

The chemical information evaluation of hydrogenated amorphous carbon films by XPS and NEXAFS at different thicknesses

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[Background] The hydrogenated amorphous carbon films (*a*-C:H) consist of two bonding structures: sp^2 and sp^3 hybridizations, which represent the graphite and diamond structures. Both structures control the physical, electrochemical and mechanical properties. However, the thickness is one of the parameters which improve such properties in this study. The X-ray photoelectron spectroscopy (XPS) and near-edge X-ray absorption fine-structure (NEXAFS) spectroscopy were selected for analyze the surface chemical information of films, which are excellent tools for evaluation the relative sp^2 and sp^3 contents in amorphous carbon films, especially, used the soft X-ray synchrotron light source. Therefore, the aim of this work was studied the chemical information of *a*-C:H films at different thicknesses.

[Experimental] The *a*-C:H films were deposited on *p*-type Si (100) substrates at different thicknesses by a radio-frequency plasma-enhanced chemical-vapor-deposition technique (rf-PECVD), using the benzene (C_6H_6) and hydrogen gas (H_2) as precursors. The XPS and NEXAFS were performed to characterize the chemical bonding information of *a*-C:H films, using the soft X-ray synchrotron light source at BL 3.2a end-station of the Synchrotron Light Research Institute (Thailand), was generated at 1.2 GeV. Moreover, the photocurrents of the samples were detected by a gold mesh in the total electron yield mode (TEY) for this work.

[Results & Discussion] As the results, it was found that the features of XPS spectra had similarities to all samples. The XPS spectra of C 1s peaks of *a*-C:H films were deconvoluted into three peaks at about 284.0, 285.0 and 287.5 eV, which represented to C-C sp^2 (graphite), C-C sp^3 (diamond) and C-O or C=O (contamination) bonds. XPS spectra were the strong peaks (C-C sp^2 and sp^3 bonds) dominated in the amorphous carbon films while other weak peaks (C-O or C=O bonds) might be attributed to the contamination from the air exposure and deposition process. In addition, the two main features were identified in the C K-edge NEXAFS spectra of *a*-C:H films as shown in Fig.1; at ~ 284 eV of photon energy associated to $1s \rightarrow \pi^*$ states (C-C bonds) from sp^2 hybrids while at ~ 293 eV related to $1s \rightarrow \sigma^*$ (C-C bonds) transitions from sp^2 and sp^3 hybrids (broad band or amorphous carbon), whereas as in the range of 286 to 290 eV that assigned to $1s \rightarrow \sigma^*$ (C-H bonds). However, it could be contributed the intermixing between sp^2 and sp^3 hybrids at ~ 287 eV but it is not clear. Finally, the XPS and NEXAFS techniques illustrated the surface chemical information of *a*-C:H films at different thicknesses.

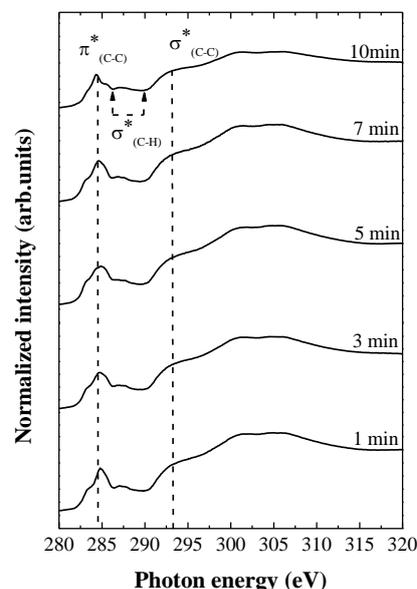


Fig. 1 C K-edge NEXAFS spectra of *a*-C:H films at different thicknesses.