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Axially-symmetric three-dimensional fluid modelling of capacitively-coupled radio-frequency tetrametylsilane plasmas for silicon-containing diamond-like carbon thin-films deposition

Akinori Oda[1], Kazuma Ohki[2], Satoru Kawaguchi[3], Kohki Satoh[3], Hiroyuki Kousaka[4], Takayuki Ohta[5]

[1]China Institute of Tehcnology, Chiba, Japan [2]China Institute of Technology, Narashino, Japan [3]Muroran Institute of Technology, Muroran, Japan [4]Nagoya University, Nagoya, Japan [5]Meijo University, Nagoya, Japan

aknr.oda@gmail.com

Diamond-like carbon (DLC) films are the hydrogenated amorphous carbon films, which is composed of a mixture of sp2- and sp3-bonded carbon. Since this films have excellent material properties in high wear resistance, high hardness, low friction, and chemical stability, the films have been widely used for many technological applications such as automotive, semiconductors, medical devices, and so on. Recently, silicon-containing DLC (Si-DLC) films have been investigated, since the Si-DLC films with lower friction coefficient, compared with conventional DLC films, can be obtained. However, the effect of silicon in Si-DLC films on friction properties has not been clarified. Therefore, the understanding of fundamental properties in tetrametylsilane (TMS, Si(CH3)4) plasmas, which are ion and radical source of Si-DLC films deposition, has been strongly required. Previously, our research group have developed a self-consistent one-dimensional fluid model of capacitively-coupled radio-frequency TMS plasmas, composed of the continuity equations for electron and sixteen TMS-derived ion species, the Poisson equation, and the electron energy balance equation, coupled with the Boltzmann equation solver. And then, the influence of process parameters (e.g. gas pressure, input power) on the plasma properties has been discussed. In this paper, in order to simulate the TMS plasmas in realistic geometry (i.e. plasma chamber with realistic size), we developed the axially-symmetric three-dimensional fluid model of TMS plamsas, and then examined the process parameter dependence of carbon-containing ion and radical fluxes on to substrate.(Acknowledgement: This work was partly supported by KAKENHI (No. 26420247).)

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