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High rate deposition of DLC coatings from pulsed plasma using different carbon containing precursors

Hiroataka Ito¹, Kenji Yamamoto², Koichiro Akari³, Satoshi Hirota³

¹Materials Research Laboratory, Kobe Steel, Kobe, Japan ²Materials Research Lab, Kobe Steel Ltd., Hyogo, Japan ³Advanced Products and Technology Dept, Kobe Steel Ltd., Hyogo, Japan

ito.hiroataka@kobelco.com

Diamond like carbon (DLC) coating is used as tribological coating for various sliding members, such as engine parts and transmission trains for automobiles. DLC can be deposited by various deposition methods, including PVD and CVD. In case of PVD, commonly used processes are arc-ion plating and sputtering from solid carbon source. On the other hand, reasonably high deposition rate and good coverage is expected for plasma-enhanced chemical vapor deposition (PECVD) as a mean of mass production method. However in PECVD process, many process parameters have to be considered to control the film property, for example, types of gaseous sources, gas pressure during deposition, gas mixture ratio, power supply type etc.

Aim of this research is to clarify the relations between PECVD process parameters and DLC film properties by using Taguchi method (factorial analysis method). Taguchi method is a powerful tool for predicting the influence of each process parameter in minimal experiments. Combination of pulsed-DC power supply and acetylene (C₂H₂) and toluene (C₇H₈) sources are used in order to increase the deposition rate.

Pulsed-DC bias was applied using an asymmetric bi-polar pulsed DC power supply. The chosen deposition parameters are pulse frequency of substrate bias, gas pressure during deposition, substrate bias voltage, Ar and C_xH_y gas mixture ratio, applied magnetic field. The result showed that the deposition rate of DLC is strongly affected by pulse frequency, gas pressure and Ar and C_xH_y gas mixture ratio. DLC indentation hardness is influenced by the pulse frequency, gas pressure, substrate bias and applied magnetic field. Taguchi method could estimate the film properties within the parameters of test conditions. Based on Taguchi method, estimated maximum deposition rate is 13.3 μm/hr in case of using toluene, and maximum indentation hardness 28 GPa is expected by using acetylene. These results showed that the deposition rate of PECVD can be more than ten times as high as the deposition rate of sputtering method.

Keywords

DLC

PECVD

pulsed-DC

deposition rate

Taguchi method