Novel SERS technique for rapid, low cost uranium monitoring in the environment

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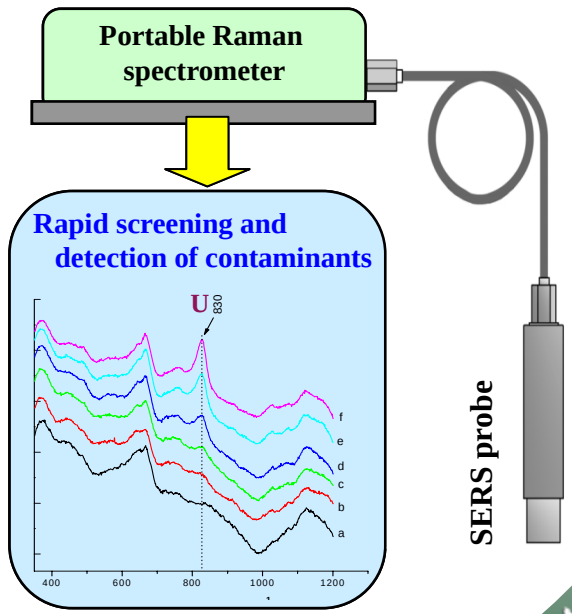
Sponsor: DOE/Office of Science/Biological and Environmental Research, ORNL-LDRD Program

- **Monitoring and analyses of environmental samples constitute more than one third of environmental remediation cost; quicker, cheaper, and reliable analytical methods are highly desired**
- **In this study a new surface-enhanced Raman spectroscopy (SERS) technique was developed and demonstrated for detecting radioactive uranium in environmental samples at low concentrations**
- **The technique can be implemented with a portable Raman spectrometer for rapid, in-situ field monitoring of uranium, thus leading to significant cost savings in the long-term monitoring and stewardship of DOE contaminated sites**



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Uranium (U) is an important radionuclide of concern. Until now, its analysis primarily relies on kinetic phosphorescence (KPA) or laser induced fluorescence spectroscopy, liquid scintillation counting, inductive-coupled plasma mass spectrometry (ICP-MS), and extended X-ray absorption near-edge spectroscopy (EXAFS) in laboratory.

For the first time, we report that surface-enhanced Raman spectroscopy (SERS) is capable of detecting U at low concentrations in realistic environmental groundwater samples. A new SERS substrate based on (aminomethyl)phosphonic acid (APA)-modified gold nanoparticles was found to produce greater than three orders of magnitude SERS enhancement compared with unmodified gold substrate. A detection limit of ~10^{-7} M was achieved with a good reproducibility. Without pretreatment, the technique was successfully employed for detecting U in a highly contaminated groundwater, which is high in dissolved salts (e.g., nitrate, sulfate, calcium and aluminum) and total organic carbon, and low in pH. Our results demonstrate that SERS can be used as a complementary tool for rapid detection and screening for U, thus lead to significant cost savings in long-term monitoring of U in the environment.

Reference: **Ruan, C. M.; Wang, W.; Gu, B. 2007. Determining uranium in environmental samples by surface-enhanced Raman spectroscopy.** ***Anal. Chim. Acta. 605, 80-86.***