Synthesis and Characterization of Amorphous Carbon Film for Potential Application in Cell Culture

W.Intatue[1],* and D.Boonyawan[1]

[1,2]Plasma and Beam Physics Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand

*** Corresponding author. E-mail: mk446.wat@gmail.com**

Abstract

Plasma enhanced chemical vapor deposition (PECVD) is the method of thin films coating for modification of surface material properties which can be applied to electronics, medicine and bioscience. This research aim to synthesize amorphous carbon film for cell culture applications by PECVD technique at different plasma conditions. Plasma generated from gas mixture between acetylene and 10% ammonia with various rf power and total pressure. Before the amorphous carbon film synthesis process, we investigated self-made PECVD reactor by a single Langmuir probe to determine plasma parameters of the system. In this work, the operating rf power ranged from 20 to 80 W and gas pressure varied from 100 to 200 mTorr. Contact angle measurement technique was used to characterize the film. The results showed that electron temperature increases when rf power increased, but electron temperature decreases if gas pressure increased. Certainly, electron density and ion density increase when rf power and pressure increased.

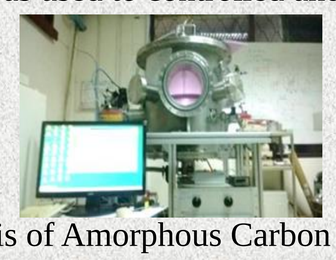
Introduction

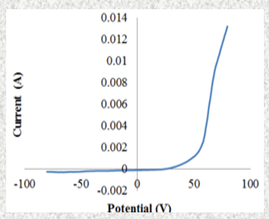
Due to PECVD technique have compatibility in biological and non-toxicity with a good adhesion ability for cell. Thus, this technique is proper to synthesis of amorphous carbon film. Before coating film, we necessary to know the relation of plasma parameter (i.e. electron temperature electron density and ion density) of PECVD system. So, the single Langmuir probe technique was used because this technique is high resolution. For coated films, the films properties (“Hydrophilic” or “Hydrophobic) was analyzed by contact angle technique that this technique is convenience to check the phase contact between liquid and solid substances.

Materials and Methods

1. Measurements of the Plasma Parameters by Single Langmuir Probe

The plasma of Argon gas was generated by PECVD reactor in order to measure the plasma parameters using a single Langmuir probe technique. At controlled parameter, operating rf power was set between 20 to 80 W and gas pressure was varied from 100 to 200 mTorr. And the probe connected to electronic system which applied electric potential and its electronic system connected to interface card PC 74 within computer. The ESPsoft software was used to controlled and analyze plasma parameters.





2. Synthesis of Amorphous Carbon Films

Diameter of 35 mm of Polystyrene polymer dish coated by amorphous carbon film. At different plasma conditions are fixed gas mixture feeding between acetylene and ammonia (10%) and are varied rf power at 100 - 200 W, total pressure at 50 – 200 mTorr and time for 5 – 20 minute. After that, analysize the “Hydrophilic” or “Hydrophobic” properties of amorphous carbon film by contact angle technique. That we used micropipette to drop the DI water of 20 µl on the surface of polystyrene polymer samples to check the phase contact between liquid and solid substances.

Results and Discussion

1. Results of Plasma Parameter by Single Langmuir Probe

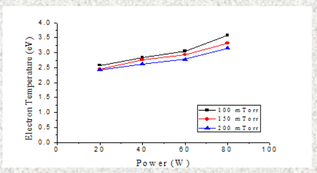


Figure 1. The electron temperature versus the rf power ranging from 20 to 80 W of plasma argon.

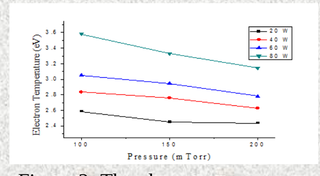


Figure 2. The electron temperature versus the pressure ranging from 100 to 200 mTorr of plasma argon.

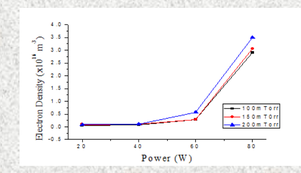


Figure 3. The electron density versus the power ranging from 20 to 80 W of plasma argon.

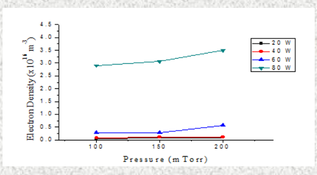


Figure 4. The electron density versus the pressure ranging from 100 to 200 mTorr of plasma argon.

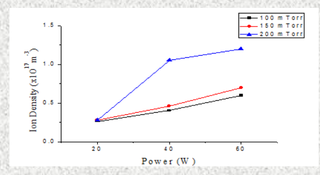


Figure 5. The ion density versus the power ranging from 20 to 80 W of plasma argon.

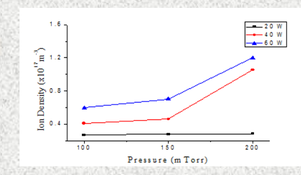


Figure 6. The ion density versus the pressure ranging from 100 to 200 mTorr of plasma argon.

Electron temperature increase from 2.58 - 3.58 eV with rf power increased from 20 to 80 W and decrease from 3.58 to 2.43 eV with total pressure increased from 50 to 200 mTorr. Electron density and ion density increase in ranging 4.75 x 10^{14} – 3.49 x 10^{16} m^{-3} and 2.66 x 10^{16} – 1.5 x 10^{17} m^{-3}, respectively. With rf power and total pressure increased.

2. Results of Contact Angle

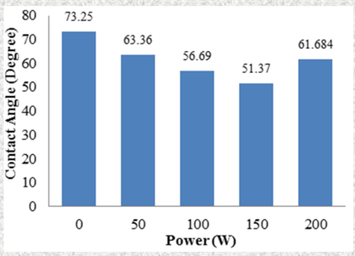


Figure 7. Water contact angle of plasma treated gas mixture between C2H2 and NH3 at pressure 100 mTorr, rf power from 0 to 200 W and 5 minute.

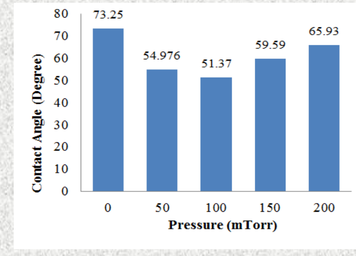


Figure 8. Water contact angle of plasma treated gas mixture between C2H2 and NH3 at rf power 150 W, total pressure from 0 to 200 mTorr and 5 minute.

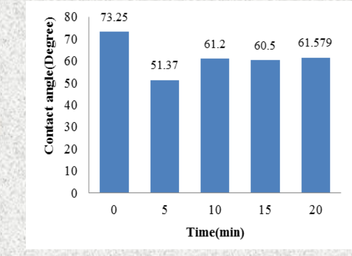


Figure 9. Water contact angle of plasma treated gas mixture between C2H2 and NH3 at pressure 100 mTorr, rf power 150 W and time from 0 to 20 minute.

From above the graphs showed that polymer styrene samples is hydrophilic at rf power 150 W, total pressure 100 mTorr and 5 minute.

Conclusions

In this study, plasma parameter using a single langmuir probe indicate the electron temperature increased with rf power increased but it decreases with gas pressure increased. Electron density and ion density increase with rf power and pressure increased.

In addition, polystyrene polymer sample is hydrophilic at rf power 150 W, total pressure 100 mTorr and time for 5 minute. And this is the proper condition of coating amorphous carbon film in application of Cell Culture.

Acknowledgments

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