## MonPE36

# Low-energy Ion Beam-based Deposition of Gallium Nitride

Magdaleno R. Vasquez Jr.[1] and Motoi Wada[2]

*Department of Mining, Metallurgical, and Materials Engineering, College of Engineering, University of the Philippines, Diliman, Quezon City 1101 Philippines*

*Graduate School of Science and Engineering, Doshisha University, Kyotanabe, Kyoto 610-0321 Japan*

*Corresponding author: mrvasquez@coe.upd.edu.ph*

A dual chamber sputter-type plasma system was used to extract low-energy ion beams for thin film growth of gallium nitride (GaN). The first chamber is made of a quartz cylinder with a 6 mm diameter copper antenna wrapped around the cylinder. Inductively coupled gas discharge was realized in the first chamber using a 13.56 MHz radio frequency power with autotuning matching circuit connected to the antenna. The discharge was then guided by electromagnetic fields into another chamber where a liquid gallium (Ga) target was poured onto a tungsten reservoir. At the back of the target are water-cooled cylindrical and annular SmCo magnets used to confine the electrons near the target surface. In addition, target was also biased negatively with respect to the chamber to control the sputtering yield of Ga. Opposite the target is a dual-electrode extraction system that forms a low-energy ion beam of gas ions as well as post-ionized sputtered Ga atoms.

A degreased silicon (Si) (100) target was placed opposite the extraction electrodes in the downstream region and exposed to low-energy ion beams of Ga, argon (Ar), and nitrogen (N). The rf power was set at 50 W while the extraction potential was varied from 50 to 70 V. Target bias was set at -300 V and deposition time at 5 hours. Partial pressure ratio of $N_2$ to Ar was set below 0.10 while the total system pressure was set at 0.088 Pa. X-ray diffraction analysis of the substrate revealed two peaks at $2\theta = 33.01°$ and $2\theta = 69.14°$ which can be attributed to GaN film and Si substrate, respectively. The result indicates the growth of highly oriented films. X-ray reflectivity measurements also revealed the film thickness with the estimated growth rate ranging from 10 to 16 nm/h.

**References**

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