

X-RAY DIFFUSE SCATTERINGS IN A Fe-Pt INVARIANT ALLOY

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Abstract-Measurements of X-ray diffuse scatterings were made in disordered single crystal of Fe-28.3at%Pt Invar alloy around a 200-Bragg peak in a wide temperature range between 15 K and 300 K. Observed diffuse scatterings were almost spherical, suggesting a homogeneous disordered alloy. However, the q -dependence of the observed thermal diffuse scattering was different from the usual type, indicating a possibility of existence of local distortion of lattice accompanied by a large gradient of stress.

1. INTRODUCTION

It is well known that a Fe-Pt alloy with Pt-concentration around 28 at% is one of the three typical Fe-base transition metal Invar alloys [1]. This alloy shows the Invar anomalies both in magnetic character and in lattice properties. There have been made a large amount of studies in both measurements of magnetic character and lattice structure [2].

The Invar character is frequently discussed in Fe-Ni Invar alloys by considering the existence of the concentration fluctuation, and the concentration dependence of the magnetic moment was reasonably explained. Among the three typical Invar alloys, the Fe-Pt Invar alloy is said to be the most uniform alloy. In this alloy the magnetic moment decreases abruptly from the Slater-Pauling curve with decreasing the Pt-concentration. However, there have never been made any detailed experimental study in the lattice inhomogeneity in this alloy.

The X-ray diffuse scattering is an excellent technique to detect a small lattice inhomogeneity caused by a very small lattice distortion. This method was developed in determining the defect structure in the research area of point defects [3].

In this report we describe a result of X-ray diffuse scattering measurement which was made to detect any small lattice inhomogeneity in a Fe-Pt Invar alloy.

2. EXPERIMENT

The specimen was a disc shape single crystal of disordered 28.3 at% Pt-Fe alloy. The disc surface was parallel to a (100) plane. The diffuse scattering measurements were made by using a four-circle goniometer. The X-ray source was a Cu-rotating target, and the beam was monochromatized through a Ge (111) reflection. The X-ray optical arrangements were made so as to make it possible to observe the three dimensional diffuse scattering around 200-Bragg peak.

The temperature of the specimen was made variable between 15 K and 300 K and controlled by using a closed cycle cryostat. The X-ray beam was lead to the specimen through a thin carbon FRP window.

3. EXPERIMENTAL RESULTS AND DISCUSSION

Observed Bragg peak profiles of the 200-reflection are shown in Fig.1. The peak intensity decreased gradually by increasing the

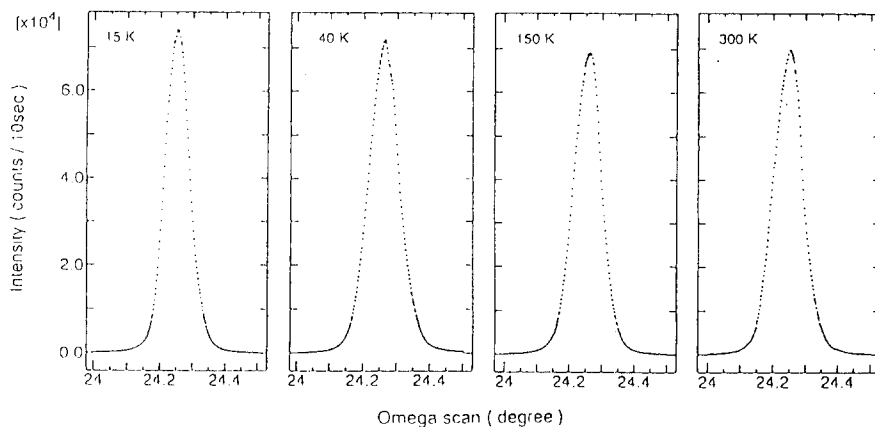


Fig.1 Temperature variation of Bragg peak profiles of 200-reflection.

