Supporting Information:

Surface Enhanced Raman Scattering Selectivity in Proteins Arises from Electron Capture and Resonant Enhancement of Radical Species

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Table S1. Change in size and zeta potential of Au NP with TRP and TRP and NaCl addition

Sample	Size (nm)	Zeta potential (mV)
Au NPs	51.46 ±1.017	-18.5±1.37
Au NP and TRP	66.7±0.745	-13.9±0.896
Au NP, TRP and NaCl	852.2±15.52	-28.5±0.577

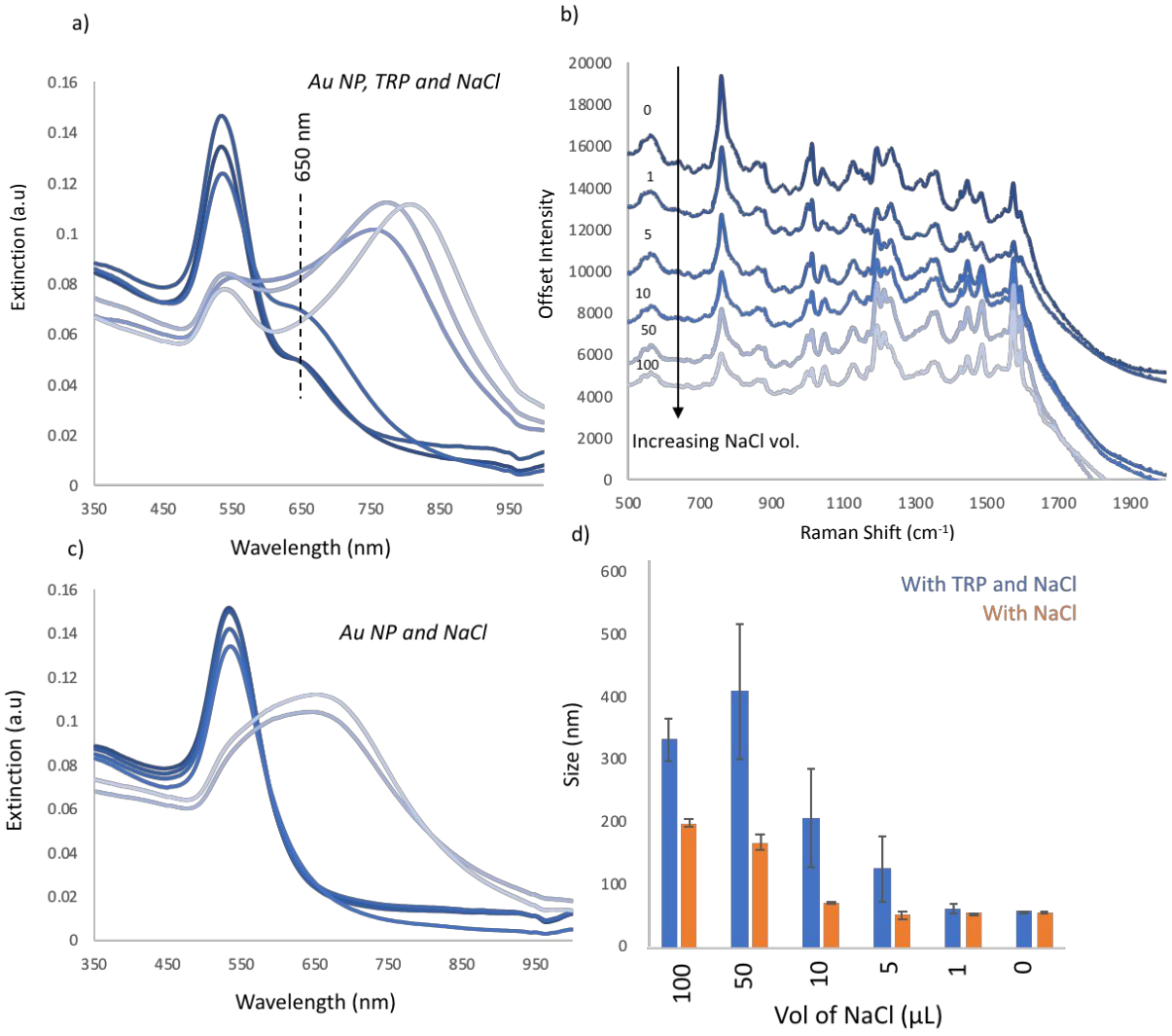

Figure S1. a) Changing extinction spectra of Au NP and TRP solution with respect to increasing volume of NaCl addition (dark blue, 0 µL of NaCl to light blue, 100 µL of NaCl) b) Associated SERS spectra for each solution. c) Changing extinction spectra of bare Au NPs with respect to increasing volume of NaCl addition (dark blue, 0 µL of NaCl to light blue, 100 µL of NaCl) and d) Bar graph indicating change in NP size upon addition of NaCl to Au NP and TRP solution (blue) and bare Au NPs (orange). SERS spectra are the average of 3 scans obtained using 638 nm laser excitation, 40 mW laser power, 10 second acquisitions, scanning between 500-2000 cm^{-1}.

