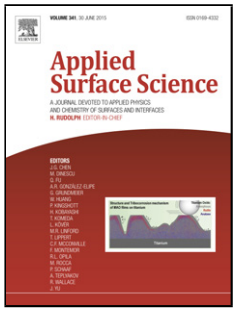

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PII: S0169-4332(16)31894-3
DOI: http://dx.doi.org/doi:10.1016/j.apsusc.2016.09.026
Reference: APSUSC 33954

To appear in: *APSUSC*

Received date: 8-8-2016
Revised date: 7-9-2016
Accepted date: 8-9-2016

Please cite this article as: L.Serenelli, L.Martini, L.Imbimbo, R.Asquini, F.Menchini, M.Izzi, M.Tucci, Metastability of a-SIOX:H thin films for c-Si surface passivation, Applied Surface Science http://dx.doi.org/10.1016/j.apsusc.2016.09.026

<AT>Metastability of a-SIO$_X$:H thin films for c-Si surface passivation

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<ABS-Head><ABS-HEAD>Graphical abstract
<ABS-P>
<ABS-P><xps:span class="xps_Image">fx1</xps:span>
<ABS-HEAD>Highlights► a-SiO$_x$:H film deposition by RF-PECVD is optimized from SiH_4, CO_2 and H_2 gas mixture. ► Metastability of a-SiO$_x$:H/c-Si passivation is investigated under thermal annealing and UV exposure. ► A correlation between passivation metastability and Si-H bonds is found by FTIR spectra. ► A metastability model is proposed.
<ABS-HEAD>Abstract
<ABS-P>The adoption of a-SiO$_x$:H films obtained by PECVD in heterojunction solar cells is a key to further increase their efficiency, because of its transparency in the UV with respect to the commonly used a-Si:H. At the same time this layer must guarantee high surface passivation of the c-Si to be suitable in high efficiency solar cell manufacturing. On the other hand the application of amorphous materials like a-Si:H and SiN_x on the cell frontside expose them to the mostly energetic part of the sun spectrum, leading to a metastability of their passivation properties. Moreover as for amorphous silicon, thermal annealing procedures are considered as valuable steps to enhance and stabilize thin film properties, when performed at opportune temperature. In this work we have explored the reliability of a-SiO$_x$:H thin film layers surface passivation on c-Si substrates under UV exposition, in combination with thermal annealing steps. Both p-and n-type doped c-Si substrates have been considered. To understand the effect of UV light soaking we have monitored the minority carriers lifetime and Si-H and Si-O bonding, by FTIR spectra, after different exposure times to light coming from a deuterium lamp, filtered to UV-A region, and focused on the sample to obtain a power density of 50 μW/cm^2. We have found a certain lifetime decrease after UV light soaking in both p- and n-type c-Si passivated wafers according a a-SiO$_x$:H/c-Si/a-SiO$_x$:H structure. The role of a thermal annealing, which usually enhances the as-deposited SiO_x passivation properties, has been furthermore considered. In particular we monitored the UV light soaking effect on c-Si wafers after a-SiO$_x$:H coating by PECVD and after a thermal annealing treatment at 300°C for 30 minutes, having selected these conditions on the basis of the study of the effect due to different temperatures and durations. We have correlated the lifetime evolution and the metastability effect of thermal annealing to the a-SiO$_x$:H/c-Si interface considering the evolution of hydrogen in the film revealed by FTIR spectra, and we have developed a kind of model for the effect of both treatment on the Si-H bonding and the metastability shown in the lifetime of a-SiO$_x$:H/c-Si/a-SiO$_x$:H structure. We have found that after UV exposure thermal annealing steps can be used as a tool for the c-Si passivation recovery and enhancement.
<KWD>Keywords: a-SiO$_x$; PECVD; passivation; metastability; thermal annealing; FTIR

<H1>1 Introduction
The PV global market trend is to reduce costs per Watt adopting the most cost-effective technologies. Crystalline silicon based solar cells are the most produced, basically on p-type doped silicon wafers, even if n-type is increasing its market share [1]. The reason of this