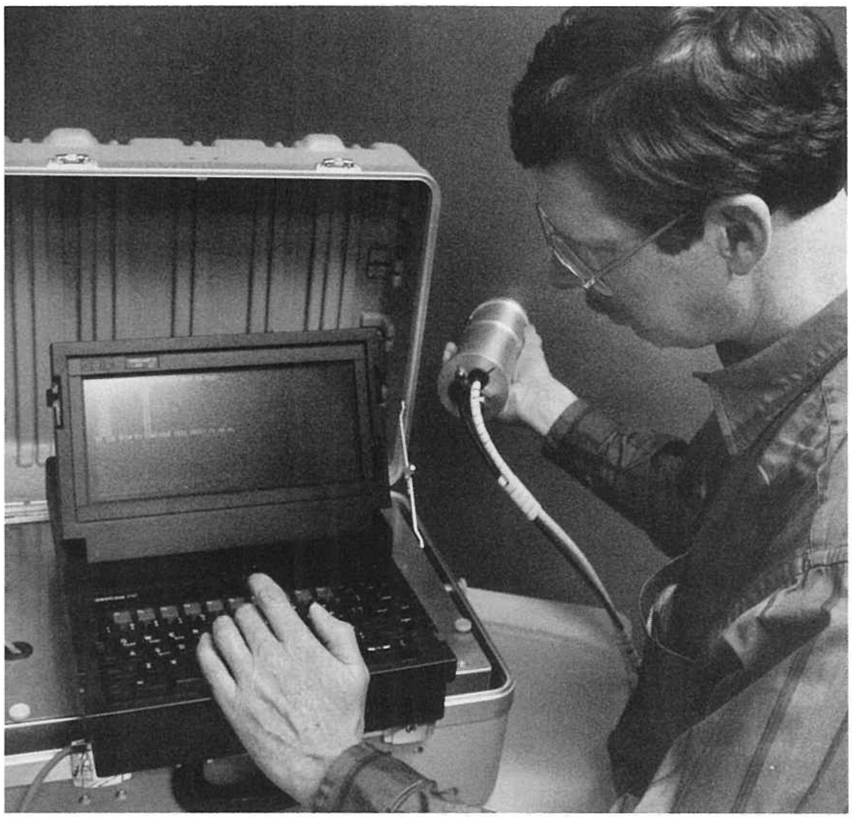
Portable Laser Spark Surface Mass Analyzer

Inventors: David A. Cremers and Monty J. Ferris, Chemical and Laser Sciences Division; and Karen Y. Kane*



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The Portable Laser Spark Surface Mass Analyzer (PLASSMA) was developed to obtain rapid measurements of surface contaminants, including lead in paint. PLASSMA fits into a small suitcase-sized package and can be used in the field. The user analyzes contaminants by holding the analyzer head, which houses a small laser, against a surface and firing the laser.

Many older homes and schools in the United States were constructed when lead was still commonly used in paint. Painted surfaces in these buildings present a health hazard, particularly to young children, who sometimes ingest lead-contaminated paint particles. To help combat this problem, researchers at Los Alamos National Laboratory developed a portable, cost-effective analyzer that can monitor and assess the extent of lead contamination in home and school environments. Our instrument, the Portable Laser Spark Surface Mass Analyzer, known as PLASSMA, also detects other toxic materials in the workplace and in the home.

Because PLASSMA provides many new opportunities for improving the efficiency of health, safety, and environmental monitoring, it was selected for a 1992 R&D 100 Award, an honor given annually by *Research and Development Magazine* to the one hundred most significant technical innovations of the year.

The Invention—Characteristics and Advantages

PLASSMA consists of two components: a lightweight analysis head that houses a small laser and a detector-controller unit. To analyze a surface, the user places the analysis head against the surface and fires the laser. The laser forms a microplasma, or spark, which atomizes and electronically excites the elements that make up the paint or other target material on the surface. A fiber-optic cable transmits the spark from the target surface to the detector-controller unit.

In the detector-controller unit, a spectrograph and photomultiplier tube detect the spark. Because of the high temperature of the microplasma, the atoms of the target material generate unique "fingerprint" emission spectra. By these fingerprints, we can identify and quantify the elements that make up the material. The laser spark vaporizes the target material and excites atoms in one step; therefore, users can rely on PLASSMA for essentially instantaneous analyses.

