# AN OVERVIEW OF MODIFIED PECVD TECHNIQUE FOR DLC GROWTH AND ITS NEW AREAS OF RESEARCH AND APPLICATION

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## 1. Introduction

DLC as an amorphous hydrogenated carbon (a-C:H) films have been used as protective coatings in many applications due to their superior properties such as: low coefficient of friction, high chemical inertness, high hardness, high wear resistance, biocompatibility, and bactericide (1,2). However a very big challenge is to overcome the residual stresses that form during the growth process and at the same time to obtain high adhesion between the DLC and the different substrates materials, like pure metals and their alloys. The PECVD technique modified with the addition of a cathode with the function of promoting confinement of electrons and ions in a plasma discharge was shown to be feasible for studies of the reduction of residual stresses. The residual stresses that form inside of the DLC films structure can be significantly reduced by using this PECVD technique, as well as showed, also, to be a prosperous technique to achieve high adhesion of DLC film on most metal substrates surface (3). Also, this non conventional PECVD technique is being able to get harder films with less porosity and with lower friction coefficients. This technique proved to be, also, very promising for DLC deposition in the form of multilayers of thicker films. This results refers this technique to other areas of applications, enabling it to the applications in the space, aeronautic, and automotive area, besides to stand out in medical and dentistry areas.

## 2. Experimental

Basically, due to the possibility of operating in very low pressure (< 10-3 Torr) (2), this technique allows to grow DLC film in three dimensions in collision less regime. The operating parameters can be well controlled and allow easily scale studies. In this work will be presented a brief description of the operating principle, as shown in Fig. 1. This additional cathode works as a electron and íons confinement at very low pressure in a collision less regime. In this particular situation the energy of ions generated in the plasma discharge is all used to the ion sub implantation process on the substrat surface, and being primarily responsible for the high adhesion of DLC in most accessed metal substrates. In order to deposit both the interlayer and DLC films, the applied bias voltage can get a variation from a -100V up to – 15 kV.

## 3. Results and Discussions

Due to the ease of control of adhesion and growth parameters of DLC films obtained by this technique it allows to obtain very thick films in multilayer form, as shown in Fig. 2. These multilayers are responsible for low residual stress of the film, in spite of very thick. The thickness of the DLC film as higher as to 10 microns correspond to an alternation of the film of amorphous silicon with the DLC film where the thickness of each layer, as well as, the concentration of silicon and carbon are very well controlled. A summary of the studies related to friction coefficient, total stresses, structural quality, and adhesion, that led to this DLC films growth technique optimization will be presented in detail. In this case, not only thin films, but also thick films depited in multilayers is an important area of new studies and new applications and will be an important part of this work.

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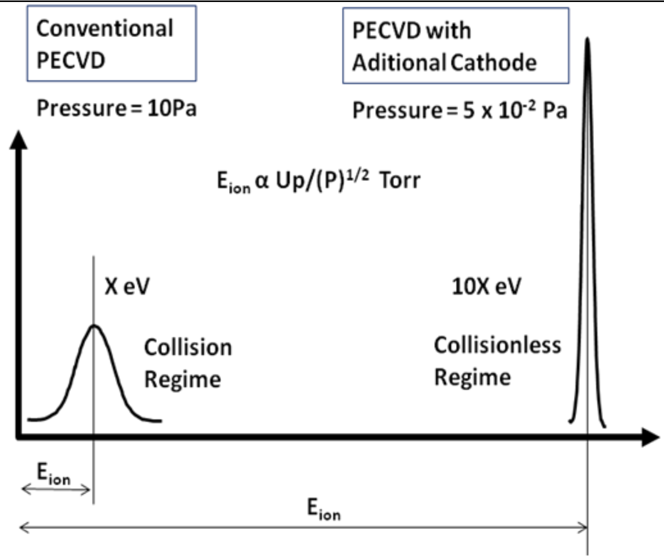


Figure 1. Collisions regime of operation

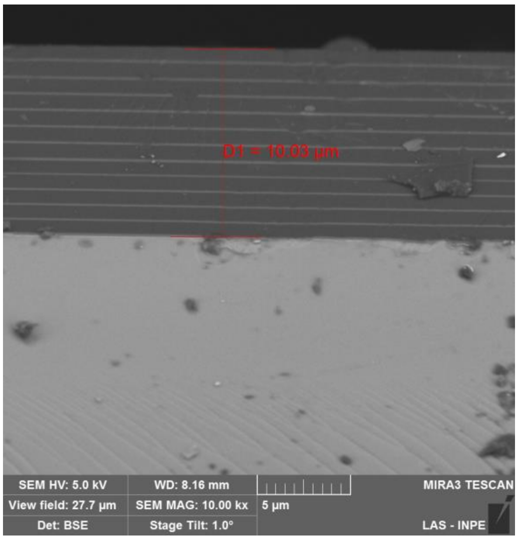


Figure 2. Multilayer DLC films on 316 SS

## 4. References

1 - Grill, A., Meyerson, B., in Syntetic Diamond: Emerging CVD Science and Technology , K. E. Spearand J. P. Dismukes, Eds., John Wiley & Sons, Inc., New York, 1994.
2 - Robertson, J., Material Science and Engineering, Revew Journal, R 37, 129-281 2002.
3 - Capote, G.; Ramirez, M.A.; DA Silva, P.C.S.; Lugo, D.C.; Trava-Airoldi, V.J.. Improvement of the properties and the adherence of DLC coatings deposited using a modified pulsed-DC PECVD technique and an additional cathode. Surface & Coatings Technology, v. 308, p. 70-79, 2016.

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