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OFFICE OF RESEARCH AND DEVELOPMENT
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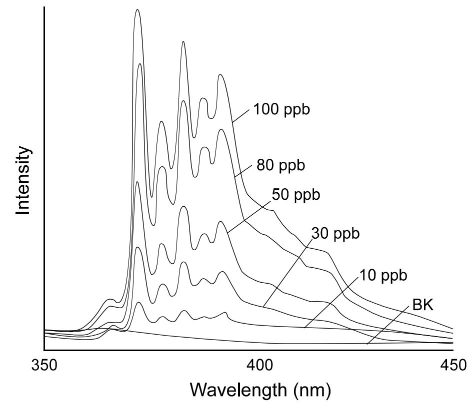
EPA

UV-Vis Luminescence in Field Screening and Monitoring



Introduction

Ultraviolet-visible photoluminescence techniques (including fluorescence and phosphorescence) are gaining recognition as useful methods for monitoring Superfund, RCRA, and other hazardous waste sites. The National Exposure Research Laboratory, Human Exposure Research Branch in Las Vegas (HERB-LV) is active in the research, development, and application of these methods. This document will focus on fluorescence spectroscopy. One applicaton of this method uses a fixed wavelength excitation and records the fluorescence emission spectrum of the sample. Another application, synchronous fluorescence spectroscopy scans both excitation and emission monochromators to produce a simplified spectrum, typically with one peak per compound. This allows polyaromatic hydrocarbons (PAHs) to be separated roughly into classes according to the number of fused rings. Both techniques hold great promise as field methods that are suitable to the screening, characterization, and monitoring of contaminants at hazardous waste sites. Although mostly used for PAHs, phenols, and pesticides, luminescence techniques are also available for metal chelates and uranium.

With the emergence of field-deployable, field-portable instruments, and fluorescence sensors, luminescence spectroscopy is joining the list of easy-to-use, inexpensive methods for evaluation of contamination at hazardous waste sites.

Instrumentation

Luminescence techniques are mostly used for the analysis of aqueous samples, though soil extracts may also be used. The most frequently used source is a pulsed or continuous xenon lamp which disperses light through a grating. Alternative light sources include mercury lamps and lasers with either fixed or tunable wavelengths. For scanning spectrofluorometers, the continuous spectrum of the light source is dispersed by an excitation monochromator, which can be scanned mechanically to select a bandpass. Then, the emitted light at each wavelength is detected (usually at right angles to the exciting light) by an emission monochromator coupled to a detector. For quantification, the fluorescence intensity is compared to the response from standards at various levels on a calibration curve.

Identification, classification, and quantification can be performed by either fluorescence emission or synchronous fluorescence spectroscopy. The generated spectra are simplified cross-sections of excitation-emission arrays.

Both emission and synchronous luminescence methods are useful for characterizing the source and concentration of various polyaromatic compounds. Current work on PCBs and PAHs demonstrates the usefulness and sensitivity of luminescence methods.

Field Use

The applicability of luminescence methods to environmental work is increasing with greater availability of compact instruments. The HERB-LV has field-deployable fluorescence instruments. In addition, a prototype of a portable synchronous spectrofluorometer with a fiber optic probe is being developed for the HERB-LV through an interagency agreement with the DOE at Oak Ridge National Laboratory. Using these instruments, scientists are able to identify and quantify total PAHs and PCBs. These methods are particularly good for environmental samples requiring relatively simple sample preparation. Field use is simple for this non-destructive technique. A typical field instrument has two parts — the spectrofluorometer and the controlling computer. Each of these units is portable and suitcase-sized. The ease of use and lack of elaborate preparation steps make UV-vis luminescence an excellent choice for many hazardous waste sites.

Advantages and Limitations

UV-vis luminescence compares very favorably with many field techniques because it has high sensitivity, is non-destructive, and can analyze thermally labile samples or heavy compounds like tars and polar compounds like phenols.

This technology has a proven track record with the U.S. Coast Guard where it is used for oil spill identification. Extending this application into various environmental areas is the next step. The HERB-LV is committed to the careful application of existing technologies to novel uses in environmental monitoring.

Advantages	Limitations
• Very sensitive for aromatic and polyaromatic analytes	• Needs derivatives for most non-aromatic analytes
• Inexpensive	• Interpretation may require special training
• Water is not an interferent	• Fluorescence yields vary
• Non-aromatic analytes usually do not interfere	
• Little or no pretreatment required	
• Simple microextraction procedure	

Future

Current research should lead to UV-vis fluorescence instruments that are smaller, cheaper, and more sensitive to a wider range of analytes. The development of reasonably priced small lasers may eventually replace xenon lamp sources. Rugged, tunable lasers in the UV range are being investigated. Some monitoring can be done with a filter fluorometer, saving the cost of the scanning step. The most versatile applications remain in the area of emission and synchronous luminescence methods.

References

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