Development of beam splitting etalons for pulsed neutrons II

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A large dimensional interferometer for long wavelength neutrons has the advantage to increase the sensitivity to small interactions. Multilayer mirror is suitable for Bragg reflection of cold neutrons. We demonstrated Jamin-type interferometer for cold neutrons using 'beam splitting etalons (BSEs), ' which enables us to align the four independent multilayer mirrors in the interferometer within required precision [1]. We are preparing for high-resolution measurement of Aharonov-Casher effect [2,3] by using this type of interferometer.

The interferometer for pulsed neutrons can increases neutron counts available for AC measurement because the phase shift is independent from the velocity of incident neutrons. Neutron interferometer with multilayer mirrors can be applied to pulsed neutrons by replacing the mirrors with supermirrors. The supermirrors can reflect neutrons with wide range of wavelength at a proper incident angle. In the case of neutron spin interferometer of Jamin type, a magnetic supermirror on the one plane of the BSE reflects only up-spin component of the neutrons and a non-magnetic supermirror on the other plane reflects transmitted down-spin component. The second BSE with supermirrors recombines the two components. High polarization of both of reflected and transmitted beam for magnetic mirror is required in order to split the beam into two paths according to the spin states.

We deposited magnetic supermirrors on silicon wafers by using both of ion beam sputtering instrument and vacuum evaporation instrument at KURRI for test of BSE. The reflectivity of the magnetic supermirrors were measured by scanning of incident angle instead of neutron wavelength. Test experiments were performed using the cold neutron beam line MINE2 at the JRR-3M reactor in JAEA. The beam had a wavelength of 0.88 nm and a bandwidth of 2.7% in FWHM. The magnetic mirrors required external magnetic field for magnetic saturation of the mirror. Strong magnetic field in local area in neutron spin interferometer would decrease the visibility of interferogram due to depolarization or deviation of the relative phase between the two spin states. We are continuing the development of the magnetic supermirror for lower external field. The interferometer for the AC measurements must have perfectly separated two paths enclosing an electrode. We are also continuing on the constructing of interferometer using BSEs with large gaps.

References

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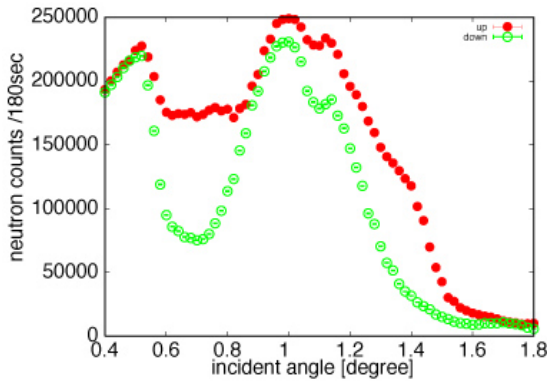

Fig. 1. Reflectivity of multilayer spin splitter with the magnetic supermirror. Because the mirror was not saturated, the reflectivity for up-spin was not high for BSEs.