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Report:

Recently a new experimental technique - nuclear resonance small-angle scattering of x-rays (NSAXS) - was introduced for probing spatial variation of magnetization in solids with resolution in reciprocal space down to $\sim 1\,\mu m^{-1}$ [1]. It allows one to measure the correlation function, the correlation length, and the dispersion of the long-range spatial variation of magnetization.

The purposes of the present experiment were:

i) improvement of the instrumental angular resolution for NSAXS (steeper slopes of the rocking curves) ;

ii) measurement of the time spectra of the almost pure NSAXS, i.e. with the fewest contribution of nuclear forward scattering (NFS);

iii) application of NSAXS for studies of the domain wall thickness as a function of temperature in α-^{57}Fe.

The set-up (Fig. 1) used in the present experiment was modified in comparison to [l] with the purpose to improve the angular resolution of the instrumental function. A kind of the Bonse-Hart small-angle scattering camera was used with two Si(111) channel-cut crystals [2]. The first crystal was used as a collimator (C) and the second

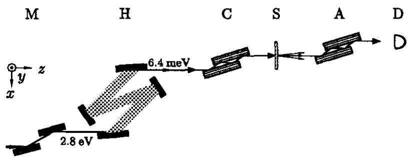

Fig. 1

as an analyzer (A). Both crystals contained four-fold reflections. The other parts of the set-up were: M - Si(11 1) high heat load premonochromator; H - Si(4 2 2) x Si(12 2 2) high resolution monochromator; S - sample; D - APD detector.

The application of the collimator and analyzer crystals with four-fold reflections resulted in the instrumental function with much steeper slopes than before [l] (Fig.2, open circles). The measurements were performed with 14.4 keV x-rays. The throughput of the instrument was 45% and the maximum count rate of the delayed quanta was 3 kHz.

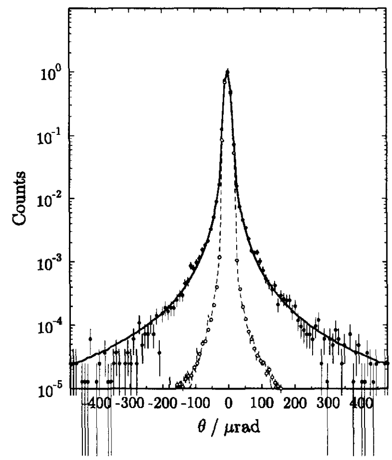

Fig. 2

The solid circles in Fig.2 are the measurements of NSAXS in an unmagnetized 6 μm α-^{57}Fe foil. The fit of the data - the solid line - shows that NSAXS amounts to 16% of the NFS intensity and originates from magnetic inhomogeneities with characteristic linear dimensions of 0.6 μm. This linear dimension corresponds to the thickness of magnetic domain walls in polycrystalline Fe.

The experimental set-up was used to measure almost pure NSAXS time spectrum, i.e. with only very small contribution of NFS. The measurements were performed with the analyzer set at 150 μrad off the maximum transmission of the instrument. The contamination of NSF was less than 3%. The time spectra in unmagnetized 6 μm and 18 μm thick α-^{57}Fe foils were measured. The time spectra of NSAXS are different for samples of different thickness.

The NSAXS was measured in a-Fe foils as a function of temperature in the range from 20° to the temperature of the magnetic phase transition Tc = 830°C. Surprisingly the angular dependences of NSAXS remained unchanged up to T_C-0.5°C. NSAXS disappeared abruptly at the temperature of the phase transition. The similar behaviour was observed in invar ($Fe_{65}Ni_{35}$).

[I] Yu.V. Shvyd'ko, A.I. Chumakov, A.Q.R. Baron, E. Gerdau, R. Rüffer, A. Bernhard, and J. Metge, *Phys. Rev. B 54,* 14942-14945 (1996).

[2] 0. Diat, P. Bosecke, C. Ferrero, A.K. Freund, J. Lambard, and R. Heintzmann, *Nuc. Instr. Meth.* **A 356**, 566-572 (1995).