High-sensitivity detection of mercury toxicity in water by plasmon-enhanced vibrational spectroscopy

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Abstract

Plasmon-enhanced vibrational spectroscopy has great potential for bio-sensor applications based on the signal enhancement in surface-enhanced Raman spectroscopy (SERS) or surface-enhanced infrared absorption spectroscopy (SEIRA). Here, we report on the in situ-controlled and chemically grown SEIRA structures containing multiple nanogaps on the Au films or Au-nanoshell particle ensembles where the electric field is extremely concentrated and amplified at the hot-spots under infrared excitation. These IR-active structures are known to show high sensitivity in sensing the vibrations of the biomolecules. In this contribution, we will present our study on the detection of mercuric ion and methylmercury in water by studying the relevant conformational changes in the vibrational signal induced by the adsorption of toxicants in glutathione (GSH)-molecules which play important roles as efficient linker molecules for detection and detoxification of the mercury toxicity.

References

[1] Hoang, C.V. et al., Sci. Reports **3**, (2013).
[2] Patrick L. Altern Med Rev. **7**(6) (2002), 456.
[3] Thi Ha L. Nghiem et al., J Nanopart Res **15** (2013).

Figure

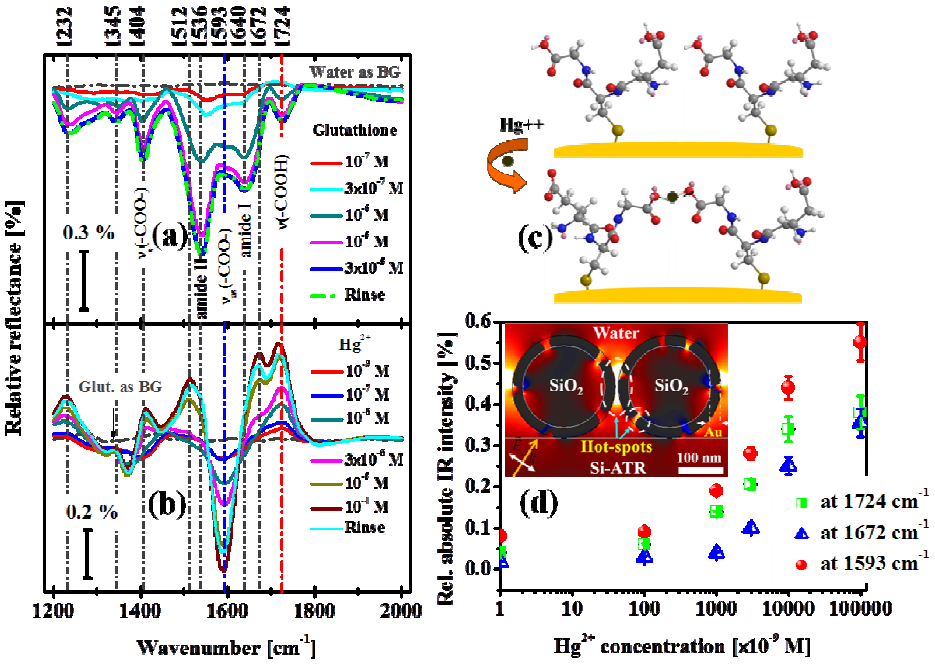

Fig.1 (a) IR spectrum of GSH molecules in water; (b) The relevant conformational changes of the vibrational signals of GSH in the presence of Hg^{2+} (water was taken as the background); (c) Interaction model of Hg^{2+} and GSH; (d) Evolution of the relevant conformational changes of the absolute IR intensity of GSH-Hg^{2+} as the increasing of Hg^{2+} concentration, the inset is FDTD calculation of the electric field distribution around Au-shell particles.