Density of State Measurements of Hydrogenated Microcrystalline Silicon Carbon Alloy Thin Films Using Fourier Transform Photocurrent Spectroscopy (FTPS)

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ABSTRACT: Hydrogenated microcrystalline silicon carbon alloys (μc-$Si_{1-x}C_x$:H) could be promising candidates to expand the toolbox of useful materials for thin-film photovoltaic devices. μc-$Si_{1-x}C_x$:H samples were deposited by standard Radio Frequency Plasma Enhanced Chemical Vapour Deposition from a silane and methane gas mixture, highly diluted in hydrogen. In the search for the optimal deposition conditions for the development of this new class of materials, a study of the defect-sensitive electrical properties using photocurrent method was performed. The impact of different deposition conditions on the resulting material properties was investigated by means of Fourier Transform Photocurrent Spectroscopy (FTPS). Experimental results obtained through FTPS are used to model the density of states of μc-$Si_{1-x}C_x$:H samples.

RESULTS :

To study the influence of deposition conditions on the growth of μc-$Si_{1-x}C_x$:H alloys, three sets of samples were deposited. For each set, the independent variation of one deposition parameter was investigated. In Table 1 the crystalline volume fraction (f_c), the total carbon-silicon ratio (R), and the average grain size (δ) are listed, with respect to the variation of deposition parameter in each set. In this work three samples with similar f_c were studied in order to establish a possible correlation between their different microstructures and their electrical properties. Interference free FTPS [2] measurements were performed to determine true absorption coefficient, α. The absorption spectra we obtained were used to numerically model the density of states (DOS) profile of the samples, as presented in Fig. 1. We have found that materials with similar crystallinity fractions could present very different densities of states. The more promising materials for future photovoltaic applications seems to be the one deposited with a RF power of 113 $mWcm^{-2}$ and a CH_4 flow rate of 1.2 sccm.

Table 1. Deposition conditions and the resulting R, f_c, and δ for each given set.

Sample		Structure	*R=[C]/[Si]*	f_c(%)	δ (Å)
SET $_{wRF}$	113 $mWcm^{-2}$	μc	0.04	65	115
	226 $mWcm^{-2}$		0.10	25	60
	339 $mWcm^{-2}$	Amorphous	0.13	0	0
SET $_{SiF4}$	0.0 sccm	μc	0.10	25	60
	0.5 sccm		0.07	40	70
	1.0 sccm		0.06	50	80
SET $_{CH4}$	1.0 sscm	μc	0.06	65	80
	1.2 sccm		0.10	25	60
	1.6 sccm	Amorphous	0.17	0	0
	1.8 sccm		0.20	0	0

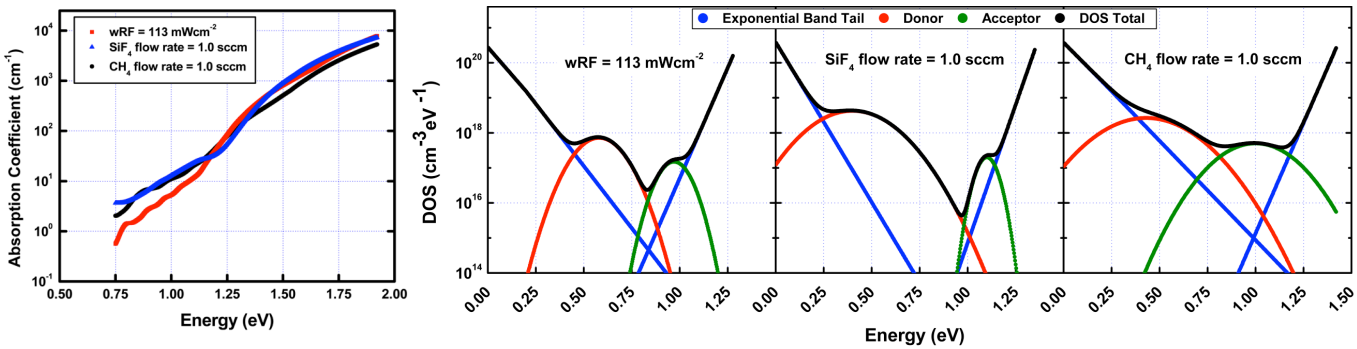

Figure 1. (Left) Absorption spectra from FTPS experiment **(Right)** DOS models for samples with similar f_c

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