How does an ICP respond to the introduction of a single micro-droplet?

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Elemental analysis of single particles (sp) with the inductively coupled plasma (ICP) is conceptually straightforward with the use of a monodisperse microdroplet dispenser. The individual entities (e.g., nanoparticles or biological cells) to be measured are embedded inside solution droplets, which are then introduced into the ICP. Ideally, each such droplet contains no more than a single particle, and the analytical signals from individual entities are well separated in time and can be registered in the form of discrete signal spikes. Because of the monodisperse size distribution of the droplets, the time (which translates into height in the plasma) required for the droplet to undergo complete desolvation, atomization, excitation and ionization is very reproducible from droplet to droplet, and it then becomes possible to predict the arrival time of the signal spike.

Motivated by the recent growing interest in nanoparticle analysis with sp-ICP spectrometry, which creates a new demand for a better fundamental understanding of the ICP, we monitored the physical behavior of the ICP during single-droplet introduction. We observed that droplet introduction perturbed the plasma in a way that involved three sequential effects: local cooling, thermal pinching and plasma reheating. In this presentation, the momentary changes in plasma characteristics caused by introduction of a single micrometer-sized droplet will be described and discussed.