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Tuesday, September 27, 7:30 AM
257 ASC II

ABSTRACT

Amorphous Silicon (a-Si:H) has been extensively used as a solar cell material because of its low cost and ease of fabrication. However, the material suffers from generally poorer quality and increase in defect states in response to illumination (Staebler-Wronski effect). For best devices, one also needs to control the bandgap of the material, which depends strongly upon localized Si-H bonding. Although many techniques have been developed to fabricate lower bandgap materials in a-Si:H, most of them lead to the lowering of bandgap at the expense of device /film quality. In this research, we pursue Chemical Annealing (or layer-by-layer growth followed by controlled Ar ion bombardment) as a technique which for fabricating low bandgap, amorphous Silicon materials and devices without adversely affecting the quality of the material. We explore the growth and properties of both a-Si:H and its alloy, a-(Si,Ge):H using chemical annealing.

In this work, chemical annealed (CA) and non chemical annealed (NON CA) A-Si:H and A-(Si,Ge):H devices were fabricated at VHF (48MHz) which leads to lower ion damage by Ar. Systematic experiments were carried out to produce high quality devices to study the role of chemical annealing in lowering the bandgap of the solar cells. Films were also fabricated to study electronic properties for various annealing conditions and also to highlight the relationship between hydrogen content and bandgap. Detailed measurements of fundamental properties of the materials and devices were made under various chemical annealing conditions. We also performed light soaking experiments to study the photo-induced instability of normal and chemically annealed devices. The results indicate that the stability of chemical annealed samples is better than continuously grown samples. All the studies convincingly prove that chemical annealing helps reduce the bandgap without adversely affecting material properties.