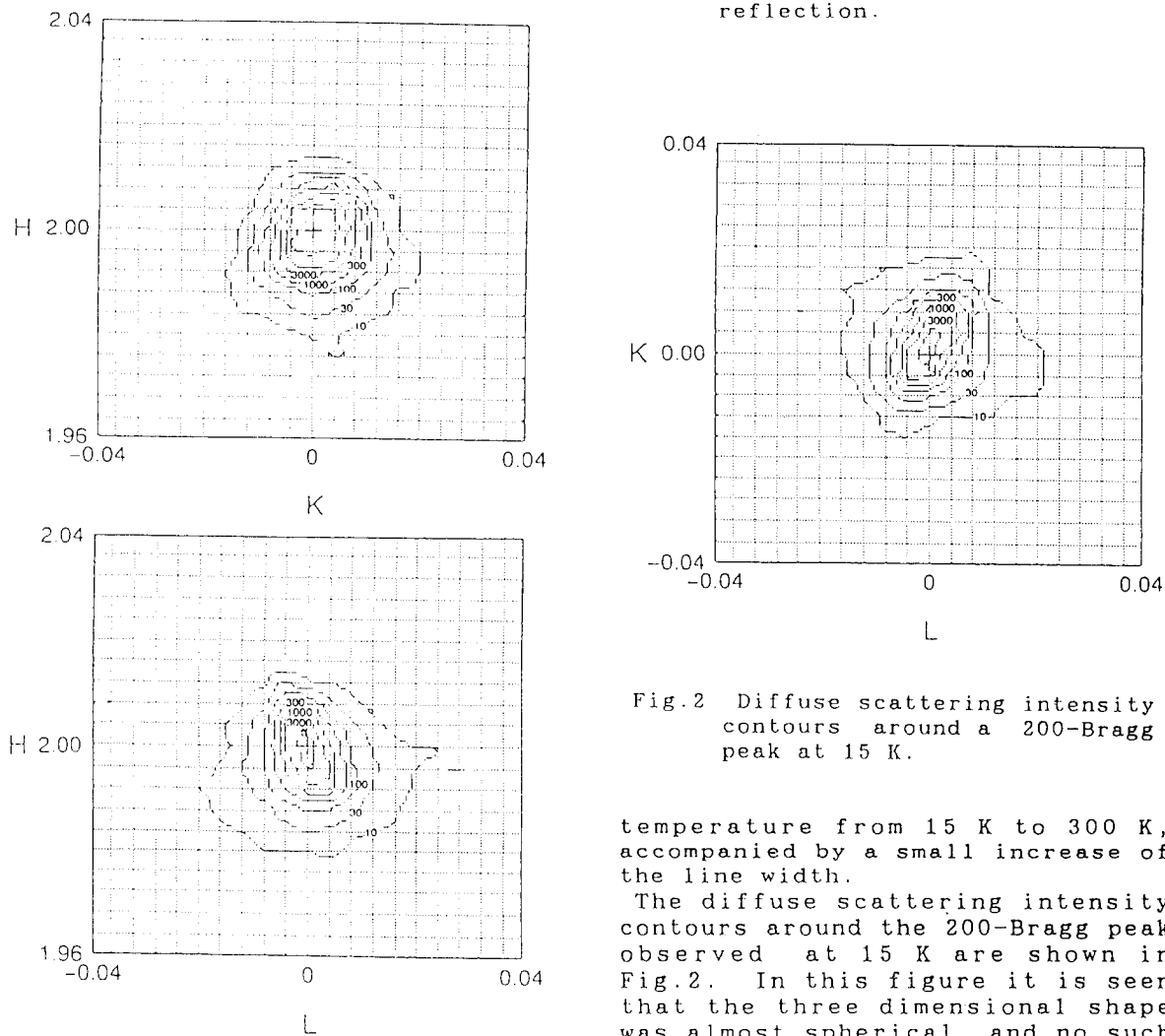


Fig.2 Diffuse scattering intensity contours around a 200-Bragg peak at 15 K.

temperature from 15 K to 300 K, accompanied by a small increase of the line width.

The diffuse scattering intensity contours around the 200-Bragg peak observed at 15 K are shown in Fig.2. In this figure it is seen that the three dimensional shape was almost spherical, and no such

