NUCLEAR METHODS OF ANALYSIS APPLIED TO QUANTITATION IN LASER MICROPROBE MASS SPECTROMETRY

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Laser microprobe mass spectrometry (LMMS) detection limits for mercury have been determined using mercury-doped Spurr's tissue embedding medium. Actual mercury concentrations were confirmed via INAA. Procedures have also been developed to measure lithium and indium concentrations in thin films of polymerized Spurr's samples via PIGE and PIXE. These elements are currently being investigated as laser power density internal standards in the analysis of human tissue for studies of trace element involvement in neurological diseases.

Introduction

Among currently available methods for trace element analysis in tissue, few offer both high sensitivity and high spatial resolution. Both characteristics are highly desirable in that the location of an element is often as important as its concentration. One technique that offers both high sensitivity and spatial resolution is laser microprobe mass spectrometry (LMMS). LMMS offers a spatial resolution of 1 μm and has the potential to determine most of the elements in the periodic table simultaneously at the μg/g level. The instrument shown schematically in Fig. 1 employs a high powered Nd:YAG laser to vaporize and ionize a microvolume of material from thin (-0.5 μm) sections of plastic embedded tissue. The area of interest is selected via a co-linear low-powered He-Ne spotting laser and a standard optical microscope. The ions created in the laser tissue interaction are mass separated via a time-of-flight mass spectrometer.

One problem in the use of LMMS for trace element analysis is the lack of quantitation. Currently, the technique is, at best, semi-quantitative. Quantitation is problematic because of the lack
of an adequate theory describing the physical process of ion creation in a laser induced plasma. Because no current theoretical model can satisfactorily predict ion yield, experimenters are forced to use empirical approaches to quantitation such as the use of an internal or external standard. Of the variety of standards that have been proposed for use with LMMS, the best choice seems the use of organometallic compounds dissolved in the embedding medium used for the tissue. This type of standard can be used either as an internal standard with the embedded tissue, or a separate external standard independent of tissue. In order to serve as a suitable standard, the concentration of the element of interest in a thin section must be assessable by independent methods.

Lithium (Li) and indium (In) are elements that have ionization energies similar to many elements of interest in our work (e.g., Al, Ca, Fe), and would, therefore, be suitable for use as internal standards in analyses of tissues for these elements. In addition, they occur in mass regions that are relatively free of organic mass fragment peaks.

Mercury (Hg) is another element of interest because it has been shown to be elevated in the brains of patients with Alzheimer's disease and amyotrophic lateral sclerosis. Lithium and In are not suitable as internal standards in the case of Hg analyses, due to the higher ionization energy of Hg. Therefore, an