National Institute of Environmental Health Sciences | **Superfund Basic Research Program**

RESEARCH BRIEF 127

Using Laser Technology to Detect Lead in Soil

Background: Lead is a naturally occurring metal with no known biological benefits to humans. Exposure to lead affects virtually every system in the body and has serious health effects – especially for young children. Nearly all environmental and occupational exposures are the result of soil, air and water contamination by human activities. Common sources of lead include residues of leaded gasoline combustion, chipping lead paint in older homes, and industrial pollution from lead smelters and refineries, battery manufacturers, plants involved in iron and steel production or plants involved in the manufacture of tetraethyl and tetramethyl lead.

Sensitive and rapid lead analytic techniques are needed for site and exposure assessments and to evaluate the progress of remediation efforts. Conventional wet-chemistry techniques for soil lead analysis involve time-intensive, multi-step processes (drying, sieving, dissolution, chelation, ion exchange, etc.). Chemical analyses of soil samples have been done using spectroscopic methods, and while these methods are quicker and require less sample preparation, there are issues with calibration, matrix effects and sensitivity.

Dr. Catherine Koshland and Dr. Don Lucas at the University of California, Berkeley SBRP lead a team of researchers working with laser spectroscopy techniques to develop a quick, sensitive method to detect lead in soil and on surfaces.

Advance: The researchers are applying excimer laser fragmentation fluorescence spectroscopy (ELFFS) technology. Their method uses high-energy photon beams to transform lead atoms to excited atomic states that emit a detectable fluorescence signal. The Berkeley SBRP team has shown that the fluorescence signal is proportional to the concentration of lead in the soil sample. This method is unique in that the sample surface is photolyzed at laser fluences (energy/area) below the threshold where plasma formation occurs. This significantly improves the signal-to-noise ratio. The detection limit for the method (defined as 3 times the standard deviation of the background) is approximately 200 ppm – half the EPA regulatory standard for the presence of lead in soil.

Other advantages of this system include:

- The fluorescence lifetime falls within the range of nanoseconds, and results are obtained in seconds.
- Minimal sample preparation is required prior to analysis – a soil slurry is placed into the sample well and dried.
- Background emissions from soil samples are small – that is they do not contain any obvious distinct peaks – and are easily corrected in the analysis.
- The method is easier to interpret and quantify than current laser based methods such as laser induced breakdown spectroscopy.

Significance: While the researchers acknowledge the inherent difficulties of analysis of soil samples from a contaminated site (soil as a matrix is inhomogeneous, and target compounds are not uniformly distributed at a site), they believe that this technique holds promise as a rapid and sensitive method for processing soil samples for site characterization, exposure assessment and evaluation of the effectiveness of soil remediation efforts.

For More Information Contact:

Catherine P. Koshland
School of Public Health
751 University Hall
Berkeley, CA 94720-7360
Tel: 510-642-8769
Email: *ckosh@berkeley.edu*

To learn more about this research, please refer to the following sources:

- Choi, J.C., Christopher J. Damm, N.J. O'Donovan, Robert F. Sawyer, Catherine P. Koshland, and Donald Lucas. 2005. Detection of lead in soil with excimer laser fragmentation fluorescence spectroscopy. *Applied Spectroscopy*. 59(2):258-261.