INHOMOGENEOUS MAGNETIZATION IN AMORPHOUS Ni-Fe BASED ALLOYS
Jodi Schneider, A. Handstein, I. Henke, K. Závěta, T. Mydlarz

To cite this version:
Jodi Schneider, A. Handstein, I. Henke, K. Závěta, T. Mydlarz. INHOMOGENEOUS MAGNETIZATION IN AMORPHOUS Ni-Fe BASED ALLOYS. Journal de Physique Colloques, 1980, 41 (C8), pp.C8-682-C8-685. <10.1051/jphyscol:19808171>. <jpa-00220273>

HAL Id: jpa-00220273
https://hal.archives-ouvertes.fr/jpa-00220273
Submitted on 1 Jan 1980

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
INHOMOGENEOUS MAGNETIZATION IN AMORPHOUS Ni-Fe BASED ALLOYS

J. Schneider, A. Handstein, I. Henke, K. Závěta* and T. Mydlarz**

*ZWF, AdW der DDR, 8027 Dresden, Postfach, DDR
**Inst. of Phys., Czechosl. Acad. Sci., 186 40 Prague 8, CSSR
***Intern. Lab. for High Mag. Fields and Low Temp., Wroclaw, Poland.

Introduction
In the amorphous Ni-rich(Fe_xNi_{1-x})_{80}P_{10}B_{10} alloys, the magnetization M(T,H) appears to be heterogeneous up to the critical concentration [1]. The analysis of the field and temperature dependence of M in fields up to 4 T for the Ni-rich magnetically inhomogeneous alloys indicated an anomalously large paraprocess [2] and showed the existence of spontaneously magnetized regions in addition to super-paramagnetic particles [3].

In the present work, we report on measurements of M(T,H) in high magnetic fields up to 14 T as well as on the results of small angle X-ray scattering experiments.

Experimental
Samples of the same nominal chemical composition were prepared by the Taylor technique in the form of thin wires and as ribbons by the conventional single-roller type quenching. All the samples used for the subsequent measurements were carefully checked by X-ray diffraction to be amorphous.

The M(T,H) curves were measured by a ballistic method in the temperature region from liquid He up to 200 K. For the small angle X-ray scattering experiments at room temperature a horizontal diffractometer and monochromatic Co-radiation were used.

Results and Discussion
The investigated samples with 0.04 ≤ x ≤ 0.2 show a remarkable nonlinear increase of the magnetization up to the highest field used. Typical M^2 vs H/M curves (Arrott-Belov-Kouvel plots) for amorphous wires and ribbons are given in Figs. 1 and 2 for x = 0.1 and 0.07 respectively. Below and above the magnetic ordering temperature a concave curvature appears as with crystalline giant moment systems like Ni-Cu. By the deviations from the linear ABK plots, which are expected for magnetically homogeneous alloys [4], one can characterize the degree of heterogeneity. No observable differences in M(H,T) were detected between wires and ribbon samples of the same composition.
The intensity distribution in the small angle X-ray scattering experiments for \( x=0.07 \) as a function of the scattering angle is given in Fig. 3. Corrections for the normal background and additional scattering were applied to the data. The intensity at low scattering angles increases upon annealing. Assuming "chemical particles" with a mean diameter of about 200 \( \AA \) and no interference effects, a reasonable fit to the observed intensity curve in the as-quenched state was obtained. The differences between the theoretical curve and the experimental points may be due to a distribution in particle size. This result supports our earlier assumption [1] that the existing compositional fluctuations or phase precipitates result in inhomogeneous magnetization and consequently in non-linear ABK plots.

Small-angle scattering experiments in alloys with \( x=0.5 \) show no formation of chemical clusters of the size of 100 \( \AA \) or

---

**Fig.1.** Arrott-Belov-Kouvel plots for \( (\mathrm{Fe}_{0.1}\mathrm{Ni}_{0.9})_{80}\mathrm{B}_{10} \) wires in high fields

**Fig.2.** Arrott-Belov-Kouvel plots for \( (\mathrm{Fe}_{0.07}\mathrm{Ni}_{0.93})_{80}\mathrm{B}_{10} \) ribbons in fields up to 14 T.
annealed sample

\[ 0.1300 \text{OC}, \] lh

\[ \text{o} \]

\[ \text{calculated curve} \]

Fig. 3. Small-angle X-ray intensity vs scattering angle:

- experimental points
- calculated curve

larger. This is expected from the experimentally determined magnetic phase diagram for \( (\text{Fe}_x\text{Ni}_1-x)_8\text{O}_{10}\text{P}_{10} \) \([2]\), according to which the compositions with \( x > 0.22 \) are magnetically homogeneous.

The reciprocal differential susceptibility \( \chi^{-1}(H,T)=(\partial M(H,T)/\partial H)^{-1} \) as a function of \( H \) is given in Fig. 4 for \( x = 0.1 \). It is seen that for some range of fields and temperatures the dependence of \( \chi^{-1} \) may be approximated as being linear in \( H \); the slope decreases with increasing temperature. Similar behaviour was also found for \( x = 0.04 \) and 0.07. This high field dependence of \( \chi \) cannot be explained by the normal law of approach of magnetization to saturation. For the paraprocess resulting from the thermally excited magnons one finds the relation \( \chi \sim H^{-1/2} \) \([3]\); a term of this form was in fact observed in magnetically homogeneous system \([5]\). Compared to this case, our magnetically inhomogeneous system displays an anomalous contribution to the paraprocess which may originate from the influence of the external field on superparamagnetic clusters present in the ferromagnetic matrix \([2,3]\).

Such a phenomenological model also explains the observed curved Arrott-Belov-Kouvel plots \([2,3,7]\).
The authors gratefully acknowledge the possibility of using the high field facilities of the International Laboratory of High Magnetic Fields and Low Temperatures in Wroclaw, Poland.

References