In the Classroom

Laser-Induced Breakdown Spectrometry

JOSEPH SNEDDON*
Department of Chemistry
McNeese State University
Lake Charles, Louisiana 70609
Jsneddon@acc.mcneese.edu

YONG-ILL LEE
Department of Chemistry
Changwon National University
Changwon 641-773, KOREA

A major advantage of LIBS over both GFAAS and ICP-AES is its ability to perform in-situ determinations with minimal sample preparation.

The basic principles of laser-induced breakdown (emission) spectrometry (LIBS) for the determination of elements in solids, liquids, and aerosols are presented. A description of the instrumentation, including laser, sample chamber, and detection is followed by a brief discussion of potential interferences from matrix effects. The importance of time resolution and space resolution to minimize these effects is

In the past 20 years, the number of instrumental techniques available to the chemist has grown exponentially. In order to help our readers keep up with this rapidly growing field, tutorial articles on chemical instrumentation will be a regular feature of The Chemical Educator. The articles are designed to serve as a brief introduction to emerging instrumental techniques, with an outline of the underlying principles and major applications.

—Martin Schimpf, Series Editor
presented. The advantages and disadvantages of LIBS over inductively coupled plasma–atomic emission spectrometry (ICP–AES) and graphite furnace atomic absorption spectrometry (GFAAS) for elemental analysis is summarized. Special applications in which LIBS could excel include remote sensing, detection in a hostile environment, and underwater determinations.

Introduction
When the output from a (pulsed) laser is focused onto a small spot on a solid, liquid, or aerosol surface, an optically induced plasma is formed at the surface, provided the laser power density exceeds the breakdown threshold value of the surface. Such plasmas are frequently called laser-induced plasmas, laser-ablated plasmas, or laser sparks, and they can be used for sampling, atomization, excitation, and ionization. When such a plasma is used in atomic emission spectroscopy, the method is referred to as laser-induced breakdown spectrometry (LIBS).

This tutorial will describe the basic principles of LIBS, the associated instrumentation, give a brief discussion of interferences that are unique to LIBS, describe some selected applications of LIBS for elemental determination, and make a comparison of its advantages and disadvantages over conventional atomic absorption and emission techniques.

Basic Principles
In LIBS the external source of energy is laser light, which impinges on the ground-state atoms. Light emitted from the excited sample is spectrally (and sometimes temporally) resolved to yield qualitative and quantitative information on the elemental constituents of the sample. The unique feature of LIBS compared to traditional atomic spectroscopic techniques, such as graphite furnace atomic absorption spectroscopy (GFAAS) and inductively coupled plasma–atomic emission spectroscopy (ICP–AES), is that the sample need not be transported to the heat source; rather, a plasma is formed in-situ.

The method for performing atomic emission spectrometry using a laser-induced plasma is simple and rapid. The energy levels for each constituent element in a sample are unique; therefore, an emission spectrum can be used to identify elements for qualitative