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PII: S0584-8547(17)30568-2
DOI: doi:10.1016/j.sab.2018.05.022
Reference: SAB 5449

To appear in: *Spectrochimica Acta Part B: Atomic Spectroscopy*

Received date: 20 November 2017
Revised date: 22 May 2018
Accepted date: 22 May 2018

Please cite this article as: J. Giersz, K. Jankowski, A. Ramsza, E. Reszke , Microwave-driven inductively coupled plasmas for analytical spectroscopy. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Sab(2017), doi:10.1016/j.sab.2018.05.022

Microwave-driven inductively coupled plasmas for analytical spectroscopy

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Abstract

New achievements in microwave-driven inductively coupled plasma technology based on formation of homogeneous H-type field inside the plasma discharge tube by using both multi-helix and partial-turn couplers are discussed in detail. These couplers range from separate washers delivering longitudinal E_z and radial E_r field components concentrated at the inner wall of the torch, through real multi-turn field shapers, which make the prevailing longitudinal H_z or hybrid EH field components, all the way to strait wires delivering a single radial E_r field component with minimum at the axis. Two novel approaches utilizing either a ring washer coupler or a multi helix coupler are developed to generating atmospheric pressure annular-shaped microwave ICPs, suitable for analytical spectroscopy. They are stably operated with argon or helium at 1-2 L min^{-1} flow rates at a power level of 300W while accepting up to 70 mg min^{-1} of water aerosol. For argon plasmas, rotational temperatures of OH (3300–4200K) and electron number densities $(1.9–2.2)\times10^{15}cm^{-3}$ are close to those measured in Ar ICP. Limits of detection for some metals were within the range of 0.006–0.035mg L^{-1} using a portable OES detection system.

Keywords: annular-shaped microwave plasma, microwave-driven inductively coupled plasma, analytical spectroscopy