The UV-Vis peak associated with the TRP-Au NP complex was observed at 643 nm when TRP was added to Au NP. The DLS measurements, figure 2 d, indicated that no aggregation took place as the NPs remained the same size as bare Au NP with no NaCl addition. A strong SERS signal of TRP was associated with this peak. Upon the addition of increasing volumes of 100 mg/mL NaCl, the 650 nm peak broadened and was lost and a 2nd LSPR was obtained between 750 and 850 nm. The higher volumes of NaCl induced a larger amount of aggregation shown in figure 2 d which was associated with a slight decrease in SERS signal, figure 2 b). This reinforces the hypothesis that the resonance with the complex was pivotal to the generation of the SERS signal and that any amount of aggregation weakened the signal as the LSPR shifted off resonance from the laser excitation. An important aspect to note is the change in the peak ratios of TRP upon the NaCl addition which was not seen in the previous experiment due to the higher concentration of salt added. While most of the peaks decreased, very noticeable when monitoring the 763 cm^{-1} peak, the 1583 cm^{-1} peak increased. These two peaks are assigned to the carboxyl and amine groups respectively. It has been reported that the addition of Na^{+} can screen the deprotonated carboxyl groups and they can no longer take part in the binding to the Au NP surface hence the decrease in 763 cm^{-1} band. Alternatively, this could represent coupling between the tryptophan and LSPR of the coupled nanostructure. The LSPR of the aggregated, or coupled, nanoparticles increase at longer wavelengths and would enhance the Raman shift at 1583 cm^{-1} peak more effectively.

