§106. Radiation Effect of Optical Components for Fusion Plasma Diagnostics

Nishiura, M. (Univ. Tokyo),
Narui, M., Yamasaki, M., Shikama, T. (Tohoku Univ.),
Nagasaka, T., Kisaki, M.,
Fujimoto, Y., Fujioka, K. (Osaka Univ.)

The purpose of this study is to characterize the optical properties in the visible wavelength after exposure to radiations which are related to the burning plasma diagnostics. In particular, optical components for radiation hardness, which are developed at Russia and Japan, exist. However as those are not widely prevalent, it is difficult to obtain and develop the optical components. The prediction of these materials after the exposure of radiations by neutrons and gamma rays enables us to establish a reliable monitoring system for a nuclear fusion device. Fusion diagnostics under DT reaction is essential to study the physics of alpha particle confinement and self-burning plasma, and first- wall protection. Since 2008, we have had a collaboration research with IMR, Tohoku University as KAKENHI project related to a lost alpha detector, where we have evaluated the fabricated $Ce:Y_3Al_5O_{12}$ scintillator. The study on radiation effect is extended to the optical components for fusion plasma diagnostics; pure metal mirrors in an inertial fusion field, Thomson scattering mirrors in LHD, JT-60SA, and ITER.

Transparency of optical components has been measured in the visible region since the fiscal year 2011. These components were irradiated at the JRR-3 nuclear reactor. The neutron flux is kept a constant of 10^{18} $m^{-2}s^{-1}$. We have investigated the quartz samples doped with different impurity densities (H, OH, F). We found that the transmittance of these quartz samples depends clearly on the doped atom and density after the irradiation.

Fig. 1 shows the prepared samples after the irradiation at JRR-3. The samples SOC-1, 2, 3, and 4 are SiO_2, CaF_2(1,1,1), MgF_2(c-cut), and sapphire(c-cut), respectively. The transmittance in the low wavelength (180-850 nm) and the high wavelength (550-1070 nm) is measured by two spectrophotometer systems. The characteristic for the sample SOC-1 remains in the wide range after the irradiation. Only at the low wavelength region less than 250 nm, the transmittance of SOC-2 exceeds that of SOC-1.

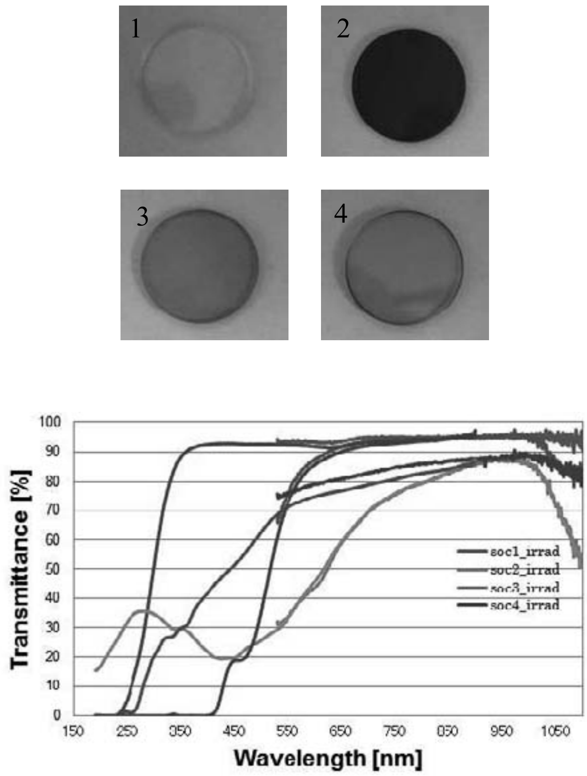

Fig.1 Transmittance of samples SOC-1, 2, 3, and 4 after JRR-3 irradiation (48 hours, 22K2009).

The fluence in the above condition is relatively low compared with that in ITER and other fusion machine conditions. To characterize higher fluence than the present one, we prepared the samples for the irradiation at the nuclear reactor, BR2 or HFIR. In addition to quartz samples, we prepared a rare earth doped SiO_2, which is expected to enhance the radiation hardness. After the irradiation, the samples will be analyzed and compared with the low fluence cases.