

QUALITATIVE TEXTURE INVESTIGATION OF A MARAGING STEEL SAMPLE
BY NEUTRON DIFFRACTION TECHNIQUE

Reynaldo Pugliesi and Ione Makiko Yamazaki

Divisão de Física Nuclear (TFF)
Instituto de Pesquisas Energéticas e Nucleares
Comissão Nacional de Energia Nuclear
Caixa Postal 11049 - Pinheiros
CEP 05499 - São Paulo - SP - Brasil

Abstract: By means of the neutron diffraction technique the texture of a maraging steel rolled sheet have been determined. The measurements were performed by using a neutron diffractometer installed at the IEA-R1 Nuclear Research Reactor, in the beam-hole nº 6. To avoid corrections such as neutron absorption and sample luminosity the geometric form of the sample was approximated to spheric and its dimensions do not exceed that of the neutron beam. The texture of the sample was analysed with help of a computer programme that analyses the intensity of the diffracted neutron beam and plot the pole figure.

Introduction

Polycrystalline materials are aggregates constituted by a great quantity of crystallites or grains. Each grain is practically a monocrystal which, in general, presents anisotropy relative to one or more physical properties. This local anisotropy is not very important if these grains are randomly oriented, but thermal treatment and mechanical processes as extrusion, rolling, sintering can induce some preferred grain orientation (texture) which will result in an anisotropy of these physical properties to the material /5,6/. In this way, becomes necessary to comprehend the texture development for get better control of some physical properties as magnetic anisotropy, thermal expansion, etc..., which are of great interest for many industrial materials and so, in this case, its quality control will must include the texture control.

Texture can be represented by means of pole figures /11/. The X-rays and neutron diffraction technique are commonly employed to its obtention.

The purpose of this paper was to determine by the neutron diffraction technique /2,9/ the texture of a maraging steel sample and to corroborate qualitatively, by means of this result, some of its properties.

Description of the Technique

The reflection and transmission methods of the incident beam in the sample are commonly utilized in this technique and the reflection one was employed /4/. According this method the sample is rotated in its own plane, around an N axis normal to its face (β angle) and around an A axis horizontal (α angle) as indicated in the figure 1.

The main difficult relative to neutron diffraction technique employment is the necessity to have a relatively high (10^4 - 10^5 n/sec/cm²) incident thermal neutron flux at the sample, obtained only in nuclear reactors.

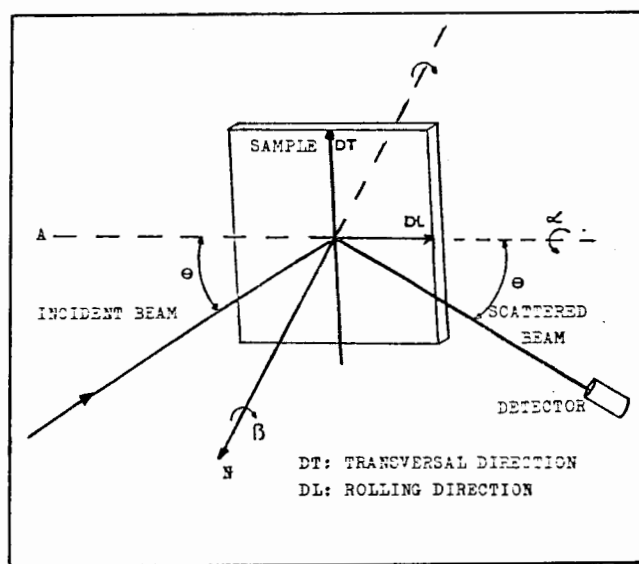


Figure 1 - Geometry of the Reflection Method

Experimental Part

Experimental Arrangement and Sample Preparation

The experimental measurements were carried out by making use of a neutron diffractometer installed at the beam-hole nº 6 of the IEA-R1 Nuclear Research Reactor /14/. A schematic diagram of this diffractometer is presented in the figure 2. The extracted neutron beam, exposure area 5 x 5 cm², is monochromatized ($\lambda=1,137\text{\AA}$) by a lead mono crystal (crystallographic plane 220) and after scattering in the sample is registered by a BF₃ proportional detector.

The sample is positioned at the diffractometer in a proper texture goniometer.

The material studied was a 90% rolled maraging steel sheet which was cut in order to obtain small cylinders which rigidly superposed and maintaining its rolling directions parallel to themselves constitutes the sample in an approximately spherical geometrical form with 2 cm diameter.

