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Effect of source gas flux from the nozzle on the thickness distribution of DLC in microwave-assisted ultra-high speed coating with gas blowing

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Recently, applications of DLC (Diamond-Like Carbon) are spreading gradually and steadily with increasing demands for energy saving by friction reduction and lifetime extension by wear reduction. In particular, higher-speed coating method with applicability to 3-dimensional shapes is strongly desired in mechanical fields. Hence, we have proposed a high-speed coating method of DLC with a novel plasma CVD employing high-density plasma (ne~1011−1013 cm−3), which is sustained by microwave propagation along plasma-sheath interface on metal surface. In our previous work, an ultra-high-speed deposition rate of 1065 μm/h was achieved with integration of the above-mentioned high-density plasma and locally blowing source gases through nozzle to substrate during DLC coating . However, the area of locally increased deposition rate was a few times of nozzle aperture and the thickness distribution of the DLC was not uniform in the area. Therefore, we need to further understand the mechanism of locally increased deposition rate for its industrial application. In this work, in order to understand the effect of source gas flux from the nozzle on the thickness distribution of the DLC coated, a particle simulation with DSMC for rarefied gas was conducted to the source gas flow employed.
For applying gas blowing, the glass nozzle with the inner diameter of 1mm was installed at the distance of 1 mm from the substrate. First of all, we deposited DLC with different total flow rates with the constant flow ratio, which is Ar : CH4 : TMS = 2 : 10 : 1. The maximum deposition rates in the area of locally increased deposition rate for the total flow rates of 65, 260, and 520 sccm were 960, 1890, and 3700 μm/h, respectively. Besides, we performed the simulation to obtain the flux distribution on the substrate. The calculated flux distribution on the substrate closely matched the thickness distribution of the DLC in the area of locally increased deposition rate.

Keywords
PECVD
DLC
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