EFFECTS OF TRACES OF MOLECULAR GASES (HYDROGEN, NITROGEN) IN GLOW DISCHARGES IN NOBLE GASES

E. B. M. STEERS[1], P. ŠMÍD[1] and V. HOFFMANN[2]

[1]*London Metropolitan University, 166-220 Holloway Road, London, N7 8DB, UK*
E–mail: e.steers@londonmet.ac.uk
E–mail: p.smid@londonmet.ac.uk

[2]*Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstraße 20, 01069 Dresden, Germany*
E–mail: V.Hoffmann@ifw-dresden.de

Abstract. The "Grimm" type of low pressure glow discharge source, introduced some forty years ago, has proved to be a versatile analytical source. A flat sample is used as the cathode and placed about 0.2mm away from the end of a hollow tubular anode leading to an obstructed discharge. When the source was first developed, it was used for the direct analysis of solid metallic samples by optical emission spectroscopy (OES), normally with argon as the plasma gas; it was soon found that, using suitable electrical parameters, the cathode material was sputtered uniformly from a circular crater of diameter equal to that of the tubular anode, so that the technique could be used for compositional depth profile analysis (CDPA). Over the years the capability and applications of the technique have steadily increased. The use of rf powered discharges now permits the analysis of non-conducting layers and samples; improved instrumental design now allows CDPA of ever thinner layers (e.g. resolution of layers 5 nm thick in multilayer stacks is possible). For the original bulk material application, pre-sputtering could be used to remove any surface contamination but for CDPA, analysis must start immediately the discharge is ignited, so that any surface contamination can introduce molecular gases into the plasma gas and have significant analytical consequences, especially for very thin layers; in addition, many types of samples now analysed contain molecular gases as components (either as occluded gas, or e.g. as a nitride or oxide), and this gas enters the discharge when the sample is sputtered. It is therefore important to investigate the effect of such foreign gases on the discharge, in particular on the spectral intensities and hence the analytical results.

The presentation will concentrate mainly on the effect of hydrogen in argon discharges, in the concentration range 0-2% v/v but other gas mixtures (e.g. Ar/N_2, Ne/H_2) will be considered for comparison. In general, the introduction of molecular gases can change the discharge impedance, alter the sputtering rate and crater profile and cause changes in the absolute and relative intensities of lines in both the atomic and ionic spectra of the sample element and the plasma gas.

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