In-situ MPECVD temperature mapping using dual-wavelength pyrometry

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The growth rate, structure and composition of microwave plasma-enhanced chemical vapour deposition (MPECVD) nanocrystalline diamond exhibit a dependence on the substrate temperature during growth[1,2]. Therefore, a non-uniform substrate temperature distribution will lead to the growth of inhomogeneous diamond films. This is particularly problematic for the scalability of MPCVD diamond, for applications such as diamond on GaN heat management technology[3], thermonuclear fusion windows[4] and photodetectors[5].

Whilst pyrometry is commonly used during MPECVD growth to measure temperature of a growth substrate, this is often restricted to a single point on the substrate. Assessment of the temperature distribution of the substrate generally comes from computational methods, with spatially resolved experimental methods such as optical emission spectroscopy focussing on probing the temperature distribution of the plasma[6].

This work demonstrates a simple method of mapping the temperature across two molybdenum substrate holders, one of them a 2” wafer holder, under a hydrogen plasma with varying microwave power and chamber pressure. This mapping was achieved by employing a dual-wavelength pyrometer in conjunction with a two-axis mirror galvanometer system, allowing the beam of the pyrometer to be scanned across the holder. The effect of the inclusion of methane in the plasma on temperature distribution was also probed.

The temperature maps generated were compared with simulated plasma electron density from a finite element model of a microwave plasma, which couples electromagnetic, plasma and heat transfer solutions in COMSOL Multiphysics®.

References

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