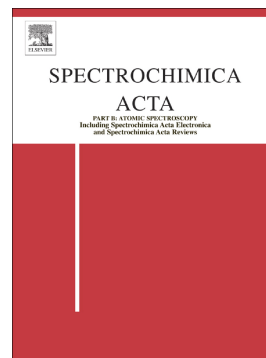


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**Spectroscopic studies of the plasma for the preparation of Al-N co-doped ZnO films**

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**Abstract**

Using optical emission spectroscopy measurements, the plasma formed for the preparation of zinc and aluminum co-doped ZnO films is studied. The O<sub>2</sub>/N<sub>2</sub> mixed gas is excited by electron cyclotron resonance microwave discharge, generating an oxygen-nitrogen plasma. A zinc plume and an aluminum plume are induced by pulsed laser ablation of a zinc target and an aluminum target. The expansion of the plumes in the oxygen-nitrogen plasma enhances the excitation of the species of the oxygen-nitrogen plasma, while the ablated zinc and aluminum species are frequently excited at the same time, forming a highly reactive oxygen-nitrogen-zinc-aluminum plasma containing active oxygen- and nitrogen-related species excited from the O<sub>2</sub>/N<sub>2</sub> gas and zinc and aluminum species ablated from the zinc and aluminum targets, as well as nitric oxide molecules produced in the plasma. The active oxygen species compose a reactive oxygen-containing gaseous environment for oxide formation, and the active zinc species react with the active oxygen species for ZnO film deposition, while the active nitrogen and aluminum species are *in situ* co-doped in the growing ZnO film. The optical properties of ZnO films are improved by zinc and aluminum co-doping including blue shifting of absorption edge, widening of band gap and preserving of high transparency.

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