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ラマン分光法による炭素堆積層の結晶構造解析
A structure analysis of carbon co-deposition layers by Raman spectroscopy

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Carbon (C) is commonly used as plasma facing materials of magnetic confinement devices. In future devices or reactors, C materials will be used mainly or partially because their good thermal, mechanical properties and their low atomic number. Studies of mechanism, properties and flaking of C deposits are important subject for safety and plasma performance of future devices.

Raman spectroscopy is a useful method for characterizing bonding structure of C materials. Although there have been a lot of Raman spectroscopy studies for structural analysis of C deposition layers, deposition layers formed under complex conditions have not been comprehensively understood. In this study, C deposition characteristics by different deposition conditions are compared to increase our knowledge on C deposition under complex conditions, such as (1) irradiation by mixed D and C ion beam, (2) deposition by magnetron sputtering, (3) deposition in divertor region of the Large Helical device (LHD) (4) deposition on test limiter of TEXTOR tokamak. In addition, we compared these results with two previous researches from JET[1] and Tore Supra[2].

Raman spectra in 800~2200 cm^{-1} region were observed. Raman spectra for all C deposition layers showed a broad G peak (at ~1570cm^{-1}), D peak (at ~1350cm^{-1}) and continuous background originated from photo luminescence (PL). For data analysis, the G and D peaks were fitted with a Gaussian function after subtracting the PL

From analysis of Raman parameters of the G peak (posG and $FWHM_G$) of deposition layers deposited in mixed ion beam irradiation and TEXTOR experiments, the parameters showed clearly dependence on temperature. It is noted that these data are continuously connected between TEXTOR data (left) and the ion beam data (right) in Fig. 1. Other deposition conditions do not affect the parameters significantly. These trends indicate that higher temperature made less sp3 bonding and less three dimensional disorders. These temperature dependences should be attributed to an annealing effect. On the other hand, characteristics of aromatic clusters estimated by I(D)/I(G) do not depend on temperature in the temperature range of ion beam experiment (493 K ~ 613 K). However, each experiment showed that different trends on I(D)/I(G). They could depend on other deposition conditions such that incident ion energy, ion flux, ion species and composition of deposition layers.

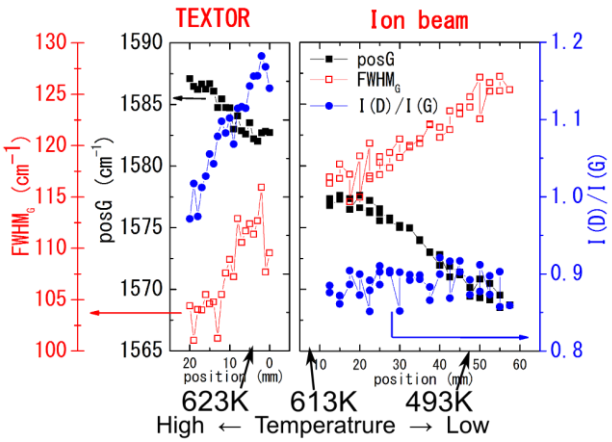

FIG. 1. Raman three parameters of ion beam experiment (right) and TEXTOR experiment (left).

[1] J. Likonen, E. Vainonenahlgren, et al, J. Nucl. Mater., 377 (2008) 486–491.
[2] C. Pardanaud, G. Giacometti, et al, J. Nucl. Mater., (2010) 8–11.