Microwave Plasma-Assisted Reactive HiPIMS of Indium Nitride Films

C. Hain1,2,3, P. Schweizer1, J. Thomet2, Aurelio Borzi4 J. Michler3, A. Hessler-Wyser2, T. Nelis1,3

1Institute for Applied Laser, Photonics and Surface Technologies, BFH, Bern University of Applied Sciences, Quellgasse 21, 2502 Biel/Bienne, Switzerland
2Laboratory for Photovoltaics and Thin Film Electronics, EPFL, École Polytechnique Fédérale de Lausanne, Rue de la Maladière 71b, 2000 Neuchâtel, Switzerland
3Laboratory for Mechanics of Materials and Nanostructures, Empa, Swiss Federal Laboratories for Materials Science and Technology, Feuerwerkerstrasse 39, 3602 Thun, Switzerland
4Center for X-ray Analytics, Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, 8600 Dübendorf, Switzerland

Email: caroline.hain@bfh.ch

ABSTRACT

The reactive sputtering of indium nitride films is an attractive deposition method, however, negative aspects can include insufficient reactive nitrogen activation for attaining stoichiometric InN, as well as compound formation on the metallic target’s surface, leading to decreased secondary electron emission and, in turn, significantly affecting the sputtering process through the development of a current onset time lag [1–5]. Different strategies have been tested to overcome these difficulties, ranging from the application of direct current (DC) and radiofrequency (RF) sputtering to the incorporation of additional ionisation sources [6–9]. This work focuses on the fabrication process of indium nitride thin films via microwave plasma-assisted reactive high power impulse magnetron sputtering (MAR-HiPIMS). The influence of microwave plasma on the HiPIMS discharge process at various nitrogen flows and microwave powers was monitored and characterised through in situ diagnostics, including studying the obtained HiPIMS I(V,t) curves, time-resolved optical emission spectroscopy (OES), time-of-flight mass spectrometry (ToF-MS) and Langmuir probe measurements. This was followed by the deposition of a series of InN films via standard R-HiPIMS (reference sample) and MAR-HiPIMS. The influence of the microwave plasma on the sputtering conditions was linked to the properties of the fabricated InN films, analysed via X-ray diffraction and reflectometry (XRD, XRR), and scanning and transmission electron microscopy (SEM, TEM).