§20. A Proposal of In-situ Diagnostics Methods for PFMs under Multiple Irradiation

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The diagnostics of plasma facing materials (PFMs) is a primary issue for maintenance of the high performance plasma in fusion devices. In order to evaluate PFMs conditions which alternate continually during long duration discharges, in-situ and real-time diagnostic methods of PFMs are highly desired as an alternative to the existing postmortem methods. In this study, optical reflectivity measurement is proposed as a convenient in-situ diagnostics of the radiation induced microstructure change and its applicability is evaluated. During the last year of the term of this LHD collaboration project, the basic laboratory experiments were performed for the development and optimization of the in-situ diagnostic methods. In addition, the meeting for the collection of research results was held, and the future policies of the in-situ diagnostic were also discussed.

To obtain the information of the depth profiles of irradiation damages, an impedance of irradiated metal samples was measured with the high frequency LCR meter. It had been expected that a high frequency current flows on the near-surface of the damaged region by a skin effect. Fig. 1 shows the frequency dependence of the impedance for the Cu samples irradiated with 3keV-He^+ at room temperature. In a high-frequency region of > 8 MHz, the increasing of the impedance is confirmed with increasing the He^+ ion. Fig. 2 also shows the evolution of the impedance in several frequencies under the 3 keV-He^+ irradiation. Although there is a large variance in the data, for the high-frequency of 9 MHz, the detectable increasing of impedance is also observed.

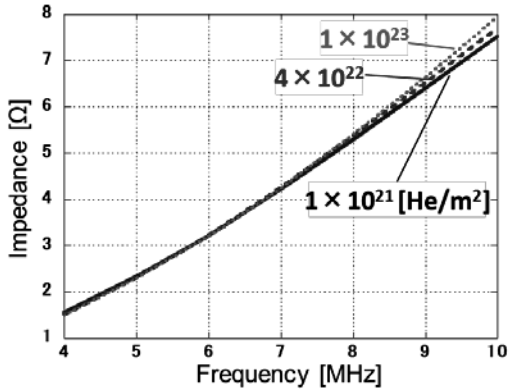

Fig. 1 The frequency dependence of the impedance for the Cu samples irradiated with 3keV-He+ at room temperature.

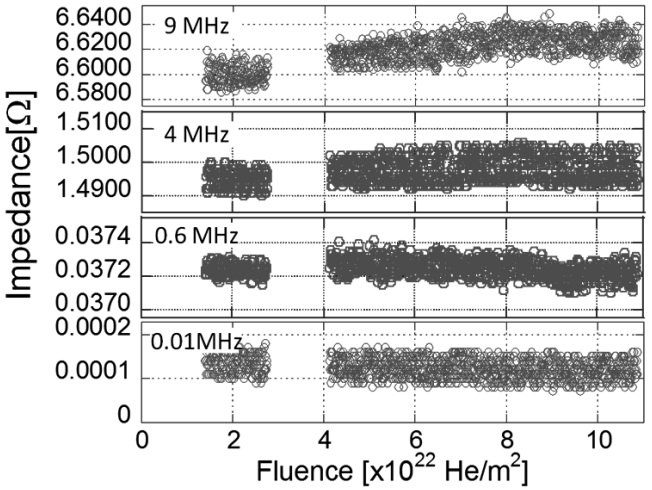

Fig. 2 T evolution of the impedance in several frequencies under the 3 keV-He^+ irradiation at room temperature.

These results indicate that one can roughly estimate depth profiles of damage by using a high frequency impedance measurement.

Thorough this LHD collaboration project, it was revealed that the optical and electrical property measurements are considered to be possible methods for convenient in-situ diagnostics for PFMs in spite of the limited application. For more accurate diagnosis combination of several diagnostics methods and accumulation of comparative basic data are required.

In order to summarize the research results, the review meeting of this LHD collaboration project was also held at Kanazawa University on 22 September as a joint meeting with new LHD collaboration project of "In situ LIBS measurements of hydrogen isotope retention and material mixing". There were 10 participants and 9 presentations in the meeting. As innovative in-situ diagnostics methods, LIBS (Laser Induced Breakdown Spectroscopy) measurements and the color measurement were introduced, and future policies were discussed. Several research projects regarding in-situ diagnostic of PFMs has already begun as a new LHD collaboration project and an exploratory research project (KAKENHI), the continuing development of this study is greatly anticipated.