Octiv VI probe application for surface wettability control and fluorination of amorphous carbon films

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Introduction

Impedans Octiv VI Probes extend its range of application from semiconductor to biomedical field. Octiv VI probes provide live and cost-effective solutions to RF measurements including current, voltage, phase and impedance etc. in CW and pulsed RF/DC environments for all kind of thin film deposition processes including organic and inorganic films.

A recent publication in Journal of Applied Surface Science highlights the application of Impedans Octiv Poly VI probe in fluorination of amorphous carbon films. Octiv measurements played a key role in identifying the bias power range for improved wettability of fluorinated amorphous carbon films.

Experimental setup

The amorphous carbon (a-C) films were fluorinated using CF4 plasma in an inductively coupled plasma reactor operated with 13.56 MHz shown in figure 1. Fluorination time was varied for 5–300 s. The a-C films were placed at the center of a 100-mm silicon wafer, which was subsequently placed on a ceramic electrostatic chuck positioned on the bottom electrode powered by 12.56 MHz. The bias voltage to the RF electrode was measured using Impedans Octiv Poly V-I probe placed in series between the bias power and the RF electrode.

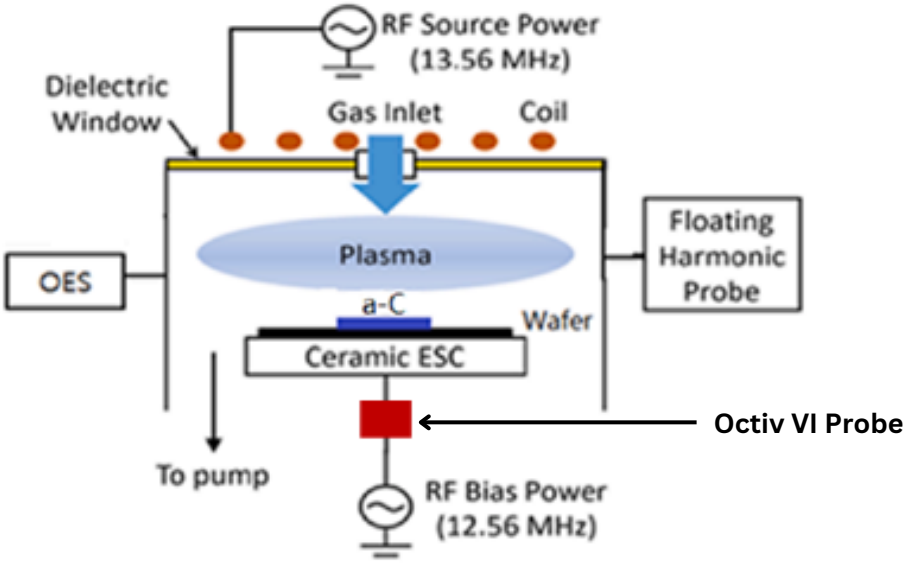

Figure 1 Schematic of the CCP reactor showing main components.

Results

The wettability and surface chemical composition of the a-C films during CF4 plasma fluorination were investigated by varying various process parameters including the bias power in an ICP reactor. Surface wettability was characterized in terms of the contact angle, whereas the degree of surface fluorination
was estimated by measuring the F/C atomic ratio.

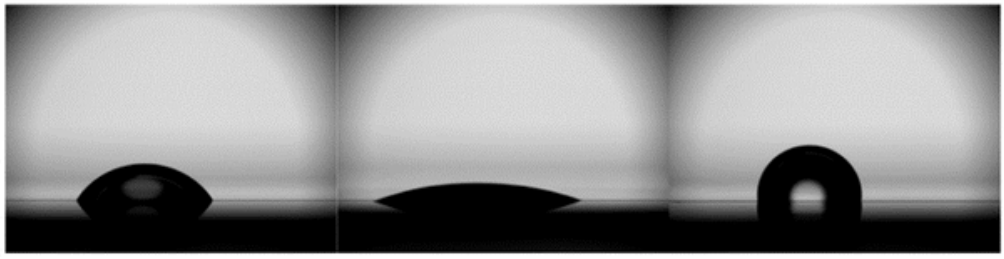

Figure 2 Contact angles of a-C films following CF4 plasma fluorination under various conditions (from left to right): as- deposited a-C; a-C following plasma treatment with a source power of 5 W for 20 s; a-C following plasma treatment with a source power of 5 W for 5 min.

