§9. Hydrogen Isotope Inventories and Structural Analysis of Co-deposited Carbon Layer in LHD

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An investigation of hydrogen isotope inventories in deposition layer the plasma facing walls is important issues related to controls of fuel recycling and in-vessel tritium inventories in fusion devices. In particular, several allotropes of carbon are known such as graphite, amorphous carbon and diamond, with different characterizations.

Two kinds of different co-deposited carbon layers were produced during the 13th experimental campaign in LHD. Target samples made by SUS316 and Si were installed the section 6.5 at inner poloidal cross-section. These samples were set in the different facing holder and mainly two kinds of group can be separated. One is the sample targets facing graphite divertor and eroded carbons from nearby divertor targets by physical sputtering deposit on these targets, namely S1 and S2. A thickness of deposition layer is about 100-400 nm. The other is the sample targets non-facing graphite divertor and thin carbon deposition layers of ~50 nm are observed and these samples are namely S3 and S4. But eroded carbon sources by physical and chemical sputtering are unknown.

In previous studies [1-3], deposition layers on the same samples were analyzed by Raman spectroscopy and X-ray photoelectron spectroscopy (XPS). Retained hydrogen by main plasma and glow-discharge irradiations was measured by thermal desorption spectrometry (TDS). From comparison with these analyzed data, characterizations of carbon deposition layer, carbon structure and carbon-carbon bindings, were discussed. This result shown characterization of amorphous hydrocarbon (a-C:H) [4] on these deposition layers. But more details for carbon bindings, such as hydrocarbons were not clear.

In this paper, deposition layers on samples are analyzed by the optical ellipsometry [5-6] in NFRI. Ellipsometry has two advantages: (i) Ellipsometry provides both film thickness and refractive index as a measure for the material property. (ii) Ellipsometry is very sensitive, so it is possible to monitor the variation of deposition and erosion with high accuracy.

Two kinds of parameters, refractive index and extinction coefficient, are measured and a comparison with results of reference targets C_2H_2-DLC, C_2H_4-polimar like, CH_4-DLC and CH_4-polimer like, and LHD deposition layers were done as shown in Fig.1. From comparison of these data, results of LHD samples S2 and S3 are located between CH_4-DLC and C_2H_2 polymer-like structures. Two kinds of hydrocarbon on reference samples are composed by C-H bindings. Then hydrocarbons in LHD deposition layer are formed of single C-H bindings. C-H bindings are a stable binding and it was observed as static retentions of trapped hydrogen in deposition layers.

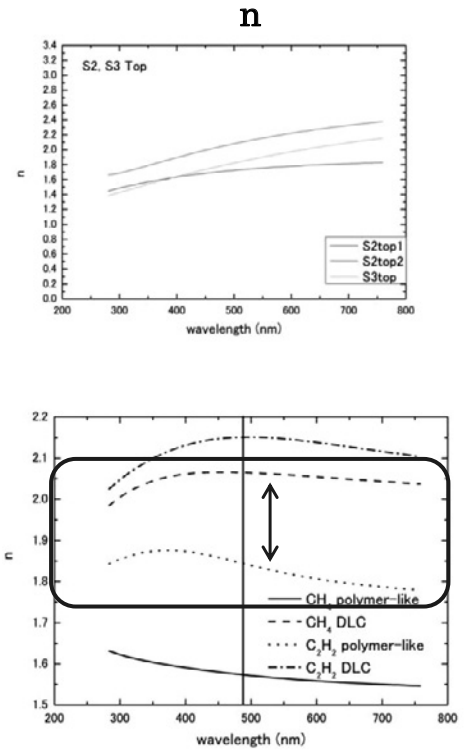

Fig. 1 Refractive index by ellipsometry for deposition layer on LHD samples, S2, S3, and reference samples of CH_4 and C_2H_2.

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