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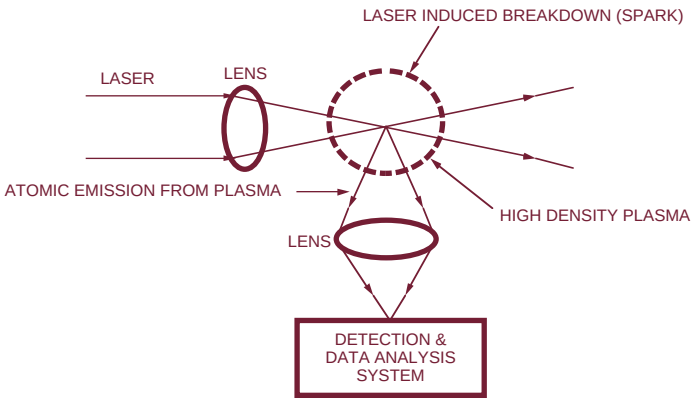
Continuous Emission Monitor Detection of RCRA Metals

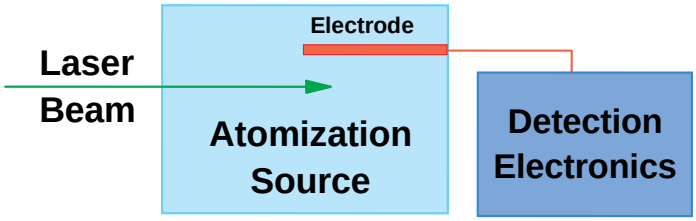
By combining the capability of Laser-Induced Breakdown Spectroscopy (LIBS) to monitor the concentration of many species simultaneously with the lower detection limits possible from Laser Optogalvanic Spectroscopy (LOGS), we have been able to develop a continuous emission monitor (CEM) capable of monitoring in the off-gases of thermal treatment systems all seven of the RCRA metals (As, Be, Cd, Cr, Ni, Pb and Sb) at and below the detection limits required by the Environmental Protection Agency (EPA). By making minor changes, other metals (such as U, Th, Tc, Pu, Np) can be monitored.

DESCRIPTION

The LIBS signal is produced by tightly focussing a high-power laser beam to a point. Any particles present will be atomized, and the atoms will be electronically excited. A fiber optic cable is used to collect some of the resulting optical emission. A spectrograph is used to wavelength-resolve the emission spectrum, which is detected by a CCD camera. The concentrations of the various species are obtained from measured intensities of the optical transitions.

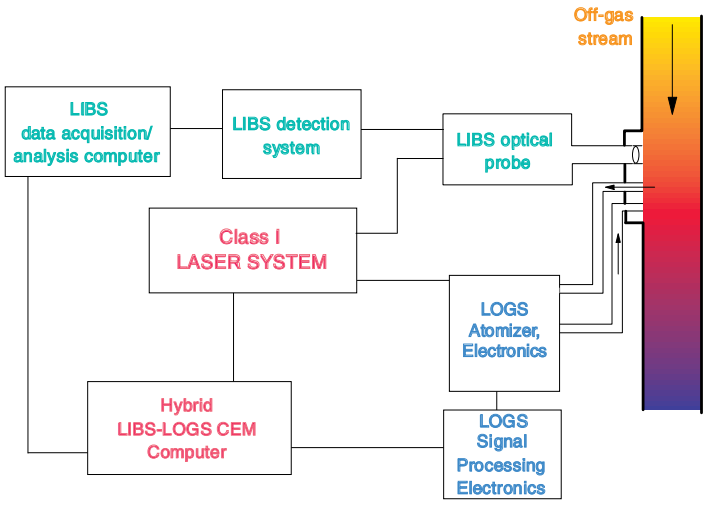


In a LOGS experiment, a tunable laser is tuned to an absorption of the species of interest in an atomization source, temporarily increasing the excited state concentration of that species. Because the energy necessary for ionization is less for an excited electronic state than for the ground state, the rate of ionization temporarily increases due to laser-enhanced electron impact ionization and/or due to direct laser photoionization.



This process can be monitored as a transient voltage change if a high voltage electrode is inserted into the atomization source. The concentration of the species of interest can be directly related to the magnitude of the LOGS signal. Because LOGS uses electrical rather than optical detection, LOGS inherently has greater detection sensitivity because the collection of charges can be more efficient than the collection of photons. However, LOGS can only monitor one species at a time. The concentration of metal species in the off-gas stream is measured in real time by extracting a portion of the off-gases via a slip-stream. The sample is atomized and then excited by a laser. After the LOGS signal has been detected, the sample is returned to the off-gas stream.

The hybrid LIBS/LOGS System uses LIBS to simultaneously monitor Be, Cd, Cr, and Pb, and



LOGS to sequentially monitor the concentrations of As, Hg, and Sb. The concentration of all seven RCRA species can be measured in under four minutes and their concentrations electronically transmitted to the facility. Both systems make their measurements on the same optical port and using the same laser system for optical excitation.

ON-SITE APPLICATIONS

A prototypical hybrid LIBS/LOGS system is available for on-site demonstrations of its ability to measure the concentration of the RCRA metals (or other desired metals) in the off-gases of thermal treatment systems. A completely integrated hybrid LIBS/LOGS system will be available for field deployment in June, 1997. The complete LIBS/LOGS CEM system will be for sale from DIAL, and upgrades and service will be made available.

Additional information about this technique or any other research being conducted at DIAL can be obtained by contacting Dr. David L. Monts at:

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