Growth and structural characterization of Al induced crystallization in amorphous Si thin films for photovoltaic applications

Abstract

Al-induced crystallization is used in the present work for the simultaneous crystallization and doping of amorphous Si thin films. The initial structure consists of an oxidized Si layer on top of which a bilayer of Al and a-Si was deposited. The Al layer was deposited by electron gun evaporation, while the a-Si layer by sputtering. After extended annealing at 450 ^{o}C for several hours, a-Si crystallization and layer reversal takes place. The crystallized Si layer is highly doped with Al. The obtained structure is adequate for use in high efficiency solar cell devices. Two groups of samples were used at this study. The first one consists of two different samples, sample D2001 and sample F2001. In both of them the nominal thickness of the SiO_2 layer was 100nm, while that of the Al and the a-Si layers was 200nm. Annealing was performed in N_2 ambient at 450^{o}C for 7.5h in sample F2001 and for 10h in sample D2001. In both cases, full layer reversal took place, so as the Al layer was fully situated on top of the polycrystalline Si layer, of thickness in the range of 200-250 nm. The polycrystalline layer was of high crystalline quality, with grains having size between: a) 150 nm and 2.2 μm for D2001 and b) 100 nm and 800 nm for F2001. The second group consists of three samples, MPV2, PVG1 and PVG2R. In both of them the nominal thickness of the a-Si layer was 20nm, while that of the Al layer was 10nm. Annealing was performed in N_2 ambient at 500^{o}C for 4h in all samples. The structural characterization of these films was performed by using conventional and high resolution transmission electron microscopy (TEM). The difference in crystal size is attributed to the different annealing temperature. Twins and other defects are observed in the Si grains and they are analyzed. Based on the TEM results, the mechanism of crystallization is discussed.