

Novel approach for deep-UV depth-profiling studies (ICP-MS) of soft waxes and asphaltenes using liquid nitrogen pre-treatment

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Abstract

Our group has developed a rapid procedure of ablating gelatinous and soft samples (gels/pastes/waxes) with a high-precision deep-UV laser (213 nm) following swift solidification by immersion in liquid nitrogen. Liquid nitrogen pre-treatment of such samples produces a perfectly solid sample whose material characteristics are suitable for depth-profiling studies. A range of samples including waxes and gels were petrified in aliquots of liquid nitrogen and immediately subjected to laser irradiation. The study was largely qualitative to demonstrate the potential of the pre-treatment approach. Uniformity of elemental distribution both spatially and depth-wise can be distinctly accomplished by iterative scanning with a high-precision laser beam. The competence, therefore, of the laser approach to delve to discreet depths below the surface of a sample is attractive for uniformity studies in bulk materials. Depth-profiling was limited to specific depths, and rapid spatial and sub-surface distributions of metal components in the petrified samples were achieved. An Nd:YAG deep UV (213-nm) laser ablation system was attached to a high-precision ICP-MS instrument. Irradiations were conducted with a flat-beam profile of 60% total energy and 55 μm diameter. The laser dwell time was 5 s; and repetition rate was 10 Hz. Following iterative surface scanning on a 9-point sample grid, the laser ablated a total depth of 25 μm at 5 μm -intervals at each point. The experimental results showed promise and the distinct capability to record spectra in the absence of “splashing” effects. This pre-treatment approach is therefore, highly viable, and a useful for analysis of crude oil and asphaltene samples.

Biography

Dr. Pillay is skilled in a wide range of instrumental techniques including Neutron Activation, XRF, Gamma ray Spectroscopy, ICP-MS, Atomic Absorption and UV-Vis Spectrophotometry. He is experienced in the area of analytical and environmental chemistry, and has supervised PhD and MSc students. He has lectured widely in these areas and in general chemistry, and is keen on promoting cross-disciplinary teaching and research. He has more than 120 peer-reviewed journal articles, and several conference presentations. He was Guest Editor and member of the Editorial Board of the International Journal of Environmental Studies between 2005 and 2009. He is presently member of the Editorial Board of the Open Hydrology Journal.