Dangling Bonds Parameters Effect on Dark and Illuminated Conductivity in a-Si:H Absorber Layer for Solar Cells Applications

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Introduction

In this paper, a contribution is made to study the impact ofthe DOS (Density of States) defects in undoped a-Si:H onthe conductivity in the dark and under solar illumination. The quality of this material is the key to the best PV efficiencies reached in the solar cells based on a- Si:H, used as an absorbing layer between two heavily doped regions. There is a strong correlation between the PV output and the quality of this region for an optimal thickness. It has been widely shown that PECVD and HWCVD techniques lead to a growth of silicon with a high density defects in its forbidden band and usually described by two decreasing exponential distributions for the valence and the conduction band tail (BT) and two correlated Gaussian distributions for deep defects introduced by dangling bonds (DB). It's in this perspective, we shall investigate the contributions of certain types of DOS defects with direct impact on undoped a-Si:H conductivity by means of computer modeling schemes requesting the solution of the basic semiconductor equations which are the hole and electron continuity equations and Poisson's equation according to the Schrafetter and Gummel model scheme [1].

Theoretical Study

The density of states (DOS) is important for the calculation of the electrical and optical properties of the material. The usual DOS model in the amorphous silicon shown in figure 1 is used to describe the U-shape distribution of the states inside the forbidden band-gap [2,3]:

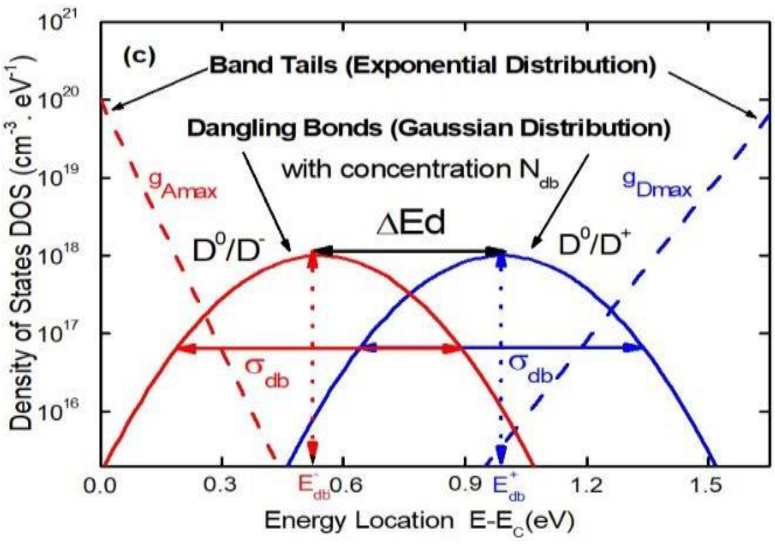

Fig. 1 Density of States (DOS) in the gap of the a-Si:H.

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Results and Discussion

The dark or illuminated conductivity (Fig.2) is at a minimum when the overlap is total with the smallest standard deviation value of 0.05 eV which is relative to the largest value of the total density Ndb equal to 5.10^{16} cm^{-3} of DB resulting in a high trapping efficiency. This conductivity increases with the increase of ΔEd and thenin this case the states D^+ and D^- moved away from the middle of the gap.

For 0 ≤ ΔEd ≤0.4 we remark a proportional evolution of σdb and ΔEd which led to an increase of conductivity this increase can be interpreted by two simultaneous phenomena the recovery of the distributions of the dangling bonds states N_{DB}^{-} acceptors and N_{DB}^{+} donors when σdb increasesthe increase in the energy difference between the centers D^+ and D^- which is ΔEd has led the traps to move away from the middle of the forbidden band and the probability of capture of an electron or a hole by a center D^0 decreases, it follows that the level of fermi Ef is pushed back to the Ec level.

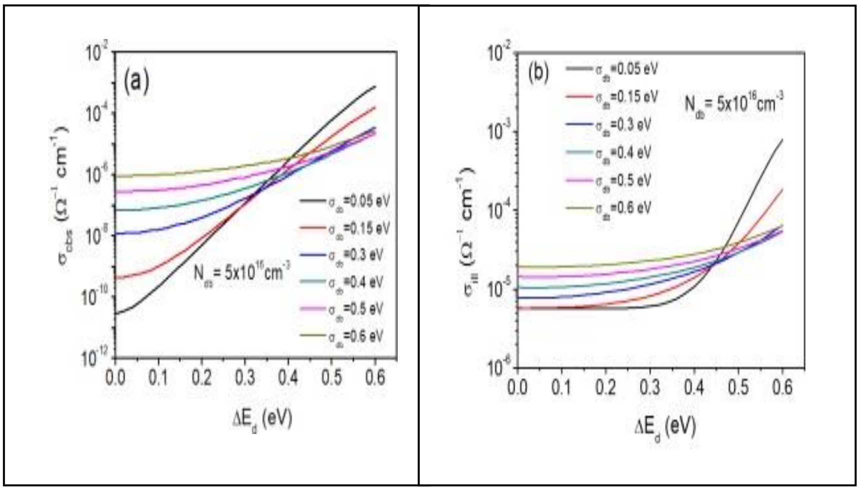

Fig.2. Variation of the conductivity as function of correlation energy for different standard deviations σdb: (a) without illumination. (b) under illumination.

Conclusion

The parameters of the dangling bonds have a directimpact on the quality of a-Si:H layer for PV applications.

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