Experimental Report

24/11/2012

Proposal:	**1-02-3**	**Council:**	4/2008	
Title:	Magnetic Quantitative Texture Analysis (MQTA) using neutron diffraction.			

This proposal is continuation of: 1-01-43

Researh Area: Physics

Main proposer: **LEON François**

Experimental Team: CHATEIGNER Daniel

Local Contact: OULADDIAF Bachir
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Samples: FeSi
NdFeV

Instrument	Req. Days	All. Days	From	To
D19	3	3	28/11/2008	01/12/2008

Abstract:

Characterisation of magnetic materials in terms of angular orientation of macroscopic magnetic moments is classically obtained using magnetisation measurements. However such measurements are not able to investigate how the resulting magnetic signals are linked to the crystallites and microstructures.

Neutron diffraction is able to probe not only crystallite texture from nuclear diffraction, but also magnetic texture from magnetic diffraction. It is proposed here, on one hand, to further develop the approach already accepted in April 2007 (1-01-43): i.e. acquiring magnetic diffraction peaks versus sample orientation, to analyse the magnetic orientation distribution functions. The previous proposal confirmed the method of QTA developed on D19, the formalism for the data treatment is in progress and will be published soon and on the other hand, to confirm the first promising magnetic orientation distribution functions (MODF) obtained for iron alloy. From the previous experiments, we obtained the first magnetic pole figures and we would like to confirm this approach by measuring other ferromagnetic samples for FeSi.

Magnetic Quantitative Texture Analysis (MQTA) using neutron diffraction

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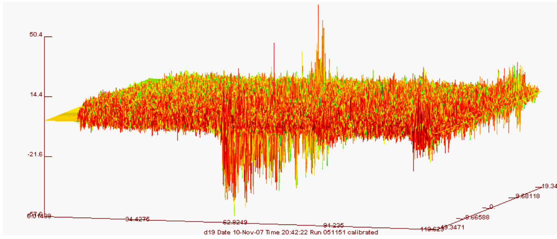
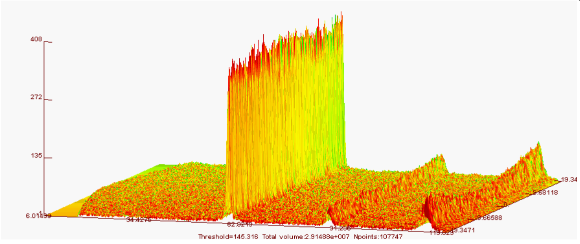
The present work was devoted to the study of Magnetic Quantitative Texture Analysis (MQTA), which characterizes magnetic moment distributions of magnetic materials, and investigates the links between magnetic signals, crystallites and microstructures.

The analysis was carried out on the new Curved Area Position Sensitive detector of the D19 beamline at ILL, Grenoble, which spans 120° in 2θ and 30° in χ. Indeed, to target MQTA, weak neutron magnetic difference signals have to be measured using large solid angle detectors to reduce acquisition times. This is indeed necessary when using unpolarised neutron beams as in this study. A special magnetic sample holder was developed which allows application of a magnetic field which is fixed relative to the sample when this latter rotates in the Eulerian cradle, and with a maximum field of 0.3T applied to the sample.

Starting from an isotropic magnetic state, we first measured the pole figures at zero field of a <110> fibre textured iron sample. We then applied a 0.3T field without sample dismounting, and worked out difference pole figures. The initial isotropic contribution of the magnetic scattering was calculated using the summed diagrams and Fullprof. Both latter steps were used to construct on one hand the total magnetic scattering pole figures, and on the other hand the scattering polarization pole figures. Using the WIMV approach we then refined the magnetic ODF, $f_m(g)$, and the magnetic scattering polarization ODF, $\Delta f_m(g)$, respectively accounting for the total magnetic scattering signal and for the magnetic scattering reorientation. We illustrate on the iron sample how one can construct from the total magnetic pole figures, the 3D orientation of the magnetic moments.

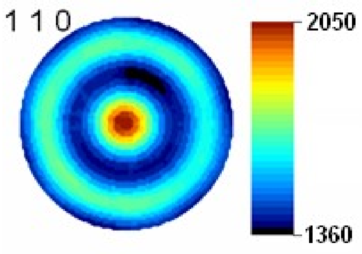


b)

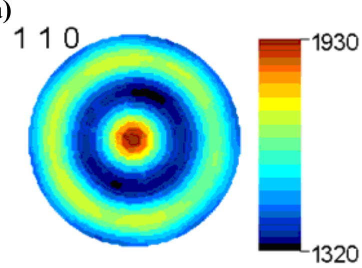


a)

