Measurement of charged-particle emission DDX for carbon with 14-MeV incident neutrons

Keitaro Kondo[1], Isao Murata[1], Kentaro Ochiai[2], Hiroyuki Miyamaru[1], Naoyoshi Kubota[2†], Chikara Konno[2] and Takeo Nishitani[2]

[1] Department of Electronic, Information Systems and Energy Engineering, Osaka University, Japan
[2] Directorates of Fusion Energy Research, Japan Atomic Energy Agency
[†] Present address: Materials Characterization Laboratory, Nippon Steel Corporation

In fusion reactor development, charged-particle emission DDX for 14-MeV neutron incidence is needed to calculate nuclear heating and fundamental values to evaluate material damages, i.e. PKA spectra, gas production per atom (GPA) and displacement per atom (DPA) cross-sections. The particularly important charged-particle emission DDX is of nuclides contained in the first wall and blanket materials highly exposed to 14-MeV incident neutrons. We recently developed an improved measurement system for secondary emitted charged-particles using a pencil-beam neutron source furnished in the Fusion Neutronics Source in Japan Atomic Energy Agency [1]. Systematic measurements are being carried out for light nuclei of which the measurement has not been performed sufficiently so far. In this symposium, a result of detailed measurement for carbon is presented.

In the measurement, a superior S/N ratio, high energy and angular resolution were realized with the pencil-beam neutron source and a counter telescope consisting of a pair of silicon surface barrier detectors, ΔE and E. Minimum detection energy of 1.0 MeV for α-particles was achieved by utilizing an anticoincidence spectrum of the ΔE detector, which includes contribution of low energy α-particles that cannot penetrate the detector. A thin carbon foil of 5-μm thickness was employed for a sample material to obtain a detailed energy distribution of emitted α-particles via the $^{12}C(n,n'+3\alpha)$ reaction. A rigorous method was applied to correction of energy loss of emitted α-particles in the sample material.

Our obtained DDX showed a large discrepancy from a previous measurement by Haight et al. [2] in lower energy region. To find the cause of the discrepancy, calculations of emitted spectra of α-particles were attempted by a Monte Carlo technique considering kinematics of a lot of reaction channels. As a result, the validity of the lower energy part of our obtained DDX was confirmed.

[1] K. Kondo et al, Nucl. Instrum. Methods Phys. Res. A **568**, 723 (2006).
[2] R. C. Haight et al., Nucl. Sci. Eng., **87**, 41 (1984).