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XPS characterization of thermochemical nitriding MoS₂ template sub-layer to prevent AlN delamination during regrowth

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Abstract

AlN-based acoustic filters serve as crucial components in Radio Frequency (RF) communications. The current performances of these devices are limited on silicon substrates because of poor AlN crystal quality. This could be improved using ALD-grown 2D-MoS₂ thin film as a template on silicon. Nevertheless, after deposition of thicker sputtered AlN films (≥ 200 nm), a systematic delamination of the AlN/MoS₂ stack occurs which prohibits the integration of these materials in RF devices [1]. That is why a new elaboration process to grow thick AlN films with an improved crystal quality while avoiding the delamination issue is proposed in this work. This process is based on the chemical conversion of the MoS₂ through a very thin 5 nm AlN seed layer using an ammonia (NH₃) heat treatment [2]. A thorough XPS study was carried out to optimize a trade-off between the AlN thickness and the reactive annealing conditions allowing the diffusion of NH₃ towards the underlying MoS₂ and its conversion into Mo(O_x)N_y. The synthesis and the analysis of molybdenum oxynitride by nitriding a well-controlled uniform molybdenum disulfide (MoS₂) layer via a 700 °C ammonia NH₃ reactive heat treatment without AlN seed layer was previously performed as reference [3,4].

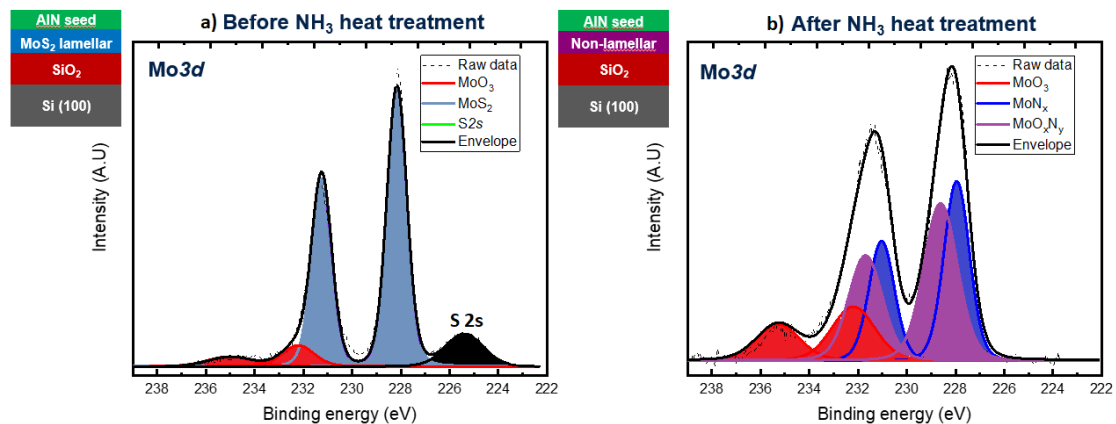


Figure 1: Mo_{3d} XPS spectra of MoS₂ before a) and after 1000 °C NH₃ heat treatment b).

The MoS₂ nitriding reaction has also been demonstrated by in-plane XRD analysis and its progressive conversion has been monitored by *in situ* reflectance measurements. To support the XPS measurements mentioned above, the films were also characterized by combining Raman micro-spectroscopy and TEM (transmission electron microscopy). Moreover, ToF-SIMS analysis highlighted the MoS₂ conversion even after a regrowth of a thick AlN film avoiding any interface (of interest AlN/MoN_x) air exposure. Finally, this new synthesis route allowed to improve the crystal quality of thick AlN layers deposited on low cost silicon substrate.

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