A Study into the Effect of Plasma Processing Parameters and Post Deposition Treatments on Low Fouling Plasma Polymer Films

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The performance of many biomedical, drug delivery, biosensor and biomedical imaging based devices are critically dependent on their protein resistant properties, and while poly(ethylene glycol) (PEG) based materials are commonly used for this purpose, the mechanism of the protein repellent properties remains an area of ongoing contention.

To analyse the effect of certain processing parameters on the chemical structure and composition of diethylene glycol dimethyl ether (DG) plasma polymer (pp) thin films and to observe any chain structuring within the films, NEXAFS was performed using beamline 24A1 at NSRRC, Taiwan. Spectra were recorded for both the C and O K-edge energy ranges with a photon incidence angle of both 90° and 45° wrt the surface normal. Analysis of the C and O K-edge NEXAFS spectra' show three and two main peaks respectively, and by comparison with the literature, peaks have been assigned to their relevant pi and sigma resonances (Table 1).

C 1s peaks	Energy (eV)	peak assignment
1	286.3	C=C; C=O π*
2	287.8	CH π*
3a	289.9	C-O; C-C
b	290.8	" "
O 1s peaks		
1a	532.0	C=O π*
b	532.6	" "
2	539.5	C-O σ*

Table 1. C 1s and O 1s NEXAFS peak assignments

The C K-edge NEXAFS spectra' of the DGpp films show that films deposited under higher plasma load power (plp), result in a higher level of unsaturation. Furthermore, the broader sigma resonance peak at ~290.8 eV (C-C;C-O σ*), appears as an unresolved doublet with the two components (a and b), appearing at approximately 289.9 and 290.8 eV. The intensity of component b shows a general decrease in films deposited under a higher plp.

A large difference in intensity of the two π* resonance peaks (Figure 1), in the C K-edge spectra of the 5W DGpp film analysed at grazing and normal incidence, suggest that the chains of the DGpp may be oriented on the surface. This is a significant finding and has not been reported previously to the best of our knowledge.

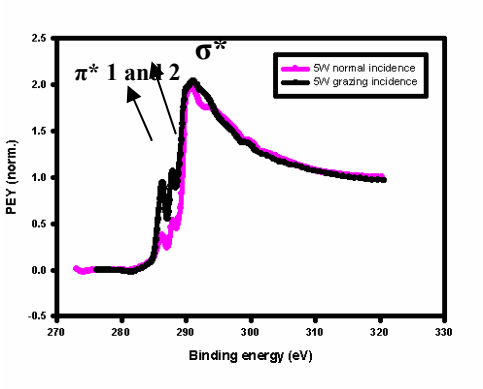

Figure 1. C K-edge NEXAFS spectra taken at normal and grazing incidence (90 and 45 degrees respectively)

Two main peaks are evident from the O 1s spectra's of the DGpp films (Figure 2). The first peak, attributed to the resonance of C=O π* transitions, appears as a doublet. The intensity of component a**,** peak 1 increases in films deposited under higher plp, and is associated with a systematic decrease in intensity from the higher energy component b. It is assumed that this peak is highly influenced from the ether component of the DG films, since we have seen from previous XPS and FTIR studies that films deposited under lower plp retain a higher level of the original monomer structure.

Follow up experiments are planned to confirm the appearance of orientation in the films by utilizing a polarized beam and preparing thicker samples. It is expected that a publication will be written from this work once it has been repeated and validated.

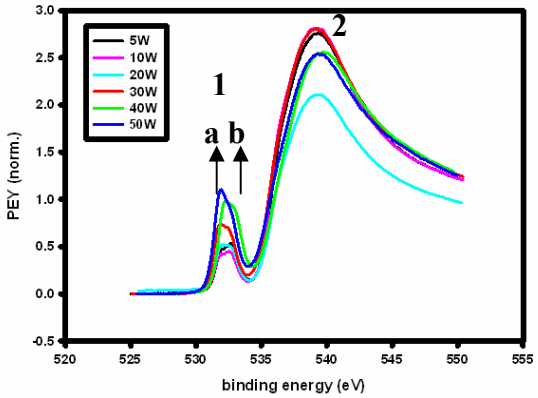

Figure 2. Overlay of O K-edge NEXAFS spectra of DGpp