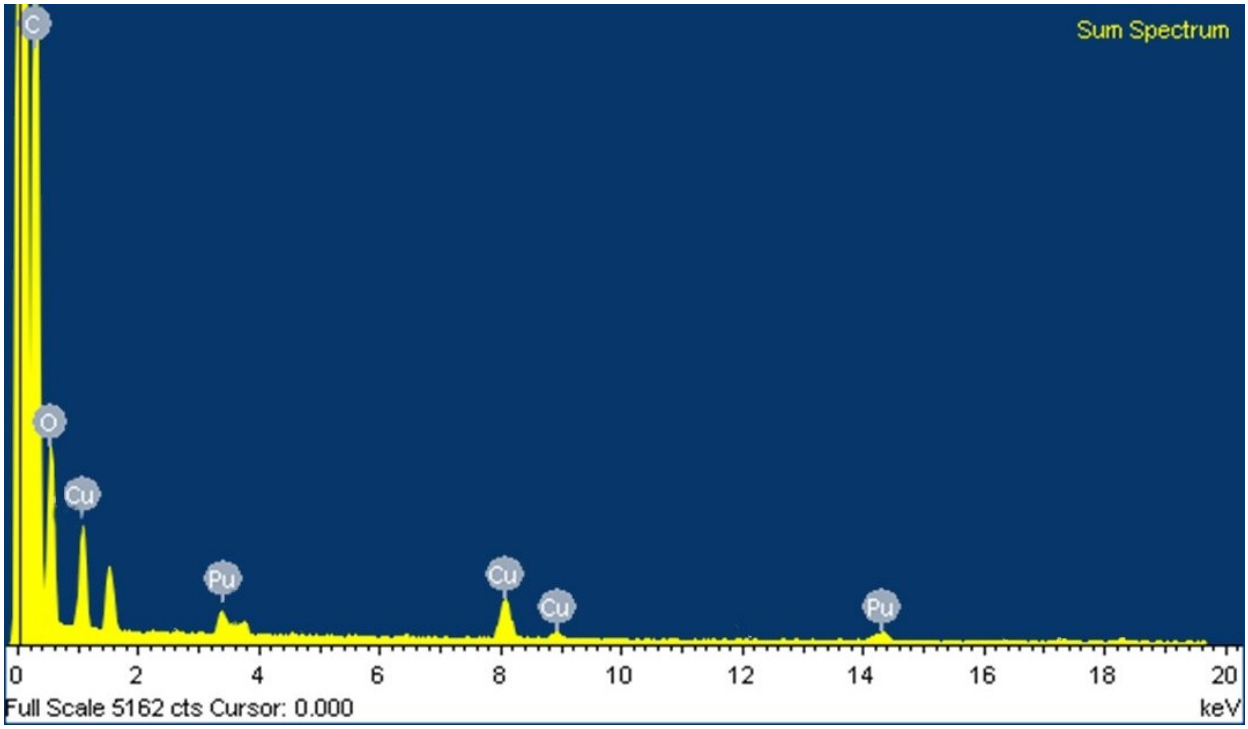

Figure S6. of the PDA sample with adsorbed plutonium.