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# Diamond Film Synthesis at Low Temperature by Pulse Modulated ECR Plasma CVD

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Plasma chemical vapor deposition (CVD) method has many advantages for high quality diamond film synthesis. In a plasma of continuous discharge, however, the densities of activated species are almost in balance and it is sometimes difficult to control their ratio as desired. Just after turning on or turning off the discharge, the density of each specie changes drastically due to its production or loss with each time constant. A repetition of such transitional reaction stages makes it possible to control the generation ratio of radicals and to provides quite different growing environments in the plasma from those of continuous discharge.

In this work, the pulse operation is carried out in the ECR plasma CVD system for the synthesis of diamond films [1–5]. In the igniting stage of the discharge, the electron temperature becomes higher than that of continuous discharge to promote the ionization, resulting in the higher dissociation rates of source molecules. The pulse modulation is advantageous for low temperature deposition because the time averaged microwave power can be reduced as decreased the duty ratio is, resulting in decreasing thermal flux to the substrates without losing its growth rate.

The dependence of the growth rate on the modulation frequency is shown in Fig. 1. The modulating source signal for square wave of nearly 2kW in amplitude and about 50% in duty cycle was applied to the microwave power source. The broken line shows the growth rate by continuous discharge with almost equivalent microwave power. The growth rate has a peak at 500 Hz twice as large as that of continuous discharge.

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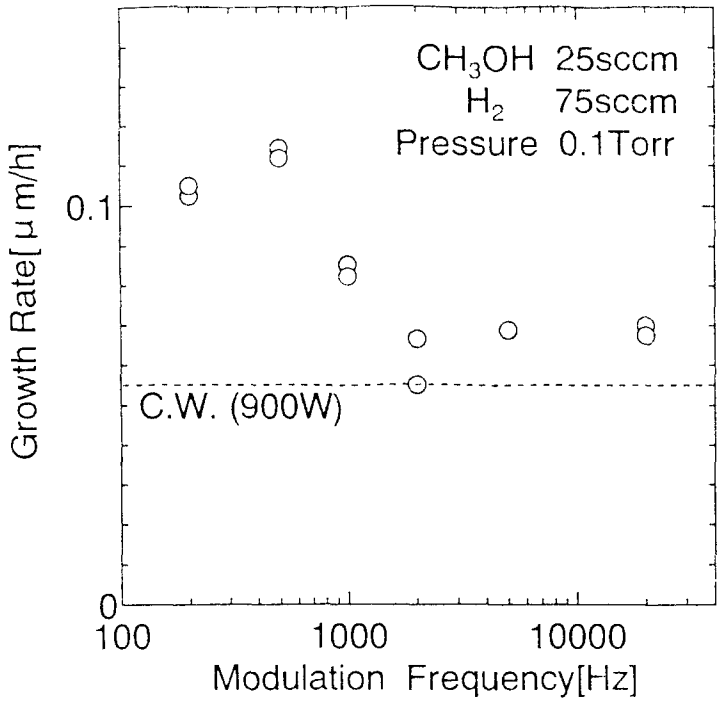


Fig. 1 Dependence of the growth rate of polycrystal diamond film on the modulation frequency of microwave.

## References

[1] J. Wei, H. Kawarada, J. Suzuki and A. Hiraki, J. Cryst. Growth 99, 1201 (1990).

[2] J. Wei, H. Kawarada, J. Suzuki and A. Hiraki, Jpn. J. Appl. Phys. 29, L1483 (1990).

[3] A. Hiraki, H. Kawarada, J. Wei, and J. Suzuki, Surface and Coatings Tech. 43/44, 10 (1990).

[4] M. Yuasa, H. Kawarada, J. Wei, J. S. Ma, J. Suzuki, S. Okada and A. Hiraki, Surface and Coatings Tech. 49, 374 (1991).

[5] M. Yuasa, O. Arakaki, J. S. Ma, H. Kawarada and A. Hiraki, Diamond and Related Materials 1, 168 (1992).