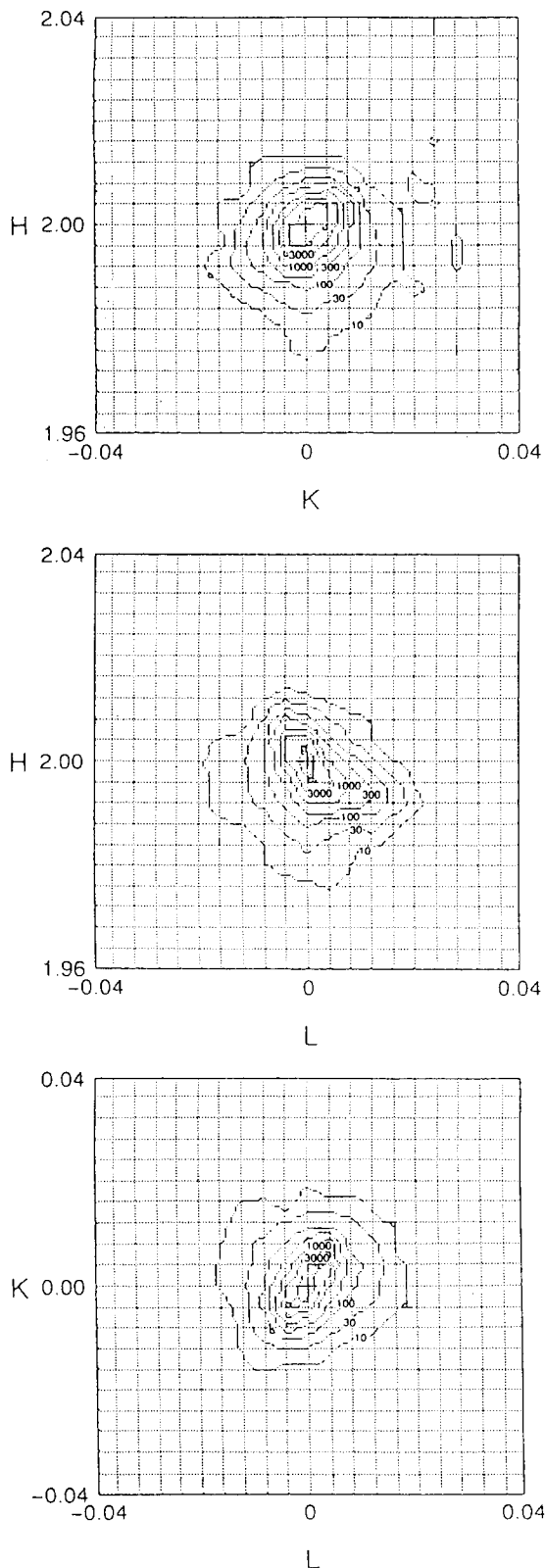


Fig.3 Diffuse scattering contours around the 200-Bragg peak at 300 K.

anomaly was observed as seen in Fe-Pd or Fe-Ni Invar alloys [4,5]. The diffuse scatterings at 300 K are shown in Fig.3. The shape was also spherical with the diameter slightly larger than that of 15 K, being reflecting the usual thermal diffuse scattering.

From the results of the present measurements it can be considered that, in contrast to other typical Fe-base Invar alloys, the Fe-Pt Invar alloy is quite uniform down to the low temperature range where the negative thermal expansion takes place.

To investigate more closely the diffuse scattering profiles, a log-log plot of the q -dependence of the difference of the intensity between 15 K and 300 K was made and shown in Fig.4. In this figure it is seen that the slope of the q -dependence is about -4, which is much steeper than the expected value of -2 from the usual thermal diffuse scatterings. This fact suggests that there is a possibility of existence of local distortion of lattice accompanied by a large gradient of stress distributed three dimensionally. This type of stress is quite different from those observed in Fe-Ni and Fe-Pd Invar alloys, which have two-dimensional and one dimensional like stress, respectively.

4. CONCLUSIONS

The X-ray diffuse scattering around a 200-Bragg peak in Fe-28.3at%Pt Invar alloy was almost spherical in the temperature range between 15 K and 300 K. The observed diffuse scattering seems to consist of the thermal diffuse scattering, but the q -dependence was a little different from the usual thermal diffuse scattering.

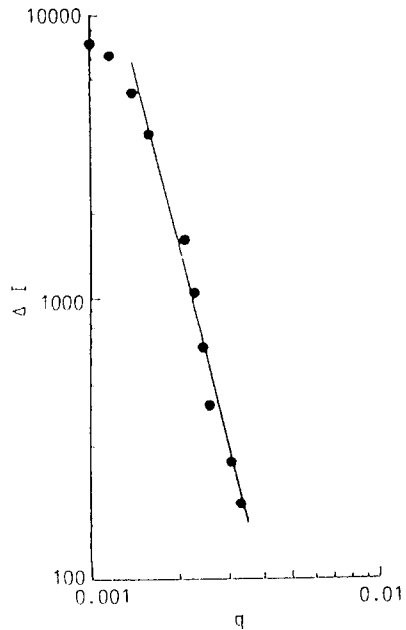


Fig.4 A log-log plot of the diffuse scattering intensity differences between 15 K and 300 K vs q -value.

This fact may suggest an existence of local distortion of lattice with a large gradient.

ACKNOWLEDGMENT

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