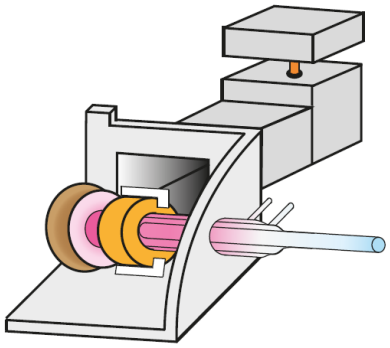
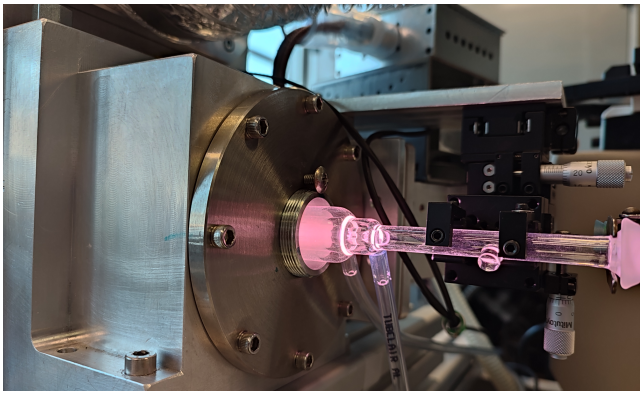
Nitrogen plasma as ion source for inorganic mass spectrometry

Monique Kuonen, Guanghui Niu, Bodo Hattendorf, Detlef Günther

Laboratory of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, Vladimir-Prelog-Weg 1, CH-8093 Zürich, Switzerland
kuonenmo@inorg.chem.ethz.ch

Nitrogen based plasmas have gained increasing attention as an alternative ion source for inductively coupled plasma mass spectrometry (ICPMS) as nitrogen is environmentally friendlier and more cost-effective than argon. While early plasma generation approaches using nitrogen were limited by their lower operating power,[1,2] a high-power nitrogen sustained microwave inductively coupled atmospheric pressure plasma (MICAP)[3] has been introduced recently. This novel source was coupled to a quadrupole mass spectrometer in our lab and is currently investigated for its figures of merit in element and isotope analyses of aqueous solutions.





The influence of forward power and nebulizer gas flow rate on sensitivity, plasma background, and polyatomic ion formation was analysed. The plasma background ions decreased with increasing nebulizer gas flow rate and decreasing power, while atomic ions could be assigned to one of three groups based on their dependence on the operating conditions. The distinction between the groups can generally be explained by physical-chemical properties of the elements such as mass, ionization energy and oxygen bond strength. However, while indicators of gas temperature (e.g. CeO^+/Ce^+ formation ratios) imply that similar temperatures can be reached in Ar and N_2 plasmas, the highly abundant NO in the latter limits the attainable sensitivity for elements with high ionization energy to a greater degree. To investigate to which extent the use of N_2 as plasma gas affects the gas dynamics during the extraction of the plasma into the MS, different geometries of the vacuum interface were studied by varying the sampler to skimmer distance, changing the sampler orifice size and employing an additional interface pump. Despite N_2 plasmas having different characteristics during the supersonic expansion compared with that of Ar, the attainable sensitivity could barely be improved by the tested modifications.

[1] D.A. Wilson, G.H. Vickers, G.M. Hieftje, *Anal. Chem.* **1987**, 59, 1664−1670.
[2] W.L. Shen, T.M. Davidson, J.T. Creed, J.A. Caruso, *Appl. Spectrosc.* **1990**, 44, 1003−1010.
[3] J. Jevtic, A. Menon, V. Pikelja, Patent No.: PCT/US2014/024306, **2014**.