The two components and the computer that controls the instrument's operation fit inside a small suitcase. Because it is small (48 by 30 by 25 centimeters) and light (18 kilograms), PLASSMA can be carried by hand into the analysis area, and the analysis can be performed on site instead of in the laboratory.

PLASSMA provides many advantages over current environmental monitoring techniques. Laboratory-based methods require time-consuming sample preparation: a sample must be collected, transported to the laboratory, dissolved in acids to produce a solution, and then analyzed. In contrast, PLASSMA performs analyses in the field, costs less to purchase and operate, and provides immediate results.

In addition, PLASSMA compares favorably to x-ray fluorescence, another monitoring technique, because of its high sensitivity. PLASSMA can detect lead at levels lower than 0.06 milligram per square centimeter, a level more sensitive than that required by the Environmental Protection Agency. PLASSMA can also detect elements in quantities of one-billionth of a gram and less—much lower quantities than any other comparable field-deployable device on the market can identify.

Because it quickly detects low concentrations of hazardous materials in the field, PLASSMA can contribute significantly to public health. Improving the

**Karen Y. Kane worked on the Portable Laser Spark Surface Mass Analyzer while she was a graduate research assistant at the Laboratory.*

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LALP 92-63
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quality of environmental monitoring and characterization will give industrial managers, school administrators, and governmental officials important, timely information about any dangers present in their environments; they can then translate the information into safer conditions for employees and the general public.

Applications

We developed PLASSMA specifically for detecting lead in paint on walls or on other objects because of the serious problems that the substance causes. However, the instrument can monitor any type of chemical contamination, whether in the form of particles, coatings, or layers. For example, users could apply the analysis head to soils, where the laser spark would form directly on the soil to determine the contaminant levels. We have recently detected chromium in soil at levels as small as two parts per million. PLASSMA can also detect other contaminants, such as lead and arsenic from industrial plant exhaust stacks, in soils.

PLASSMA can be used both for measuring contamination levels and for surveying the extent of the contamination. Because the instrument works so quickly, the user can take repeated samples of a surface. These samples then allow the user to determine the location, depth, and concentration of the contamination.

In the future, we may refine applications in biomedicine. For example, lead exposure is determined by blood tests. Using PLASSMA's laser spark would reduce the amount of blood necessary to test for lead levels; medical workers could also perform analyses at schools, reducing the cost of screening programs. Forensic analysis could use PLASSMA to examine tissue immediately in the pathology laboratory to determine its atomic composition. Both of these applications will require further work to test the effectiveness of PLASSMA's analysis method for blood and tissue samples.

David A. Cremers joined the Laboratory in 1980 as a postdoctoral research fellow; in 1981 he became a technical staff member in the Photochemistry and Photophysics Group of the Chemical and Laser Sciences Division. He received his Ph.D. in physics from Washington State University in 1990. PLASSMA was his second R&D 100 Award; he received his first award in 1988 for developing the mobile beryllium monitor. His current research interest is developing laser-induced breakdown spectroscopy for a variety of applications, including environmental and industrial monitoring and studies of lunar and planetary materials. He is also developing optical diagnostics for real-time process control of laser welding.

Monty J. Ferris has been in the Chemical and Laser Sciences Division for twelve years and is currently a laser optics technician in the Photochemistry and Photophysics Group. Ferris has worked on a variety of projects, including methods of converting methane to methanol, applications of lasers to combustion diagnostics, and remote sensing with the light detection and ranging (lidar) system. Currently, he is applying laser-induced breakdown spectroscopy to environmental monitoring and process control.

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Inventors of the Portable Laser Spark Surface Mass Analyzer are (from left) David A. Cremers, Monty J. Ferris, and Karen Y. Kane.

Karen Y. Kane, a student at the University of New Mexico, worked on PLASSMA and other applications of laser-induced breakdown spectroscopy as a graduate research assistant in the Laboratory's Chemical and Laser Sciences Division in 1991 and 1992. The subject of the thesis for her M.S. in electrical engineering from the University of Illinois was the chemistry of the iodine monofluoride laser; she also has industry experience in advanced imaging systems.