§11. Irradiation Effects on Reactor Relevant Material Surfaces by Slow Highly Charged Ion Beam

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Much attention has been paid to Er_2O_3 thin film fabricated by Metal Organic Chemical Vapor Deposition (MOCVD) for the coating material of a thermonuclear reactor blanket. It is known that the luminescence of Er_2O_3 provides information on its crystallinity. We observed spectral distributions of luminescence of Er_2O_3 thin film during the irradiation with highly charged ions (HCIs) produced by an electron beam ion source (EBIS).

We used Kobe EBIS installed at the Kobe University for the production of HCIs. The Kobe EBIS is designed for the application of ion beam processing of materials so that it is constructed and operated easily without demanding expertise of EBIS using a separate, commercially available super-conducting magnet. Maximum designed values of electron beam energy and electron current are 40 keV and 300 mA, respectively. For the present experiment, the acceleration potential of HCIs extracted from the Kobe EBIS is 3kV, and beam current is in the range of 100 pA. Spectral distribution of visible light emission from the sample irradiated with HCI (Ar^{q+}, q = 6 ~ 11) was measured using a polychromator with the effective wavelength range of 420 ~ 670 nm. Fig. 1 shows a CCD image indicating the spectral and spatial distributions of emitted light. From an Er_2O_3 thin film processed through MOCVD on the substrate.

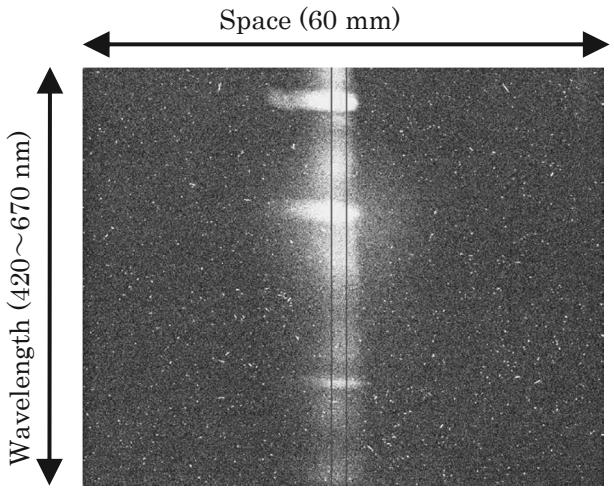

Fig. 1. An example of CCD image of the output lights from the polychromator.

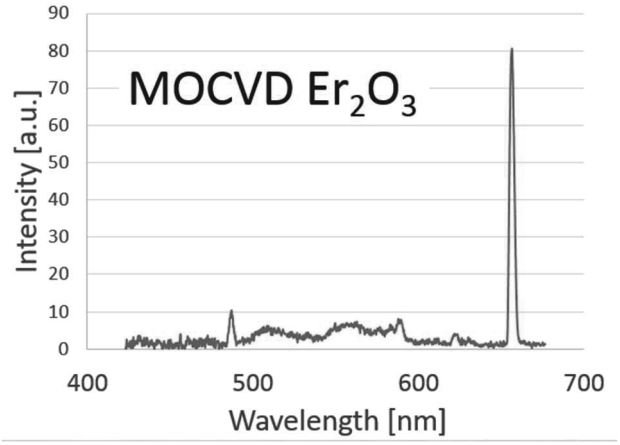

Fig. 2. Visible spectrum from MOCVD Er_2O_3.

Fig. 2 shows spectrum emitted from Er_2O_3 thin film irradiated with Ar^{11+} ions. The spectrum is constructed from the intensities of selected pixels between two lines indicated in Fig. 1. Broad band observed between 500 and 600 nm is ascribed to luminescence from bulk Er_2O_3 while sharp peaks at 486 and 656 nm are identified as Balmer lines from atomic hydrogen generated by the potential sputtering mechanism. The intensity of Balmer lines, which are not observed at the experiment with Ar^+ irradiation[1], steeply increases with the charge state of primary HCI.

1) Kato, D. et al : Plasma and Fusion Research, 7 (2012) 2405043.