A new layer structure for large-m polarizing neutron supermirror

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Magnetic multilayer mirror consisting of ferromagnetic layers and nonmagnetic layers is useful to polarize neutron beam. Polarizing supermirror is a stack of magnetic multilayer with gradually increasing value of the d-spacing. Several kinds of magnetic supermirror have been developed as neutron polarizeing device.
There was no m>4 polarizing supermirror except for our previous report[1]. Some of authors have succeeded in fabricating m>5 Ni(C)/Ti supermirrors and small d-spacing multilayer monochromator
with high reflectivity by using ion beam sputter (IBS) technique [1,2].It is possible to fabricate smmoth and small d-spacing layer structure but it is nessesary for strong external magnetic field.
In the report, we succeeded in fabricating m=5 Fe/Ge polarizing supermirror by using improved magnetic sputter target[3]. The target is well deoxidized iron target by heating it in hydrogen atmosphere.
The reflectivity and polarization efficiency under an external magnetic field of 45 mT were above 0.67 and 0.90, respectively.
The reflectivity is very high but the polarizaition is not so high.
The durability of the sputter target was not long enough for production. Thus we tried improve magnetic property of the supermirror without the deoxidized iron target. Here we noted the different magnetic property between Fe/Ge and Fe/Si multilayers. By inserting thin Si layer in which thickness 0.5 nm between Fe and Ge layer, the magnetic property of Fe/Ge(Si:0.5nm) multilayer is better than Fe/Ge and Fe/Si ones.
We have fabricated m=4.9 Fe/Ge(Si:0.5nm) supermirror using IBS technique and tested the performance as a polarzing divice.
The measurement was carried out at C3-1-2-3 port (MINE2) at JRR-3M at JAEA. The average wavelength of incident neutron is 0.88 nm and the resolution is 2.7 % in full width half maximum. The divergent angle of neutron beam was smaller than 1 mrad. The strength of external magnetic field is 45 mT. The reflectivity and polarization efficiency is estimated to be above 0.7 and 0.94, respectively.

References

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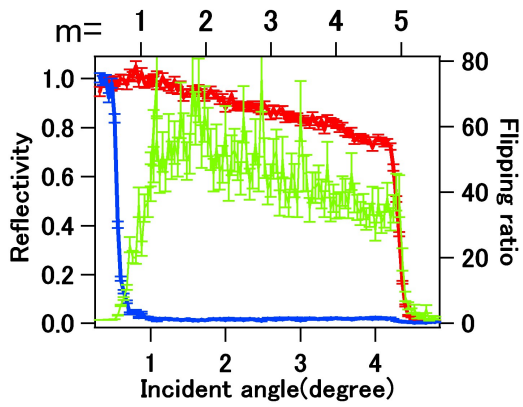

Fig. 1. Measured reflectivities of up (red) and down (blue) spin neutron for m=4.9 Fe/SiGe3(Si:0.5nm) supermirror. The green line indicates flipping ratio that reflectivity of up spin neutron devided by that of down spin one.