Design and Optimization of a new microwave plasma source for atomic emission spectrometry to determine total organic fluorine concertation in liquid and gaseous samples.

Microwave-induced plasmas (MIPs) operating at 2.45 GHz have emerged as efficient excitation sources for trace-level elemental analysis, particularly for challenging elements such as fluorine in both liquid and gaseous matrices, using atomic emission spectrometry. In this study, we present the design and optimization of a novel microwave resonator incorporating quarter-wavelength ceramic coaxial resonators (2.45 GHz) fabricated from high-permittivity dielectric materials to effectively focused microwave energy for the generation of the helium plasma.

The utilization of helium as plasma sustaining gas is crucial for fluorine detection, as its high ionization potential (24.6 eV) enables the production of a plasma with high excitation temperature, therefore enhancing the excitation efficiency of fluorine atoms. This improved energy coupling is expected to significantly enhance signal to noise ratio and reduce detection limits. The proposed MIP operates in the form of a high-frequency surface-wave-sustained discharge (SWD), in which the plasma column propagates as a traveling wave along the surface of a quartz capillary. The resulting discharge within the capillary yields high sample-introduction and excitation efficiency. Furthermore, the compact and low-cost design of the ceramic resonator offers a practical alternative to conventional waveguide-based microwave-plasma systems, such as the Beenakker cavity. Moreover, Gas Chromatography (GC) system will be coupled with the MIP. Volatile compounds will be separated in the GC, and the vaporized compound directly carried to plasma and detected quantitatively using atomic emission.

In this work, various resonator configurations are examined and optimized using 3D electromagnetic simulations (ANSYS HFSS) in conjunction with experimental.