Optical emission spectroscopy study of a DC magnetron discharge in Ar/(O2-N2)

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Metallic (Me) oxynitrides (MeNₓOᵧ) are attracting the attention of many researchers for the last two decades due to a unique set of versatile properties, resulting from the combination of those from the pure metals and those of the correspondent binary nitrides and oxides. Among the group of already studied oxynitrides, and due to the combination of aluminium and aluminium nitride and oxide, aluminium oxynitride (AlNₓOᵧ) has some interesting potential applications in different technological fields, but the available knowledge of this system is very reduced and mostly related with its spinel structure. Recent results showed that AlNₓOᵧ thin films deposited by PVD present a particular changing morphology, consisting of Al nanoparticles embedded in a AlNₓOᵧ matrix and, depending on the amount of oxygen and nitrogen in the matrix, very different electrical and optical responses. This work presents a study of the evolution of several discharge parameters (target voltage, reactive gases partial pressures) and plasma emission spectrum responses during thin film deposition, for different N₂ and/or O₂ gas flows, in order to understand the effect of processing conditions on the chemical composition and bonding characteristics, and its effect on the morphological and structural features, which, all together, explain the wide range of property variations that can be obtained in the AlNₓOᵧ film system. The partial pressure of each reactive gas was monitored using a mass spectrometer and the Al, Ar, N₂ and O₂ emission lines were recorded using an optical emission spectrometer at two different discharge spots, one close to the target and the other close to the substrate. For the Ar-N₂ based reactive gas mixtures, a smooth evolution of the different discharge parameters was observed as a function of reactive gas flow. On the other hand, for Ar-O₂ mixtures, there was an abrupt transition in the different parameters for certain critical O₂ flows. For the pure Ar discharge, the plasma density and temperature could be obtained, using a simple collisional radiative model, based on the Ar emission lines.

Keywords
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