

## NUMERICAL STUDY OF PECVD PROCESS WITH ACTIVE SCREEN AS AN ADDITIONAL CATHODE TO THE GROWTH OF DLC FILMS

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### 1. Introduction

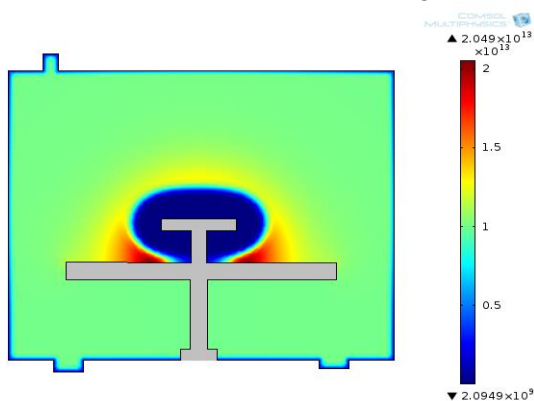
Plasma Enhanced Chemical Vapor Deposition (PECVD) is a well established method for growing DLC films in substrate with complex shape, in a fast and efficient way [1]. By this technique, surfaces of mechanical components are protected, especially, from wear and corrosion due to excellent properties (mechanical, tribology, etc.) that feature this film. However, PECVD owns some disadvantages. Homogeneous deposition is usually difficult to achieve, especially when treating samples of complex shape. The problems arise from the non-uniform plasma density and expansion of plasma sheath. In order to overcome these limitations, we have to look for additional techniques that can generate high plasma density. In particular, an Active Screen (AS) as an additional cathode in the PECVD technique can be used to achieve this goal [2]. In this sense, numerical simulation was carried out in order to study the behavior of plasma in PECVD process and in presence of AS. A hole on top of the AS was prepared to avoid the Faraday cage effect. Furthermore, the plasma density was studied as a function of hole-diameter.

### 2. Numerical Simulation

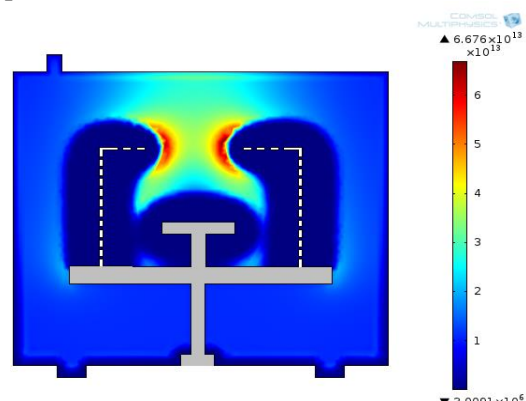
The simulation was performed using the COMSOL computer code in two dimensions. The simulation is based on the actual dimensions of experimental PECVD vacuum chamber, that is, 76cm-length and diameter of 22cm, as shown in Fig. 1. The arrangements of AS is shown in Fig. 2. Their dimension is 11cm-length and diameter of 7.5cm. To evaluate the process, a target with dimension 4.5cm-diameter and 0.6cm-length was simulated. The simulation is started with an argon plasma ( $n_0 = 1 \times 10^{13} \text{ m}^{-3}$ ) at pressure of  $5 \times 10^{-3}$  Torr and pulse voltage of 10 kV.

### 3. Results and Discussions

Our numerical results have shown dependence of the plasma density with the change of the AS hole-diameter. Fig. 2 shows a high plasma density region formed around the target, in relation to the case without AS. This is due to the intense background gas ionization caused by the confined electrons inside of the AS. As a result, the sheath dynamics was significantly affected by the confinement of plasma in front of the target. These results can be beneficial to PECVD process due that the growth rate of film can be enhanced by simple change of hole-diameter of AS. This result is in agreement with the experiment.



**Fig. 1.** Arrangement of PECVD system without active screen.



**Fig. 2.** Arrangement of PECVD system with active screen.

### 4. References

- [1]- Michelmore et al., *Frontiers in physics*, **3**, 1-5, (2015).  
 [2]- Marco R. Ramirez et al., *Surf. & Coat. Tech.*, **284**, 235-239, (2015).

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