PLASMA-SURFACE INTERACTIONS INDUCED BY PULSED CORONA DISCHARGE IN WATER*

Petr Lukes, Martin Clupek, Vaclav Babicky and Pavel Sunka
Institute of Plasma Physics, Academy of Sciences CR
Za Slovankou 3, 182 00 Prague 8, Czech Republic

Pulsed high voltage discharges generated directly in water initiate a variety of chemical and physical effects including the high electric field, intense ultraviolet radiation, overpressure shock waves, and, of particular importance, formation of various chemically active species (OH, H and O radicals, H2O2). These reactive species and physical conditions in turn have been shown to be effective at degrading a variety of organic compounds; in the destruction and inactivation of microorganisms; and also in the modification of surface properties of polymeric materials.

Recent research has showed that plasma chemical activity of electrical discharge in water can be enhanced by the addition of solid particles into the discharge reactor. Several types of materials have been tested such as activated carbon, silica gel, alumina, titanium oxide or zeolites. However, despite observed synergistic effects there is only limited knowledge about the role of these materials in the plasma assisted processes in water. It is apparent, that presence of these materials can affect chemical activity of the discharge in various ways including in addition to the simple adsorption processes also plasma induced catalytical reactions on their surface. Consequently, plasma-surface interactions can also alter the electrical discharge properties through the formation of non-equilibrium surface layers and local electric field at the solid surfaces. These processes were determined important particularly during generation of pulsed electrical discharge in water using ceramic-coated electrodes prepared by thermal plasma spraying. It has been found that characteristics of these discharges strongly depend on type of ceramic material and also chemical composition of the aqueous solution. In the present study, comparison is made for two types of ceramics – oxide (corundum) and silicates (almandine). The possible mechanisms of plasma-surface interactions will be discussed with regard to the polarity of applied power and chemical composition of the aqueous solution.


* Work was supported by the Academy of Sciences of the Czech Republic under contract No. K2043105.

INTRINSIC STRESS OF DLC FILM PREPARED BY RF PLASMA CVD AND FILTERED CATHODIC ARC PVD

Peter C.T. Ha, D.R. McKenzie and M.M.M. Bilek, E.D. Doyle, P.K. Chu
1. School of Physics, University of Sydney, Sydney, NSW, Australia
2. Swinburne University of Technology, Melbourne, Australia
c. Department of Physics and Materials Science, City University of Hong Kong, Hong Kong, China.

Diamond-like carbon (DLC) films frequently exhibit poor adhesion strength and delaminate instantly due to high internal compressive stress [1], as high as 8.5 GPa generated in the film, thus resulting in the limitation of the film. Our recent experimental results suggest a functional relationship between the intrinsic compressive stress and the negative biasing voltage applied to the substrate [2].

For the first time, we have obtained DLC compressive stress data as a function of DC bias voltage for films prepared from the C2H2 RF plasma and we compare them with data obtained from the cathodic arc. Although the deposition rate was different, the DLC deposition rate of the filtered cathodic arc being ~1 nm per sec. while the rate in the RF process is approximately 2 nm per min., a similar trend in the stress-generation and the stress-relief region was observed in both methods of deposition.

The motivation for this study was to establish a coating methodology for DLC that yields a high sp3:sp2 ratio and strong adhesion strength. Such a coating is expected to be hard but not easily delaminated, and would be useful when coated on to steel substrates such as industrial cutting tools, to enhance life performance and cost savings. The preliminary results showed that a thicker DLC film can be obtained by incorporating a lower stress, graphitic layer or a silicon layer.

Reference:

* The extension to this project was funded by the Australian Endeavor Cheung Kong Award 2005 and the Australian Postgraduate Award (Industry) 2002-2004.