GaN thin film: Growth and Characterizations by Magnetron Sputtering

Chaudhry Muhammad Furqan[1,2], Hoi-Sing Kwok[1,2]

[1]State Key Laboratory on Advanced Displays and Optoelectronics Technologies, Department of Electronic and Computer Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China.

[2]Center for Display Research, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, Chin

香港科技大學 THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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HKUST

Abstract Gallium Nitride (GaN), remarkably, shows very high electron mobility, wide energy band gap, biocompatibility, and chemical stability. In this research growth parameters of GaN have been studied based on sputtered gasses ratio, pressure, sputtering power, duty ratio of pulse signals and temperature by pulsed DC-magnetron sputtering technique. The crystal quality of GaN is found to improve with decrease in working pressure. Room temperature PL, Raman analysis, AFM and Optical transmittance were performed to characterize the structural and optical properties.

Results and Discussion

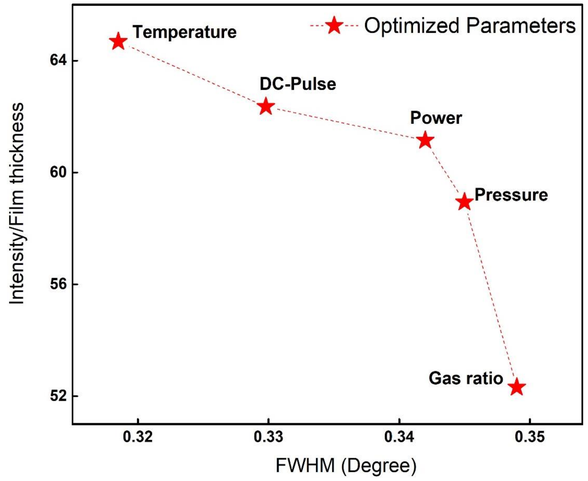

Figure 1: (XRD) Intensity/thickness of thin film as a function of FWHM of (002) characteristic peak of Wurtzite GaN

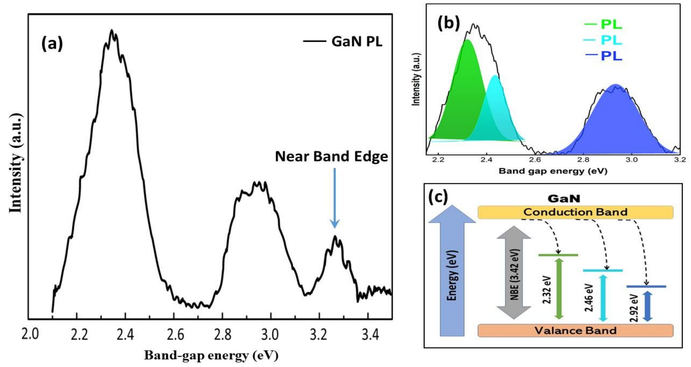

Figure 2: μ-PL-spectrum of GaN thin Film

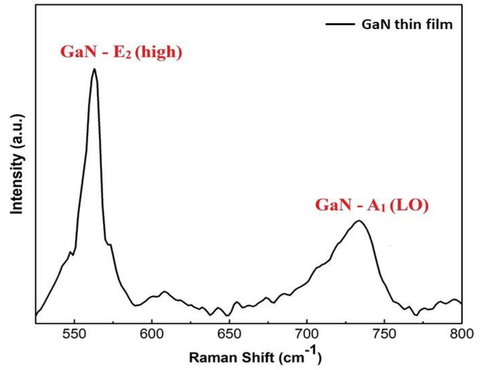

Figure 4: Raman Spectrum

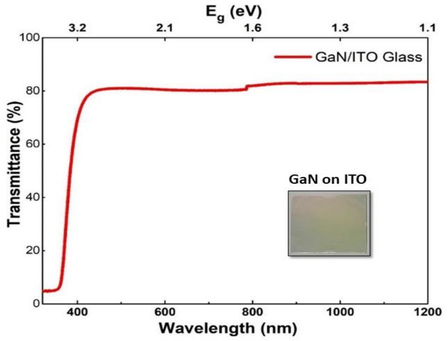

Figure 3: Optical Transmittance

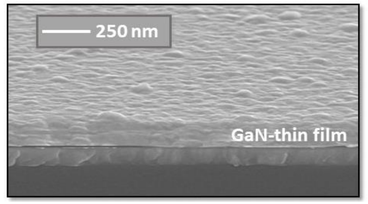

Figure 5: SEM image of thin film

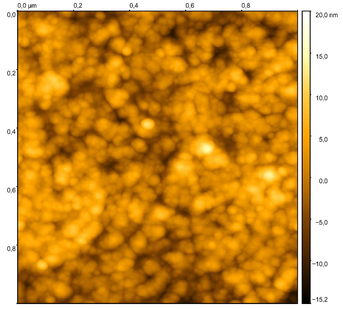

Figure 6: AFM images

Conclusion:

High purity Ga (99.99999%) was used as target and placed parallel to the substrate with high purity sputtered gasses such as argon (99.99999%) and nitrogen (99.99999%). We concluded our results based on lattice strain and dislocation length density from XRD pattern. The N_2/Ar gases ratio at (41:09) sccm suggest the best possible growth with lowest working pressure of 7.5 mT. Room temperature PL spectrum shows the slightly weak peak at NBE, Raman analysis shows the slight blue shift in the E_2 (high) mode which indicates the compressive stress due to lattice mismatching with the substrate. Optical transmittance shows the transmission edge around ~3.3 eV correlates to wurtzite GaN structure. AFM image of GaN thin film with the estimated Root Mean Square (RMS) roughness of 3.76 nm.

References:

1. M. Junaid, *Magnetron Sputter Epitaxy of GaN*, no. 1482. 2011.
2. Itoh, T. *et al.* Fabrication of InGaN thin-film transistors using pulsed sputtering deposition. *Sci Rep* **6,** 29500 (2016).