

Spectroscopic ellipsometry investigation of amorphous carbon films with different fraction of sp³ bonds: relation with protein adsorption

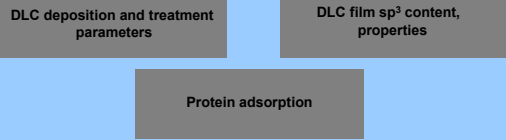
M. Vinnichenko, R. Gago, N. Huang¹, Y.X. Leng¹, H. Sun¹, U. Kreissig, M.P. Kulish², and M.F. Maitz
¹College of Materials Science and Engineering, Southwest Jiaotong University, Chengdu 610031, China
²Physics Department, Kyiv Taras Shevchenko University, 64 Voldymyska St., Kyiv 01033, Ukraine

Background and Motivation

Diamond like carbon (DLC) thin films possess high mechanical hardness, chemical inertness, and good biocompatibility
 Protein - DLC surface interaction determines the biocompatibility and it is not properly addressed in the literature
 sp³ bonds fraction and hydrogen content determine the properties of DLC
 Both protein adsorption and variation of bonding structure in the DLC film are known to change optical response of its surface, therefore they can be probed by spectroscopic ellipsometry (SE)

Objective

Investigation of the relation between:



Film Deposition

- Ion beam assisted deposition (IBAD)
- Filtered Cathodic Vacuum Arc (FCVA)
Deposition at temperatures from 50 to 400°C to obtain different sp³ content

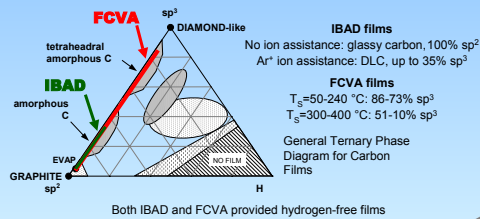
Surface Treatment

- Plasma Immersion Ion Implantation: Argon (RF, 15min, 300W, substrate bias -500V)

Analysis

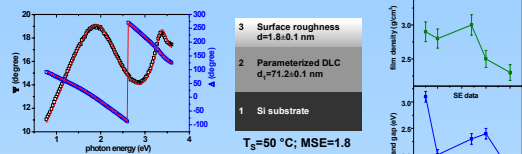
- Bonding Structure and Composition: SE, Raman Spectroscopy, Elastic Recoil Detection Analysis (ERDA)
- Roughness: Atomic Force microscopy (AFM)
- Protein Adsorption: enzyme linked immunosorbent method and in situ ellipsometry

Film Composition



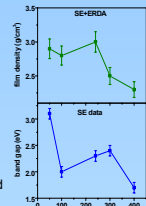
Spectroscopic Ellipsometry Data Analysis

Parametric semiconductor model (WVASE)

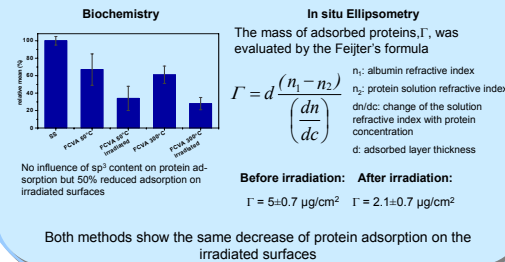


The WVASE model (center) provides a good fit for the measured ellipsometric parameters (left).

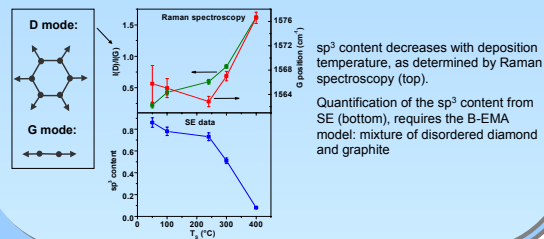
The films can be characterized by density and band gap with this model (right)



Protein Adsorption



Bruggeman Effective Medium Approximation (B-EMA)



Conclusions

- Spectroscopic ellipsometry can be used to monitor sp³ content, band gap values and surface roughness of DLC films
- The sp³ content of a DLC film produced by FCVA sharply decreases with deposition temperature above 250°C (it is accompanied with a change of DLC band gap and the film density)
- In situ ellipsometry for quantification of protein adsorption is in good correlation with biochemical methods
- The amount of adsorbed proteins is not influenced by the sp³ content of the DLC film

Acknowledgements

Dr. T. Dekorsy (FZR, Germany) for help with Raman spectroscopy
 Dr. A. Ferrari (University of Cambridge, UK) for useful suggestions on analysis of DLC optical data.
 Mr. A. Reichel (FZR, Germany) for assistance with Ar ion treatment of the samples
 This work was financially supported due by YS INTAS Grant 01/2-113