Laser-induced plasma at reduced pressure and its application for solid organic sample analysis

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Abstrak

<i>ABSTRACT
A series of experimental studies on the emission spectra of laser-induced plasma at reduced ambient gas pressure were carried out for the analyses of organic materials. The plasma was generated by means of a Q-switch Nd-YAG laser having a pulse width of 8 ns, wavelength of 1,064 nm and operated at an energy of 120 mJ. The emission was detected with time-integrated and time resolved spectroscopic techniques. These studies were intended to investigate the possible extension of the previously established technique of laser induced shock-wave plasma spectroscopy (LISPS) for its applications to organic samples of different natures as well as to examine the related excitation mechanism and the effects of different experimental conditions on the plasma generation.

The first experiment was conducted on soft solid organic samples or samples which have low melting point. It is well known that plasma emission from soft organic samples can not be directly produced by Nd-YAG laser irradiation even in low pressure surrounding gas. We have shown in this experiment that this problem can be overcome by placing a hard sub-target behind or underneath the soft samples or putting an obstacle in front of it. The sharp emission lines of light elements such as hydrogen, carbon and chlorine from organic samples were clearly observed from a black polyvinyl chloride plastic sheet when the shock wave plasma was generated in appropriately chosen low-pressure of the ambient air.

In the second experiment, the same technique has been successfully applied for hydrogen and carbon atomic emission analysis in various fossil samples at low gas pressure around 3 Torr. The quality of the spectrum allows a quantitative comparison of the carbon and hydrogen emission intensities with the associated molecular band spectra, yielding a rough estimation of the period of fossilization process. In the third experiment, another successful application of this technique was also achieved for spectrochemical analysis of bead samples, which offers the possibility of its applications for non destructive identifications of genuine beads as well as its potential application to other areas of forgery inspection.

In addition to the variety of applications demonstrated in those experiments, the related study has also verified the distinct role of laser induced shockwave in the generation of excitation process leading to the observed favorable plasma emission. We show in this connection the crucial condition of low pressure ambient gas for producing the sharp emission lines desirable for high resolution and quantitative analysis. It was further demonstrated that the mass difference between the host elements and the impurity elements has a sensitive effect on the pressure dependent characteristics of the emission lines to be analyzed.

On the basis of those results, we have reason to hold out hope for the extension of the technique developed

in this study to more credible quantitative spectrochemical analysis of organic samples, including those of biomedical interest and those in the form of thin films.</i>