Effect of Rapid Thermal Annealing on Polycrystalline InGaN Deposited on Fused Silica Substrates

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InGaN alloys are very promising candidates for efficient photovoltaic applications, since their engineered bandgap can cover the entire Air-Mass 1.5 solar spectrum. Deposition of amorphous-polycrystalline alloy films is potentially very interesting for low cost, large area solar cells deployment.

In this work we report on rapid thermal annealing (RTA) studies of polycrystalline InGaN films deposited on amorphous fused silica substrates. The films were grown at low substrates temperatures (200 ^{o}C) by exposure of the substrates to indium and gallium beams under radiofrequency nitrogen plasma. Films with compositions in the range of 20% to 50% indium content were obtained. In order to study the annealing effects, the films were subsequently subjected to consecutive RTA treatments, under N_2 ambient for 10 mins. Annealing temperatures spanned the range from 400 to 900 ^{o}C. X-ray diffraction (XRD), atomic force microscopy (AFM), photoluminescence (PL), Hall effect measurements and energy dispersive x-ray spectroscopy (EDXS) were utilized to characterize films properties. The optical properties of the films were systematically studied, employing variable angle spectroscopic ellipsometry (VASE).

As deposited films were polycrystalline and showed a preferential (0002) orientation. Annealing promoted crystallization, resulting in an increase in the grain size of the original crystallites, which was more evident in the high indium mole fraction films. Also, in this case, a phase separation was observed above 850 ^{o}C. Upon annealing, films' resistivity reduced by at least two orders of magnitude and PL intensity was enhanced. In the high indium content films, a monotonic bandgap increase at temperatures greater than 500^{o} C was found utilizing VASE. This bandgap increment can be attributed to the Urbach tails reduction due to the disorder lowering and to the Burstein-Moss shift due to the higher electron concentration, upon increasing temperature.

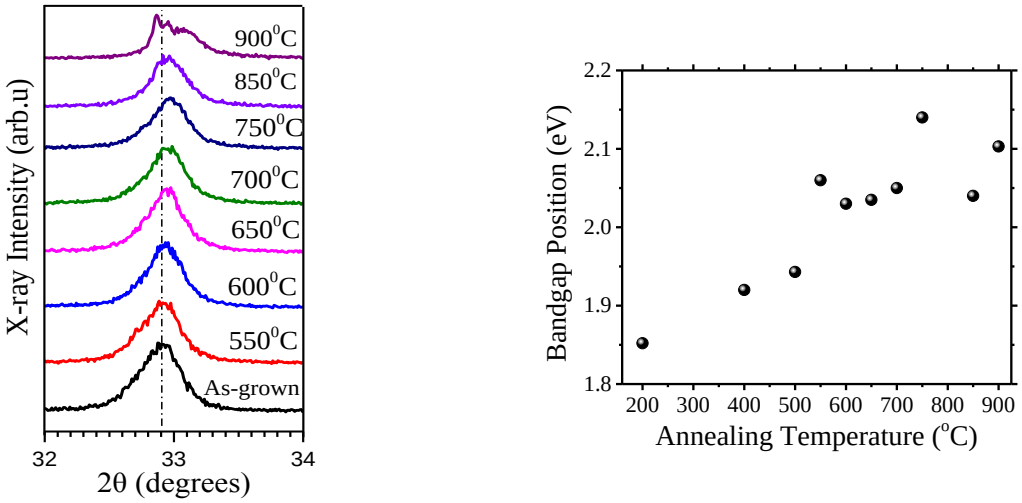

Fig.1. XRD of polycrystalline InGaN film on FS with 50% In composition, after RTA at different temperatures and the corresponding evolution of bandgap position as measured by VASE.

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