

Study of glow discharge plasma processes: effect of molecular gases (H₂, O₂, N₂) on mass spectra.

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It is already known that analytical results in glow discharge can be significantly affected by traces of molecular gases as H₂, O₂, N₂ which may be present in the plasma gas (argon), often arising from sample constituents. With the main purpose of understanding better the processes occurring in the plasma, small fractions (0-2% v/v) of H₂, O₂ and N₂ were introduced into the discharge gas and the changes in ion signal intensities for sputtered analyte, plasma gas and trace gases were examined for various samples. This investigation was carried out with fast flow high resolution Element GD mass spectrometer on Cu, Fe and Ti matrices.

The most pronounced changes on the matrix and plasma species ion signals were observed when H₂ was added into the plasma and less significant changes were caused by O₂ and N₂. The changes were most pronounced for molecular gas content in the plasma in the range 0-0.5%. The changes in the matrix ion signal due to molecular gas presence are in the range of one or two orders of magnitude. By normalizing the ion signal of sample impurities to the matrix signal it is noticeable that these signals show only minor changes relative to the matrix signal. A very significant drop in the intensities of the Ar ion signals by varying amounts depending on the matrix up to four orders of magnitude was observed with the fast flow glow discharge source, while Ar⁺⁺ signal increases.

The sputter rates are also affected by molecular gases; they may be reduced due to reduced Ar ion and atom population or due to poisoning effects of the added gas on the sample surface. Especially the polishing effect of O₂ on the Ti sample is obvious. Therefore the changes in the sputter rates give additional information which helps to interpret the data. In the constant pressure/constant current mode, the addition of molecular gases causes a large increase in the discharge voltage.

Time resolved analysis with a pulsed dc mode was used to find out in which sequence ions are formed in the discharge process.