

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

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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:

DLC deposition and treatment parameters

DLC film sp³ content, properties

Protein adsorption

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

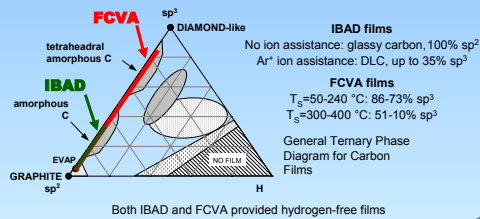
Surface Treatment

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

Analysis

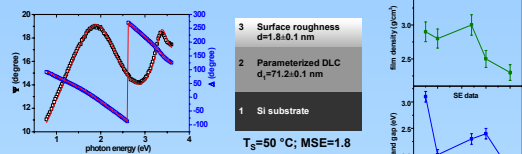
- Bonding Structure and Composition: SE, Raman Spectroscopy, Elastic Recoil Detection Analysis (ERDA)
- Roughness: Atomic Force microscopy (AFM)
- Protein Adsorption: enzyme linked immunosorbent method and in situ ellipsometry

Film Composition



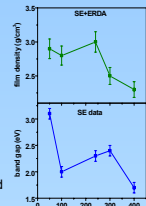
Spectroscopic Ellipsometry Data Analysis

Parametric semiconductor model (WVASE)

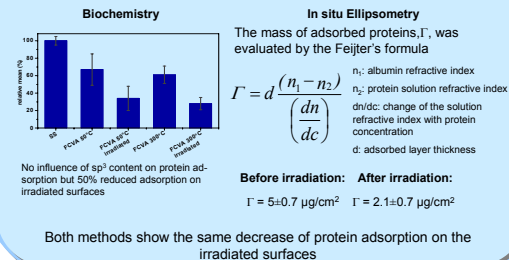


The WVASE model (center) provides a good fit for the measured ellipsometric parameters (left).

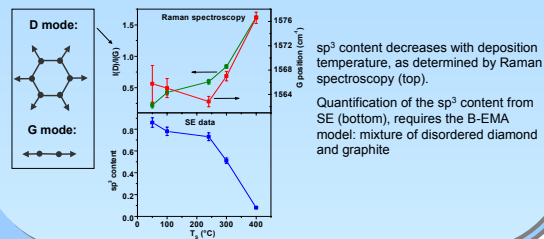
The films can be characterized by density and band gap with this model (right)



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

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