One 2D Debye-Scherrer pattern for one sample orientation without field (left) and difference pattern for the corresponding sample orientation (right).



a)



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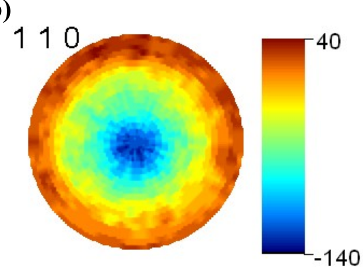
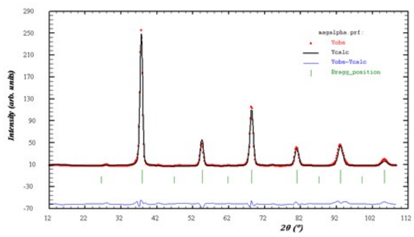
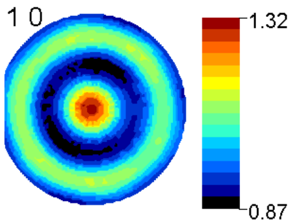


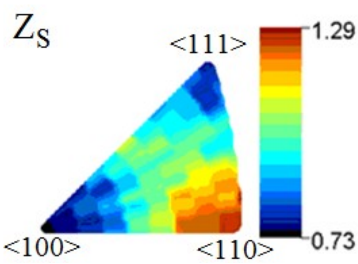
c)



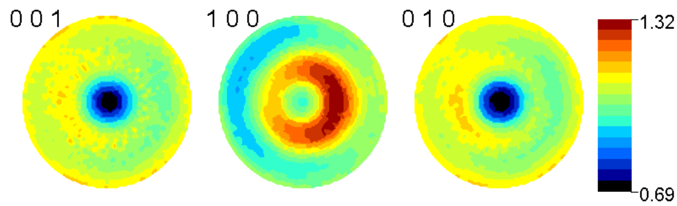
d)



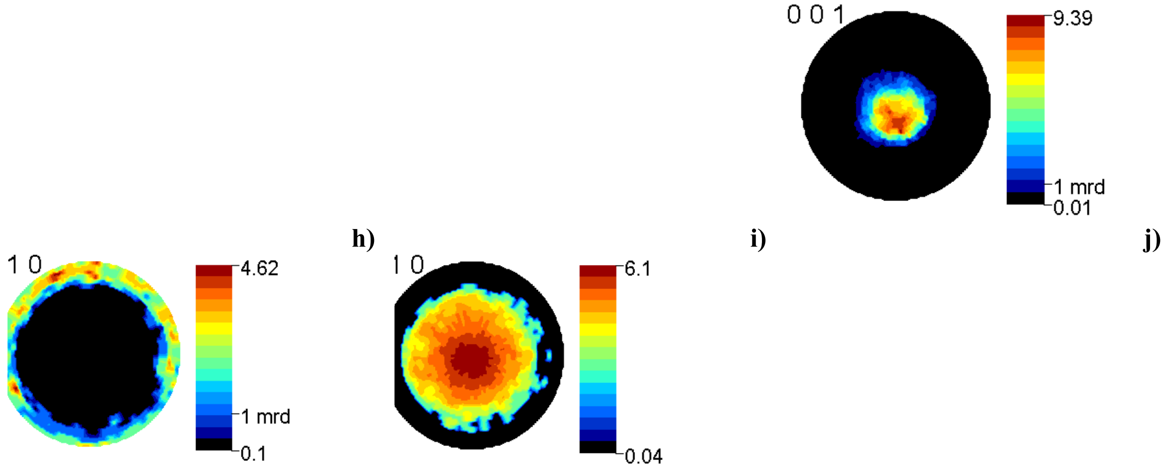
e)



f)



g)



{110} pole figures at zero field (**a**), under 0.3 T (**b**) and difference (**c**). Fit of the sum of all diagrams at zero field using the orthorhombic magnetic sub-group in Fullprof (**d**), and WIMV recalculated-normalised nuclear {110} pole figure (**e**). Inverse nuclear pole figure for the cylinder sample axis direction (**f**) and WIMV recalculated-normalised magnetic-scattering contribution for the main orthorhombic axes (**g**). Recalculated-normalised magnetic-scattering polarisation pole figures for the positive (**h**) and negative (**i**) parts of the difference pole figures, and corresponding positive {001} magnetic-scattering pole figure illustrating the magnetic moment reorientation (**j**).

This work is now published:

D. Chateigner, B. Ouladdiaf, F. Léon: Magnetic Quantitative texture analysis using isotropic thermal neutron beams: *Solid State Phenomena* **160**, 2010, 75-82,

http://www.ecole.ensicaen.fr/~chateign/pdf/SSP160_75.pdf