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CHANGES IN THE OPTICAL PROPERTIES OF AMORPHOUS SiCx:H INTRINSIC AND PHOSPHORUS-DOPED LAYERS BY ANNEALING AT HIGH TEMPERATURES.

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Abstract – This paper deals with changes in the optical properties of the carbon layers of hydrogenated amorphous silicon (a-SiCx: H) 300 and 100 nm thick. For the confirmation of the presence of nonocristales formed randomly and the change of amorphous to crystalline layers of a-SiCx:H intrinsic and phosphorus-doped was used in-situ measures during annealing process by equipment XRD at 900 ºC (fig 1) and verified with the FTIR spectrum (fig 2) From the fitting of the experimental curves with the model of Lorentz oscillators, the refractive index and the extinction coefficient of the different layers were obtained.

By annealing thin hydrogenated amorphous silicon carbide (a-SiCx:H) films deposited by Plasma Enhanced Chemical Vapor Deposition (PECVD) on crystalline silicon (c-Si) wafers, pn-junctions with very low inverse saturation current can be formed. This has been shown in heterojunction bipolar transistors [1] and solar cells [2]. Also, for thin film transistors applications a-SiCx:H layers have been deposited by PECVD at low temperatures and then annealed using solid-phase crystallization (SPC), either at medium temperatures (≈600 degrees Celsius) during a long time (20–60 hrs) or at higher temperatures (≈1000 degrees Celsius) during short times in a rapid thermal annealing (RTA) [3]. The characterization of the annealed structures indicates that the a-SiCx:H films partially recrystallize during the annealing process forming Si-nanocrystals embedded in the amorphous film. To better understand this process and to further improve pn-junction we are studying the recrystallization process by X-Ray Diffraction (XRD) measurements and optical transmission measurements in the infrared (FTIR).

Both, intrinsic and phosphorus-doped a-SiCx:H were deposited on a c-Si substrate type-p of 300um-thick and crystallographic orientation <100> with a cylindrical parallel plate PECVD reactor. The parameters of the deposition were a pressure of 350mTorr, a substrate temperature at 400 degrees Celsius, and a 13.56MHz radio frequency power of 60mWcm-2. For the confirmation of Si-nanocrystals formed randomly and the change of amorphous to crystalline layers of a-SiCx:H intrinsic and phosphorus-doped was used in-situ measures of the peak at 2(theta)=27 during annealing process with SPC during 15 hrs, using an equipment X-ray diffraction (XDR) with camera temperature at 900 degrees Celsius.

The presence or absence of Si-nanocrystals changes the optical properties of the a-SiCx:H/c-Si samples is verified by the measurements of the transmission spectrum using fourier transform infrared spectroscopy equipment (FTIR) in the range of 1500–9000 cm-1. From the fitting of the FTIR transmission spectra using the model of Lorentz Oscillators, the refractive index (n) and the extinction coefficient (k) of the different layers are calculated in the range of 1500-9000 cm-1.

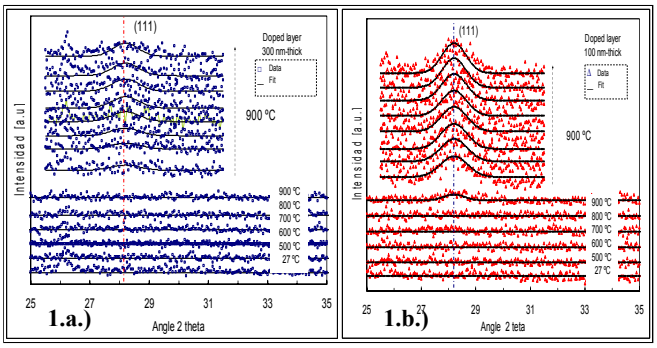

Figure 1: In-situ measures with equipment X-ray diffraction (XDR) at 900 degrees Celsius of the Confirmation the change of amorphous to crystalline layers of a-SiCx:H intrinsic and phosphorus-doped. **a)** Layer 100nm-thick **b)** Layer 300nm-thick

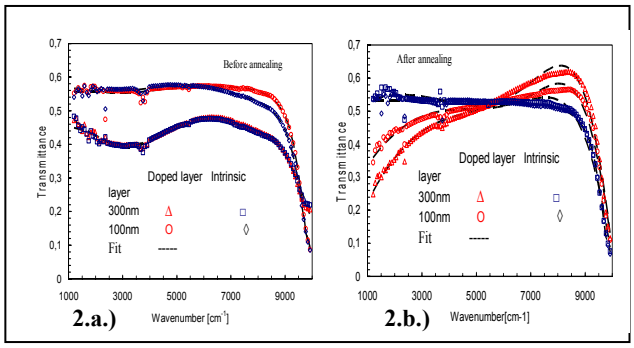

Figure 2: Measured and fitted transmittance FTIR spectra of the a-SiC$_x$:H/c-Si intrinsic and phosphorus-doped layers. **a)** Before annealing and **b)** after annealing

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