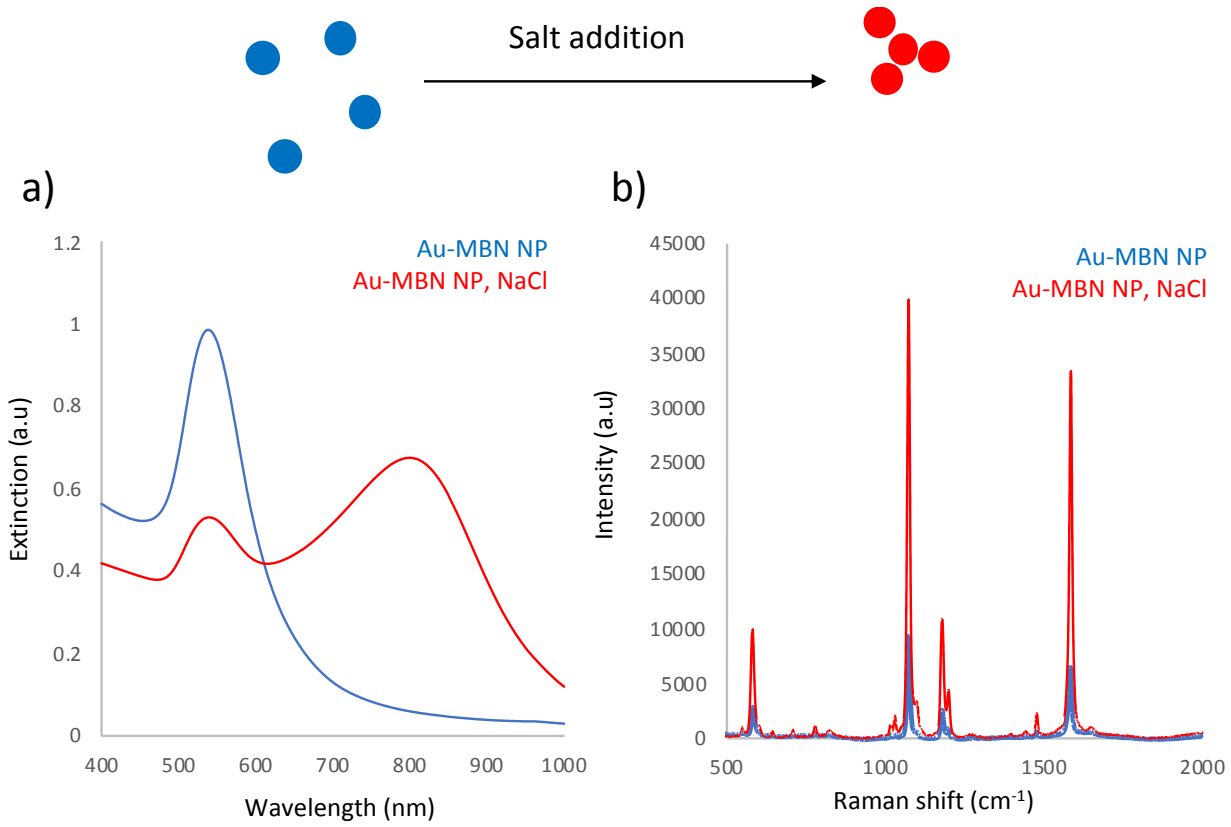

Figure S2. The extinction (A) and SERS spectrum (B) of Mercaptobenzonitrile functionalized gold nanoparticles (AuNPs) were obtained from a stable suspension (blue) and from NaCl aggregated particles (red). The SERS signal is observed to increase with the aggregation and the formation of hotspots as expected.

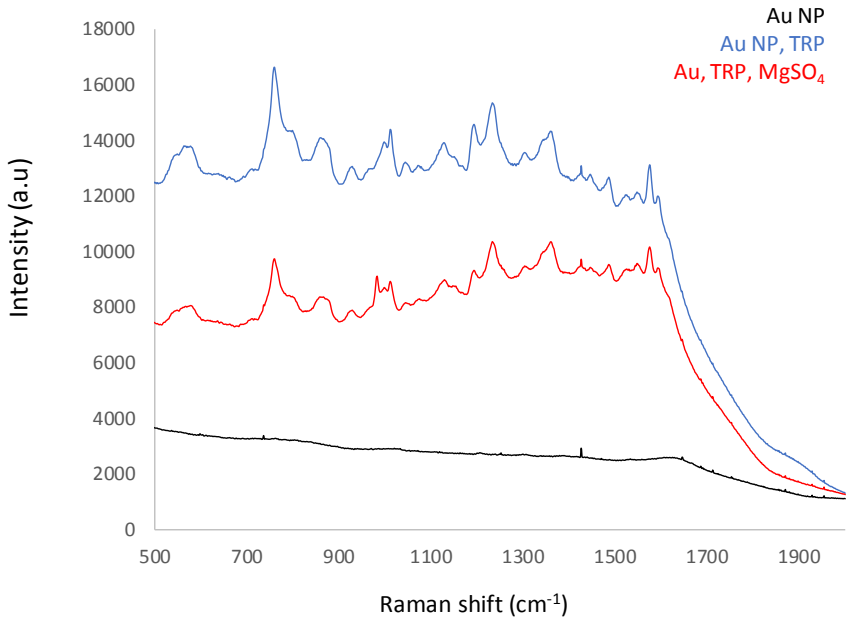

Figure S3. SERS spectra of Au NP (black), Au NP and TRP (blue) and c) Au NP, TRP and $MgSO_4$ (red). SERS spectra are the average of 3 scans obtained using 638 nm laser excitation, 40 mW laser power, 10 second acquisitions, scanning between 500-2000 cm^{-1} on samples in solution. The spectra were obtained at 638 nm first and then treated with $MgSO_4$. The overall signal is observed to decrease with the addition of salt.

