

# Generation Of Atmospheric Plasma In The Open-air And Its Application For Chemical Vapor Deposition Of Hard Carbon Films

Hidetsugu Yagi<sup>1</sup>, Hideki Motomura<sup>1</sup> and Masafumi Jinno<sup>1</sup>

<sup>1</sup>*Fculty of Engineering of Ehime University, 3 Bunkyo-cho Matsuyama, Japan*

Recently, process using plasma under atmospheric pressure have been widely researched. The plasma process under atmospheric pressure is expected to be high speed. In this situation, if the process under atmospheric pressure realizes in “the open-air”, the processing system becomes simple, the controllability of substrates such as the processing area and the handling of substrates is improved and the growth rate of the process becomes high in the open-air process. This enhances the availability of plasma process under atmospheric pressure. In this experiment, we deposit diamond and DLC (Diamond-like-Carbon) films by the plasma CVD process under entire open-air condition.

Reactive plasma has been generated under the open air condition by microwave excitation of a downstream flowing mixture of hydrogen and methane. Also, the helium gas was supplied from the periphery of plasma for shielding the plasma from the atmospheric gas such as the nitrogen and the oxygen gas. The plasma was characterized by optical emission spectroscopy (OES). The peaks of the OES originated in the components of the air like nitrogen and oxygen were seen in the plasma without employing the gas for shielding. The experimental conditions are shown in Table 1.

The quality of the films became worse by the components of the air. In order to improve the quality of the films, we developed new type of torch with shield gas flow. In the experiments of the open-air condition with shield gas flow, diamond

Table 1. Experimental conditions

	Diamond	Diamond-like-Carbon
Incident power	80-100 W	30-60 W
Temperature	700-850 °C	300-350 °C
Density of process gas (CH <sub>4</sub> /H <sub>2</sub> )	2-5%	8-12%
Flow rate of process gas	100-400 sccm	
Flow rate of shield gas	200-1000 sccm	

films were deposited in using hydrogen and methane gases and Diamond-like-Carbon films were also deposited in good quality. The peaks of OES originated in the components of the air were decreased according to the flow rate of the shielding gas (He).