Substitution effects of Fe on magnetic excitations of antiferromagnetic metal Mn_3Si

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Mn_3Si is an antiferromagnetic metal with $T_N = 21$ K. Magnetic satellite Bragg peaks arise below T_N, and a magnetic steep dispersion appears above $\sim$6 meV [1]; this trend reminds us that of Cr. A considerable difference between Mn_3Si and Cr is the magnitude of T_N: the ratio reaches to $\sim 1/14$. Hence, as for the magnetic properties, Mn_3Si is regarded as an alternative of Cr with a small magnetic-energy scale.

Recently, we measured inelastic spectra of Mn_3Si on a TOF spectrometer at MLF/J-PARC. Unexpectedly, broad inelastic signals were observed above 20 meV at some (not all) zone-center Γ positions, i.e., at $(2, 2, 2)$ and $(2, 0, 0)$. In order to specify and quantify the scattering, we planned to investigate Fe-doping effects on the zone-center signals. Note that the $Mn_{3-x}Fe_xSi$ system shows the antiferromagnetic phase at $x_c \leq 1.2$, but it changes to a ferromagnetic phase above x_c [2]. Therefore, the Fe-doping process most probably introduces ferromagnetic interactions in the antiferromagnet Mn_3Si.

Unpolarized inelastic-neutron-scattering experiments have been carried out on a high-flux triple-axis spectrometer, PUMA, at FRM II in Germany. Measurements were done in the (h, k, k) scattering plane using three single crystals of $x = 0, 0.6$, and 1.5, which are nearly the same in volume.

Figure 1 shows typical **Q** spectra at $\omega = 35$ meV for $x = 0$ and 0.6 below T_N, in which the scan trajectory passes through $(-2, -2, -2)$, $(-2, 0, 0)$, and $(-2, 2, 2)$. The following facts are found. First, the broad signal of $x = 0$, which was observed previously in the TOF measurement, was reproduced. Second, the inelastic pattern holds even for $x = 0.6$, but the intensity is obviously suppressed. Therefore, the inelastic signals are most likely magnetic in origin and attributed to antiferromagnetic fluctuations. Actually, the same scan for $x = 1.5$ below T_C (not presented) showed no such the signals at the Γ points, naturally corresponding to disappearance of antiferromagnetic correlations in the ferromagnetic phase. It is interesting whether this type of magnetic excitations commonly exists among antiferromagnetic metals, such as Cr.

References

[1] S. Tomiyoshi *et al.*, Phys. Rev. B **36**, 2181 (1987).

[2] H. Miki *et al.*, Physica B **237-238**, 465 (1997).

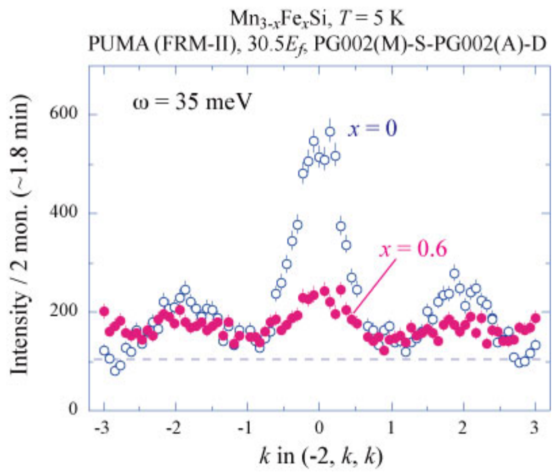

Fig. 1. Wide-range **Q** spectra of inelastic magnetic scattering at $\omega = 35$ meV in the antiferromagnetic state of Mn_3Si (open circle) and $Mn_{2.4}Fe_{0.6}Si$ (closed circle). The broken line represents the background level.