Total and Double Differential Scattering Cross-Section Measurements of Isotropic Graphite

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Abstract: Nuclear-grade graphite has been considered as an efficient neutron moderator and reflector for the following reasons: its low atomic mass number, small neutron capture cross-section, high neutron scattering cross-section, easy availability, and comparatively low cost. However, the reported total cross-sections of graphite [1] are inconsistent in the low-energy region. To examine the origin of these discrepancies, the total and double differential scattering cross sections (DDSCS) of graphite have been measured in the Materials and Life Science Experimental Facility (MLF) in the J-PARC.

Isotropic graphite has higher homogeneity and mechanical properties than those of traditional extruded graphite and has been widely used in recent years. Five isotropic graphite samples with different densities and grain sizes were prepared for the experiments. The DDSCS were measured using the Beam Line #14 (AMATERAS) in the MLF. The measurements were performed for nine incident neutron energies ranging from 1.2 to 94 meV. The scattering cross-section data were normalized using those of vanadium as a standard. Small angle scattering and Bragg edges were observed in the derived cross sections, and their intensities varied among the samples. The neutron total cross sections in the energy region from 1 to 100 meV were measured using Beam Line #04 (ANNRI) in the MLF. In the epithermal range (over 40 meV), all samples tended to have values. close to the free atom cross-section of graphite. However, at the first Bragg edge, the deduced total cross sections by those samples started to separate from each other. The difference became more significant with decreasing the neutron energy, and the value tended to increase with the grain size of the sample. The results of these measurements suggest that the discrepancies between the derived total cross sections in the low-energy region are due to small-angle scattering caused by grains of graphite with uniform size.

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[1] S. Petriw *et al*., Journal of Nuclear Materials 2010; 396: 181–188.