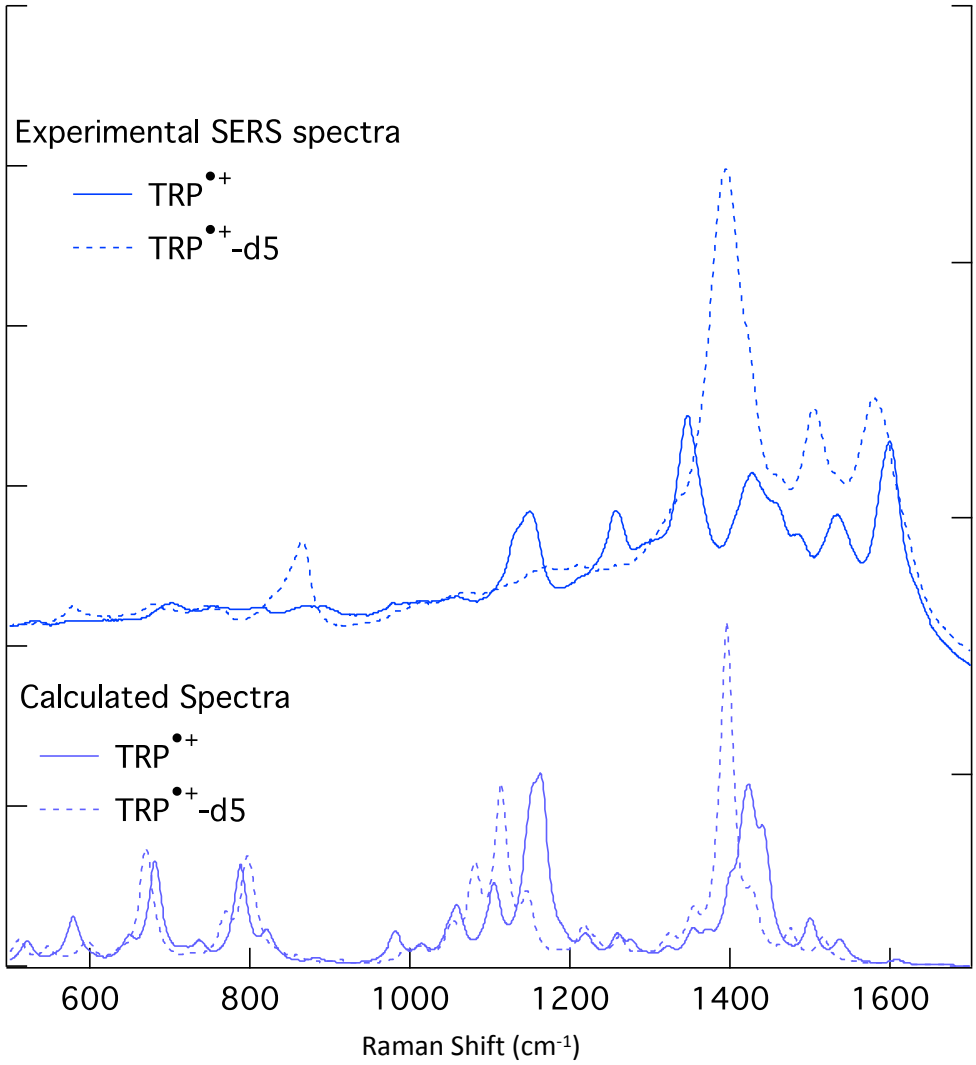

Figure S4. The experimental SERS (top) and DFT calculated (bottom) ground state Raman spectra for $Trp^{\bullet+}$ (solid) and the isotopologue, $Trp\text{-}d5^{\bullet+}$ (dashed) are shown. The $Trp^{\bullet+}$ species was produced by chemically oxidizing Trp using $Ce^{IV}(SO_4)_2$. The spectra are offset and normalized for better comparisons. The calculated vibrational frequencies have been scaled by 0.97 to account for electron correlation.[1]

