

Is the new material clean? Analytical strategies from sample to signal for trace element determination by atomic spectrometry

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Whenever a new material, compound or product is designed, a simple question sooner or later arises: is it clean? Toxic and potentially toxic elements may be introduced through raw materials, catalysts, additives or processing equipment. When the material is intended for human consumption or comes into contact with the human body, as in food packaging, medical devices, cosmetics or toys, both the nature of the element and its concentration become critical, often at levels that can only be reached by highly sensitive spectrometric instrumentation. Although well-established techniques, such as inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS) offer excellent sensitivity, their high acquisition and operating costs, together with their high power and argon consumption, have driven growing interest in miniaturized, resource-efficient alternatives. This lecture focuses on one such alternative: a small-sized capacitively coupled plasma microtorch operated at low power and low argon consumption (15 W, 150 mL min⁻¹), serving as the excitation source for optical emission spectrometry (μ CCP-OES), coupled to a compact, low-resolution microspectrometer. Particular attention will be paid to analytical strategies for sample preparation and analyte introduction that allow this miniaturized system to reach the sensitivity required for trace element determination. At the core of these strategies is electrothermal vaporization (ETV) from a small-sized Rh coil filament, which enabled simultaneous multielemental determination from microlitre sample volumes, providing limits of detection (LODs) comparable to those of conventional laboratory techniques. To further improve the LODs, ETV- μ CCP-OES was coupled with preconcentration techniques, namely diffusive gradients in thin-films (DGT) passive sampling and micro-solid phase extraction (μ -SPE). Beyond preconcentration, DGT provided access to the labile, bioavailable fraction of metals and avoided the non-spectral matrix effects to which low-power microplasmas are prone. Overall, the lecture will demonstrate how the combination of miniaturized instrumentation with appropriately designed analytical workflows can provide reliable, sensitive and resource-efficient information on trace elements in diverse materials and products.

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