GROWTH OF DLC FILM IN A METALLIC TUBE WITH HIGH ASPECT RATIO

E. J. D. M, Pillaca*[1], Jesus Manuel Gutierrez Bernal[2] and Vladimir J. Trava-Airoldi[1]

[1]*Sensor and Materials Associated Laboratory, National Institute for Space Research, S. J. Campos, São Paulo, Brazil*
[2]*Universidad Nacional de Colombia, Facultad de Ingeniería, Colombia.*

1. Introduction

PECVD is a well-established method for the growth of DLC films on substrates with complex shapes, in a fast and efficient way [1]. By this technique, thick layers of DLC are coated on the surfaces of mechanical components. However, it was pointed out in the literature that plasma-based treatments inside pieces with hollow cylindrical geometry, such as pipes or tubes result quite difficult to be performed [2]. On the other hand, plasma-based coatings on the tube interior are usually restricted to be performed inside of a vacuum chamber. This limit the treatment of tubes with long length, considering that a vacuum chamber with higher dimension than the tube itself is required; in practice, it becomes expensive from the economic viewpoint. This situation has led to the use of the tube as a deposition chamber. Under this idea, the system shown in Fig. 1 was constructed aiming the use of a Stainless Steel (AISI 304) tube with high aspect ratio (200 cm in length and 10 cm in diameter) as a deposition chamber. So, in this work is reported the results of the study of the longitudinal distribution of DLC film coated on the inner surface of the tube. Issues such as current discharge, gas flow and temperature were studied too.

2. Experimental

For the characterization of the surface coated, five samples of AISI 304 were longitudinally distributed on the inner surface of the tube. The coating was performed by using the Plasma enhanced Chemical Vapor Deposition (PECVD) process and the acetylene gas, as precursor. The system was pumped down to a base pressure of the order of 10^{-4} Torr by a set of mechanical and diffusion pump. The discharge is carried out by a bipolar pulsed voltage feed. The pulse width, the repetition rate, the voltage and the working pressure were kept constant during all experiments at 15 µs, 21 kHz, 500 V and 70 mTorr, respectively.

3. Results and Discussions

Our measurements of current have shown the presence of a low discharge current. This result, in particular, it is interesting for DLC growth (thermal viewpoint) due that the ion impact on the inner wall of the tube has caused temperatures less than 50 ^{o}C. Growth of DLC film was carried out on the inner wall of the tube. Amorphous carbon hydrogenated (a-C:H) films were obtained. Raman analysis performed on the coated surface confirmed the presence of DLC film with good quality. However, it was not uniform along its longitudinal distribution.

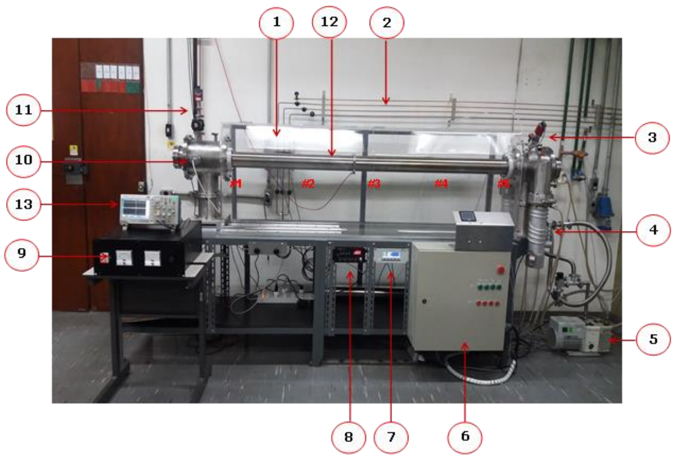

Fig. 1. Photograph of the system used as a deposition chamber for the growth of DLC film. The numbers in the circle indicate the components of the system; 1. Mass flow controller; 2. Gas line; 3. Pirani gauge; 4. Diffusion pumps; 5. Mechanical pump; 6. Electric control module; 7. Vacuum measurement; 8. Flow control module; 9. High voltage source; 10. Gas inlet; 11. Baratron; 12. Tube; 13. Oscilloscope. The typographic sign #1, #2, #3, #4 and #5 indicate the location of samples inside of the tube.

4. References

[1] K. Choy, Progress in Materials Science 48 (2003) 57.
[2] T. E. Sheridan, J. Appl. Phys. 80 (1996) 66.

Acknowledgments
This work was supported by grant #15/09781-0, São Paulo Research Foundation, FAPESP.

* mitma.elver@gmail.com