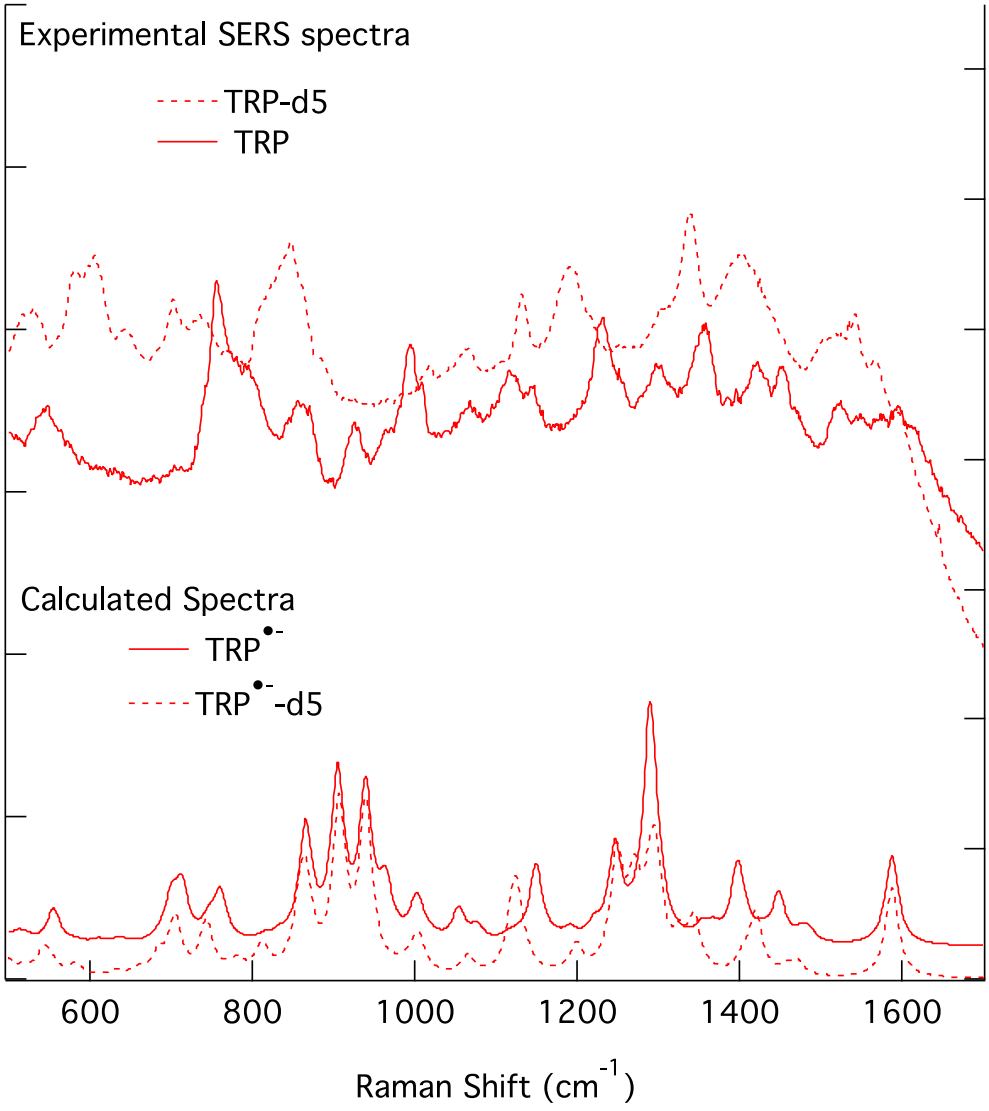

Figure S5.

The experimental SERS (top) obtained from Trp (solid) and the isotopologue, Trp-d5 (dashed) are plotted with the DFT calculated (bottom) ground state Raman spectra for $Trp^{\bullet-}$ (solid) and the isotopologue, $Trp\text{-}d5^{\bullet-}$ (dashed). The agreement suggests the SERS spectrum derives from the radical anion species. The calculated vibrational frequencies have been scaled by 0.97 to account for electron correlation.[1]

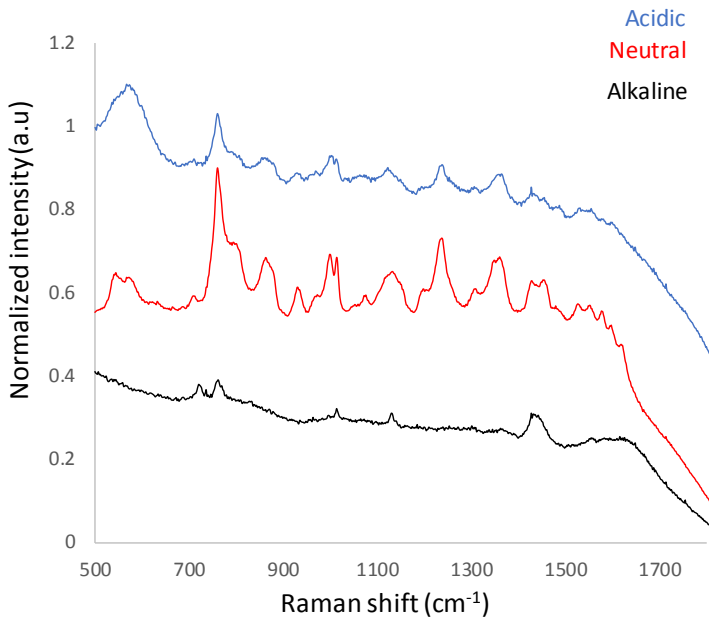

Figure S6. Normalized SERS spectra of Au NP with the addition of TRP in an acidic (blue), neutral (red) and alkaline (black) environment. The intensities have been normalized and offset for clarity. The SERS spectra are the average of 3 scans obtained using 638 nm laser excitation, 40 mW laser power, 10 second acquisitions, scanning between 500-2000 cm^{-1}.

References:

1. Scott, A. P.; Radom, L. Harmonic Vibrational Frequencies: An Evaluation of Hartree−Fock, Møller−Plesset, Quadratic Configuration Interaction, Density Functional Theory, and Semiempirical Scale Factors. *J. Phys. Chem.* **1996**, *100*, 16502-16513.