FORMATION AND INVESTIGATION OF INTERFACE MOVING IN NANOSCALE

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Recently amorphous Si and a-Si based alloys have been widely studied and utilized in micro- and optoelectronic devices. The new generation of these devices (thin film transistors, single electron transistor, etc.) require p- or n-type doped active channels with high level of concentration and concentration variation control. Antimony (Sb) is the most frequently used n-type dopant. Thus the knowledge of diffusion mechanisms and data is highly desired for understanding the physical properties of this material. Although the diffusion of Sb in crystalline Si is widely studied, little known about diffusion in amorphous silicon. In our work the diffusion and transformation processes in amorphous Si_{1-x} Sb_x mono-, Si/$Si_{1-x}Sb_x$/Si tri- and Si/$Si_{1-x}Sb_x$ multilayers–systems with different composition (x=5-26 %) were investigated. After annealing the samples, the most interesting result was that under hydrostatic pressure (100 bar - 4,7 kbar Ar) in the Si/SiSb/Si trilayers (and only in this type of samples and only under hydrostatic pressures) the SiSb layer underwent a spinodal-like decomposition, resulting in three Sb-rich stripes parallel to the interfaces [1]. The transformation at given temperature strongly depended on the initial Sb concentration of the SiSb layers and the applied hydrostatic pressure. No such stripes could be detected when the samples of the same geometry and composition were annealed in vacuum.

In our next experiments the concentration of Sb in the samples was reduced to 5 % to avoid the fast crystallization and decomposition in the SiSb layer. Secondary Neutral Mass Spectrometry (SNMS) has been applied to measure the distribution of Sb in as-deposited and heat treated films. In order to detect the possible crystallization and structural transformation processes of the samples Transmission Electron Microscope (TEM) measurements were carried out. The SNMS measurements showed that no concentration changes take place during the annealing of the series of samples in vacuum at temperatures 723 K, 773 K and 823 K for different times. We also found that sample with 5% Sb concentration annealed lower then 823 K remains in amorphous state [2]. From the time evaluation of SNMS concentration profile $D_{Sb} = 1{\cdot}10\ m^2/s$ diffusion coefficient was calculated for Sb diffusion in amorphous Si at 823 K [3]. To get information for the temperature dependence of diffusion coefficient we carried out the annealing of the same samples at higher temperatures range (873-1023 K). Unfortunately, as it can be seen from TEM pictures, the samples annealed at 873 K in vacuum and under 100 bar Ar pressure for 5 hours crystallizes. It can be clearly seen that small crystals appears at 873 K and sample annealed 150 K higher shows a fully crystallized state.

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