The contact angles were first determined following CF4 plasma fluorination under various conditions. Microscopic images of the contact angles of the as-deposited a-C film and those obtained following plasma fluorination are shown in figure 2.

The effects of the bias powers on film wettability were investigated, as shown in figure 3. An increase in the bias power corresponded to an increase in the contact angle to 105 ◦ , even with a small bias power of 5 W and no transition in the contact angle. The contact angle remained constant with further increase in the bias power. These results indicate that the contact angles of the a-C thin films are highly sensitive to fluorination and transition under certain bias conditions.

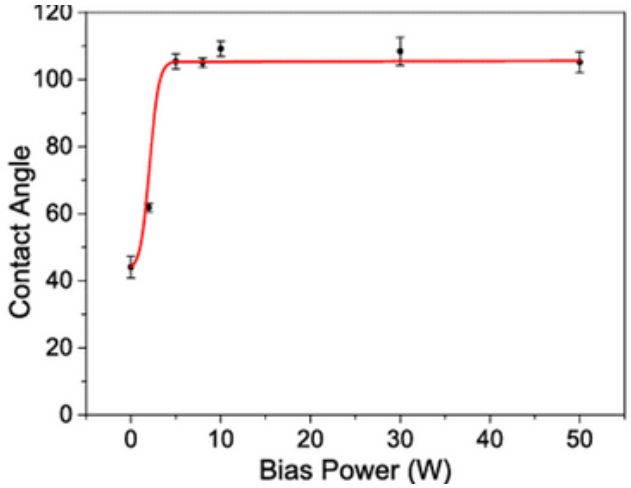

Figure 3 Contact angles of a-C films following fluorination for 5 s with a source power of 5 W and various bias powers.

The effect of plasma bias power on surface fluorination is shown in figure 4. The F/C atomic ratio substantially increased to 0.42 with a relatively small plasma bias power of 10 W, indicating that energetic ions considerably increased the surface fluorination. The F/C atomic ratio remained unchanged with further increase in the bias power, possibly owing to the saturation of fluorine atoms on the a-C film surface.

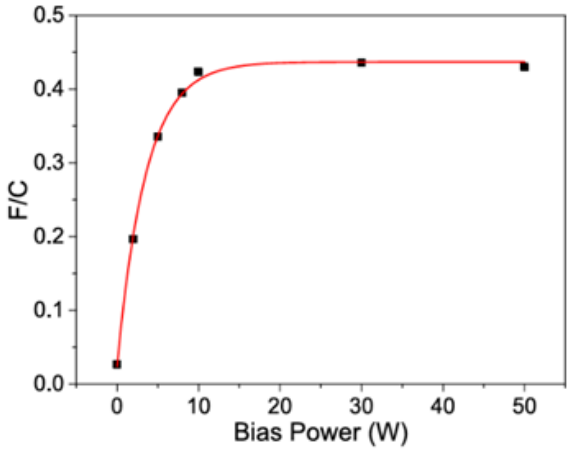

Figure 4 F/C atomic ratios of a-C following plasma fluorinations for 5 s with a source power of 5 W and various bias powers.

Summary

Experiments were conducted to study the wettability of amorphous carbon films tuned by controlling the degree of plasma fluorination and the degree of fluorination on the surface was characterized by varying the bias power in inductively coupled CF4 plasmas. A close relationship was observed between the contact angle and F/C atomic ratio on the a-C film surface. Octiv measurements helped the researcher to understand the dynamics of surface fluorination. The study demonstrates that the surface fluorine fraction increased with increasing ion energy on increasing bias power before reaching a saturation level. Same trend is followed by the wettability then.

Utilizing Impedans' Octiv VI probe to measure the bias voltage on the electrode offers direct insights into the fluorination process enabling improved understanding of the wettability properties of the a-C films. Consequently, control over the film surface structure and wettability can be achieved through manipulation of bias RF power. Top of Form

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