Nanotechnology for Detection of Ultralow Levels of Explosives

Benjamin Saute and Dr. Radha Narayanan
51 Lower College Road, University of Rhode Island, Kingston, RI 02881. Email: rnarayanan@chm.uri.edu

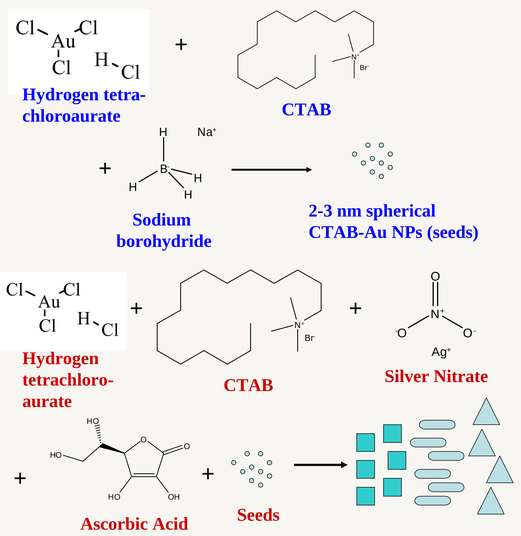
Abstract

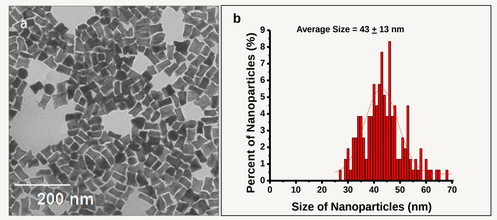
The overall goal of our research is to synthesize gold nanoparticles of different shapes as colloidal SERS substrates for detection of ultralow levels of different explosives. We hope to achieve low nM and pM detection of the explosives. Also, our method is a rapid and direct readout quantitative method for detection of the explosives. Our research can be transitioned to the customer or end user as a rapid and sensitive method for detection of common explosives.

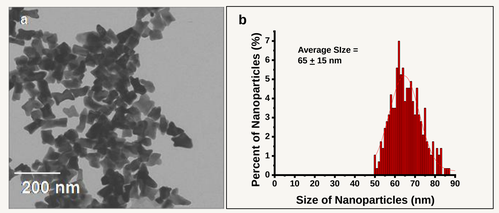
Relevance

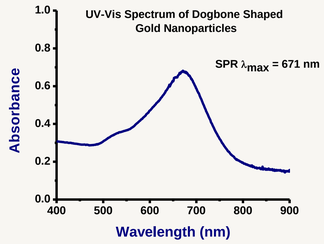
Solution-based SERS with gold nanoparticles of different shapes has not been used for detection of important explosives such as dicyanodiamide, methylnitroguanidine, and picric acid. Existing methods of detection of explosives such as TNT and DNT involve the detection of vapors that are adsorbed as thin films in gold substrates. Our work expands on this work since we are using solution-based SERS with colloidal gold nanoparticles of different shapes for detection of explosives in solution. This research is important for DHS applications where detection of low nM and pM of explosives in solution are needed. Overall, our method involves detection of explosives in solution, while existing methods involve detection of explosive vapors adsorbed onto SERS substrates.

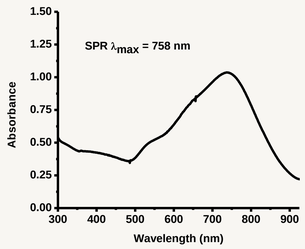
Technical Approach

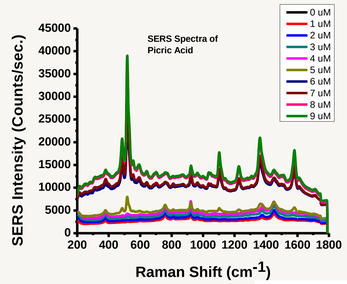


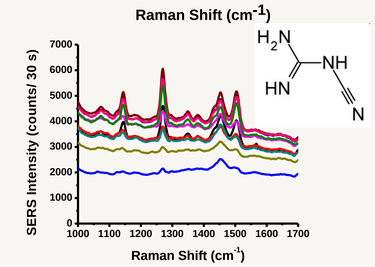












SERS has been used for detection of TNT and DNT vapors adsorbed as thin films in gold substrates. SERS has not been used as a quantitative analytical tool for detection of ultra-low levels of explosives such as dicyanodiamide, methylnitroguanidine, and picric acid. We are using gold nanoparticles of different shapes as colloidal SERS substrates for detection of ultra-low levels of dicyanodiamide, methylnitroguanidine, and picric acid in solution.

Accomplishments Through Current Year

We have obtained SERS spectra for picric acid which forms a covalent bond via the Au-O bond when it is in the deprotonated form. We have also obtained the SERS spectra of dicyanodiamide bound to DSP modified Au NPs. Development of the solution-based SERS method will be useful for DHS applications where detection of ultra-low levels of explosives in solution is needed.

Future Work

Solution based SERS spectra will be obtained using dogbone shaped gold nanoparticles for different concentrations of dicyanodiamide, methylnitro-guanadine, and picric acid. We will also synthesize star-shaped gold nanoparticles to harness the lightning rod effect to obtain even higher SERS enhancement and lower limits of detection.

Opportunities for Transition to Customer

Developing a solution based SERS method for detection of explosives would be relevant for DHS applications where ultra-low levels of explosives need to be detected in solution. The ability to detect explosives in solution would be useful in applications involving detection of liquids.

Patent Submissions

US Provisional Patent, 61/347,867, "Synthesis of Colloidal Supported Metal Nanoparticles as Interme-diate Catalysts", May 25, 2010

Publications Acknowledging DHS Support

Saute, B. and Narayanan, R. "Dogbone Shaped Gold Nanoparticles as Colloidal SERS Substrates for Detection of Important Explosives in Solution", in preparation.

Other References

Saute, B. and Narayanan, R. "Solution-Based Direct Readout Surface Enhanced Raman Spectroscopic (SERS) Detection of Ultra-Low Levels of Thiram with Dogbone-Shaped Gold Nanoparticles", *Analyst*, **2011**, *136(3)*, 527-532.

This material is based upon work supported by the U.S. Department of Homeland Security under Award Number 2008-ST-061-ED0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied of the U.S. Department of Homeland Security.