§2. Characterization of Erbium Oxide Coating by Irradiation Induced Luminescence

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The development of an Er_2O_3 electrical insulating coating for reduction of MHD pressure drop in a liquid Li cooled blanket system has been conducted under the collaborative studies between NIFS and universities. The objective of the present collaborative study which has been started in this year is to examine relations between material conditions of Er_2O_3 coatings and photon, electron and ion induced luminescence spectra. The relations are considered to be applied for initial evaluations of the Er_2O_3 coatings and for examination of characteristic changes in various experiments simulating the blanket environment. And, the mechanism of the characteristic changes with radiation would be studied by investigating the change in the theoretical transition spectra with calculated model structures that include the defects.

A simple electron beam irradiation system has been constructed for a cathode luminescence (CL) measurement at NIFS. A luminescence spectrum from the ultraviolet to visible light region is obtained at room temperature by a monochromator under irradiation of a beam of several tens μA with the maximum energy of 15 keV. At Nagoya University, in order to obtain the theoretical transition spectra of Er_2O_3, multiplet energy levels and absorption spectra were calculated by relativistic first-principles many-electron calculation (DVME method). [1)] The cluster models used were constructed on the basis of the crystal structure of Er_2O_3 at room temperature. And, the absorption spectra of Er_2O_3 sintered sample were measured by diffuse reflection method.

Fig. 1 shows a preliminary result of the CL spectrum measurement for an Er_2O_3 sintered disc. The peaks at the wave lengths of 380-400nm, 530-580nm and 650-700nm were obtained similar to the luminescence spectrum previously measured with a 100 keV H^+ ion beam irradiation. In case of the ion beam irradiation, it might be possible to form broad emission peaks because of its high energy density. On the other hand, the sharp emission peaks that might give the detail electron energy levels in Er_2O_3 were obtained by the CL measurement.

Fig. 2(a) shows absorption spectrum of Er_2O_3 sintered sample measured by diffuse reflection method at room temperature. It is found that absorption bands correspond to those in the experimental emission spectrum shown in fig.1 were obtained. The difference in wavelength between positions of the band of the absorption and emission spectrum might be due to stokes shift. Fig. 2(b) shows theoretical absorption spectrum calculated with the cluster model based on the structure around the 24*d* site in Er_2O_3. It was confirmed that the spectrum corresponds to experimental one could be obtained from theoretical calculation, though the calculation result about the Er ions occupy the 8*a* site needs to be considered.

In a previous ion beam irradiation simulating production of irradiation defects, the height of the peak at 650-700 nm in Fig. 1 decreased with the irradiation fluence while those at 380-400 nm and 530-580 nm did not change significantly. Studies on the relations between irradiation damages and changes in luminescence spectrum are planned from both aspects of experiments and theoretical calculations in the year of 2009. In the experiment, measurements of luminescence spectra will be performed especially focusing on Er_2O_3 coating samples with different cristallinity and samples after ion beam irradiations. In the theoretical study, electronic states will be calculated with the models simulate the circumstances around defects and the prediction of the effects in absorption and emission spectra will be examined.

1) Ogasawara, K. et al. : Phys. Rev. B **64** (2001) 115413

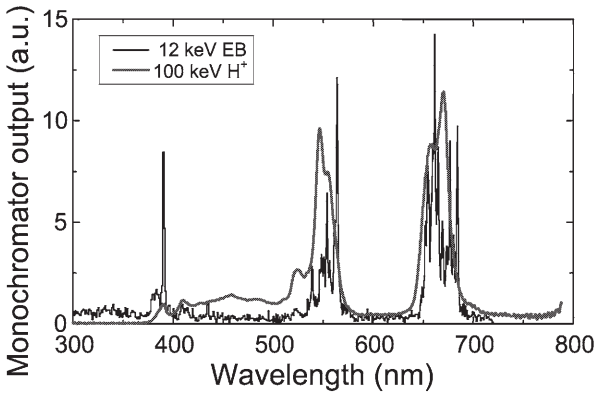

Fig. 1. CL spectrum for an Er_2O_3 sintered disc.

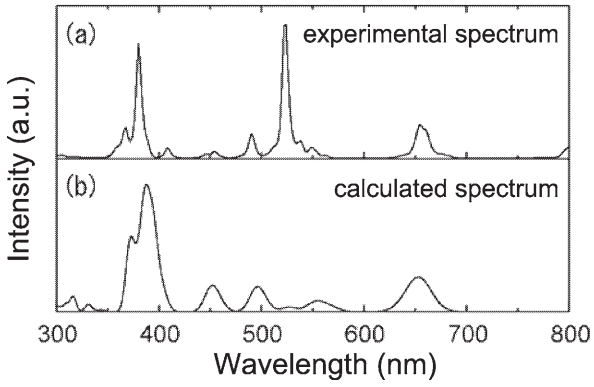

Fig. 2. Experimental and calculated absorption spectrum for Er_2O_3.