"Growth and Characterization of InGaN Thin Film for Solar Cell Application"

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Ternary indium gallium nitride (InGaN) with high absorption coefficient (10^5 cm^{-1}) and tunable direct bandgaps (only know the material from III-nitride family which provide an almost perfect match to solar spectrum), is one of the most promising material candidates that can be used for the development of a high-efficiency thin-film photovoltaic application. In the realization of a such applications, it is required that the development of InGaN films towards an extensive indium content with an adequate thickness (thickness must exceed 120 nm to absorb 90% of incident light with energy higher than its bandgap) and in high quality of crystallinity. Thus, an investigation and optimization of InGaN epilayers need to be carried out prior to moving into designing and developing a full solar cell structure. In this work, InGaN/GaN heterostructures were grown on undoped-GaN (ud-GaN) buffer layer over a standard 2" c-plane flat sapphire substrate (FSS) using a commercial metal organic vapor deposition (MOCVD) system with horizontal reactor configuration by Taiyo Nippon Sanso Corporation. The effect of InGaN epilayer growth temperature on structural, crystallinity, surface morphology and optical properties were investigated using high resolution X-ray diffraction (HR-XRD), field emission scanning electron microscope (FE-SEM) and ultraviolet-visible (UV-Vis) spectrophotometer, respectively. Preliminary elaboration and characterization on structural and optical analysis have been conducted in which concludes that few challenges need to be overcome in the realization of InGaN-based solar cells mainly on the film's quality and the requirement of complex analysis. In unoptimized growth conditions, InGaN films tend to exhibit phase separation and composition inhomogeneities within its structure because of the solid-phase miscibility gap. Thus, optimization of growth parameters such as growth temperature and growth rate has been carried out to achieve higher indium content with better homogeneity as well as to increase overall film quality. Currently, up to 28.9% of indium composition has been achieved which were obtained through the simulation fitting of the XRD triple-axis pattern. In achieving higher indium composition in InGaN epilayer, further optimization of the parameters is needed to reduce the defect density within the films such as In-droplets and phase separation, which act as a recombination center for photoexcited electron. Thus, this study provides a new insight into the structural and optical properties of InGaN/GaN-based heterostructures grown on FSS, which could be useful to develop into high-efficient InGaN-based solar cell devices.

- Funded by Toray Science Foundation, Japan

The above final report has not been presented at the annual "MTSF Grant Research Symposiums" as the scheduled Years 2020 & 2021 Grant Research Symposiums were cancelled due to the Covid-19 pandemic.