# §8. Characteristics of Polycrystalline Ceramics Scintillator for the Lost Alpha Probe for ITER

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The understanding of alpha particle loss mechanism is important to improve plasma confinement under burning plasma experiments. The diagnostics by a scintillator probe is one of the possible tools for lost alpha particle measurements. Charged particles escaping from plasma follow a gyration motion along with a magnetic field line and hit a scintillator surface through an aperture, which determines the pitch angle and gyration radii resolutions of incoming particles (Fig. 1). Fluorescent emission caused by collision is collected by lens or mirror system and image-transferred to optical fiber. Optical signals are split into two light paths by a beam splitter; each of them is measured by a photomultiplier array and a CCD camera.[1)]

Our interest is to be clear up the characteristics of inorganic phosphor materials under burning plasma conditions. As one of the specimen, transparent polycrystalline ceramics of Ce:$Y_3Al_5O_{12}$ (Ce:YAG) is provided by Osaka University. The polycrystalline ceramics becomes one of the candidates, and is a main part of the lost alpha probe. The polycrystalline ceramics of Ce:YAG ( A peak wave length of fluorescence from Ce:YAG is 560nm). We measured the fluorescent emission caused by irradiating 3-MeV $H^+$ and $He^+$ simulating high-energy lost alpha particle produced by DT reaction, using the dynamitron accelerator at Fast Neutron Laboratory in Tohoku University. Here we report relations between emission intensity and (i) incident particle flux, (ii) irradiation time.

Fig.2 shows the relation between light emission intensity versus the incident particle flux. For both beam species the light emission intensities have a linear dependence on the particle flux. The irradiating particles gave the energy to electrons for excitation effectively, so emission intensity increases as the amount of flux dose goes up. The largest flux is 6.7 x $10^{12}$[ions/sec.cm$^2$]. This condition covers the normal operation range in ITER (~$10^{12}$ [ions/sec.cm$^2$]).

Fig.3 shows the relation between emission intensity and irradiation time for 3-MeV $H^+$ beam. The light emission intensity decreases to roughly 88% of the initial one in the dose of 4.2 x $10^{15}$[ions/cm$^2$]. The beam current is monitored every 15 minutes by a Faraday cup, which is installed into the upstream of the ion beam path. The monitoring time was less than 2 minutes. The unstable intensities in the figure are not essential, because they are caused by beam instability. Temperature quenching is also studied.

At normal experimental conditions in ITER (~$10^{15}$[ions/cm$^2$]) for 1,000-second duration, the intensity keeps 98% of the initial value.

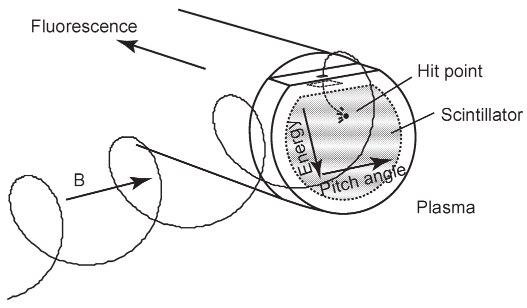


Fig.1. Illustration of scintillator probe. Fluorescent light is detected by a CCD camera and photomultiplier array simultaneously.

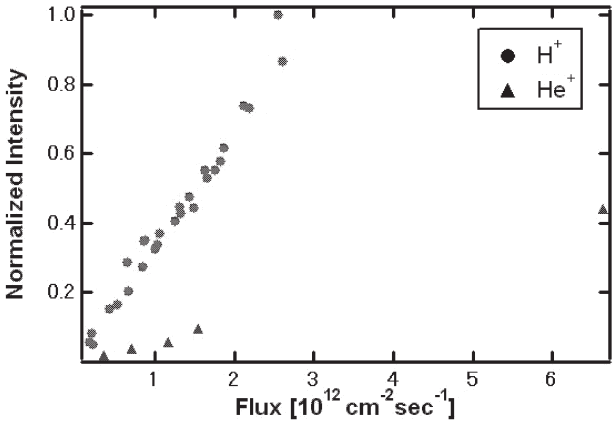


Fig.2. Light emission intensity of sintered polycrystalline 1% Ce:YAG for the incident H+, He+ beam energy of 3 MeV.

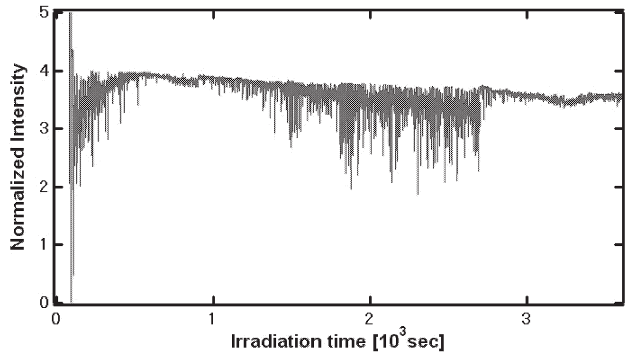


Fig.3. Dose relativity of light emission intensity for incident H+ beam energy of 3 MeV.

Reference

1) M. Nishiura, M. Isobe, T. Saida, M. Sasao and D. S. Darrow, Rev. Sci. Instrum. Vol. 75 (2004) 3646-3648