The "maraging" term is an abbreviation of "martensite age hardening" and is applied to a special steel groups with high mechanical resistance obtained by an aging reaction (around

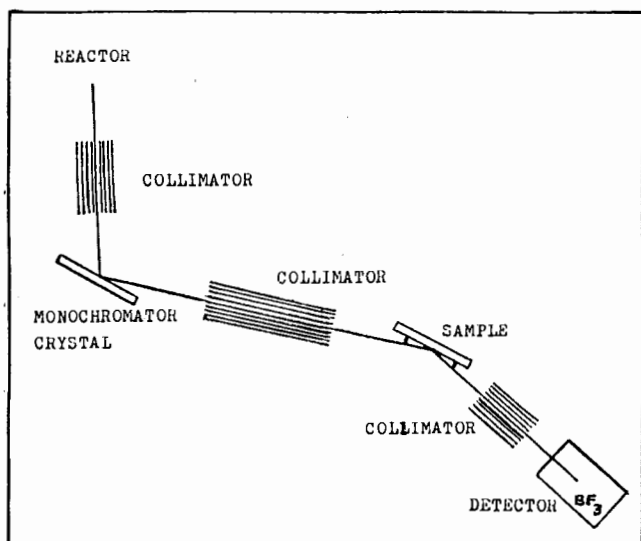


Figure 2 - Schematic Diagram of the Neutron Diffractometer

500°C) of a martensitic matrix with low carbon content /1/. Its composition is = Ni 18%; Co 10%; Mo 5%; Ti 0.8%; Fe 66%; C < 0.05%.

The dimensions and the shape of this sample are in such a way that stay completely immersed in the neutron beam hence absorption and illumination corrections are avoided when the sample is rotated for each angular coordinate (α, β) in which the measurements are achieved /13/.

Obtention and Data Treatment

The neutron diffracted beam intensity measurements were performed by positioning the diffractometer at the Bragg angle $2\theta = 32.23^\circ$ corresponding to the 110 crystallographic plane.

A total of 722 experimental points correspondent to α and β coordinates varying between 0° to 180° and 0° to 90° , respectively, in a 5° interval were necessary to the pole figure construction. The time interval for obtention of these experimental points was approximately 100 hours.

The background, subtracted from measured intensities, comes from incoherent scattering by the sample and of the surroundings where the diffractometer is located. Owing to be a qualitative texture analysis this was the only correction made to the experimental data /14/.

A computer programme analyses the experimental intensities and generates the pole figure correspondent to the data assemblage /8/.

Results Analysis

The results obtained in this paper confirm qualitatively some characteristics of the maraging steels.

The pole figure is presented in the figure 3 and by observing point density distribution we can conclude that the poles are not well defined meaning that although the sheet had suffered a high degree of lamination it was not occurred a high preferred grain orientation.

These results and the pole figure assymetry are expected to materials with a high mechanical resistance and a good tenacity to fracture, both characteristics of this type of steel /1/.

To testing the reliability of this pole figure we have performed texture measurements for an aluminium sample highly laminated (98%) and

compared them with the literature /7/. The results are presented in figure 4 and 5 and by a visual comparison we can observe its agreement.

It is important to point out that some of the characteristics of this sample such as grain size, sheet thickness becomes difficult its texture analysis by X-Rays diffraction technique /3,10,11,12/.

The IPEN-CNEN/SP Nuclear Physics Division has developed the neutron diffraction technique applied to texture analysis which, as demonstrated by several authors /8,4,6/ is desirable to these studies and has been constantly developed and commonly employed in others research establishment for material analysis.

REFERENCES

1. A.H.P.de Andrade; P.I.Ferreira; W.A.Monteiro Thermal treatment influence in fragilization of a maraging steels. In: Brazilian Association of Nuclear Energy. Nuclear energy: annals of the 1st General Congress of ... held in Rio de Janeiro, March 17-20, 1986 p. 125.
2. G.E.Bacon: Neutron diffraction 2.ed. Oxford, Claremon, 1962.
3. V.Baffigo; M.Domenici: Atompraxis, 13(8):121-5, 1967.
4. H.J.Bunge: Mathematical methods for texture analysis. Berlin, Springer-Verlag, 1981.
5. H.J.Bunge: Z.Metall kd., 76(7):457-71, 1985.
6. H.J.Bunge: Texture analysis in materials science. Mathematical methods. London, Butterworths, 1982. p.85-88.
7. O.J.Eder; R.Klemencic: J.Appl.Crystallogr., 8:628-35, 1975.
8. N.B.de Lima; E.Gallego; K.Imakuma: Texture Analysis by Means of Incomplete Pole Figures. (IPEN-Pub-95).
9. A.Ol3s; J.Szpunar; J.Sosmowska: Nukleonika, 13(2): 173-8, 1968.
10. E.F.Strucken; J.W.Croach: Trans.Metall.Soc. AIME, 227: 934-40, 1963.
11. J.Szpunar: At. Energy Rev., 14(2): 199-261, 1976.
12. J.Szpunar; A.Ol3s; B.Buras; J.Sosmowska; E. Pietras: Nukleonika, 13(11): 1111-2, 1968.
13. J.Tobisch; H.J.Bunge: Texture, 1:125-7, 1972.
14. S.I.N.Ueno: Preferential orientations in niobium determined by neutron diffraction. (IEA-DT-98).

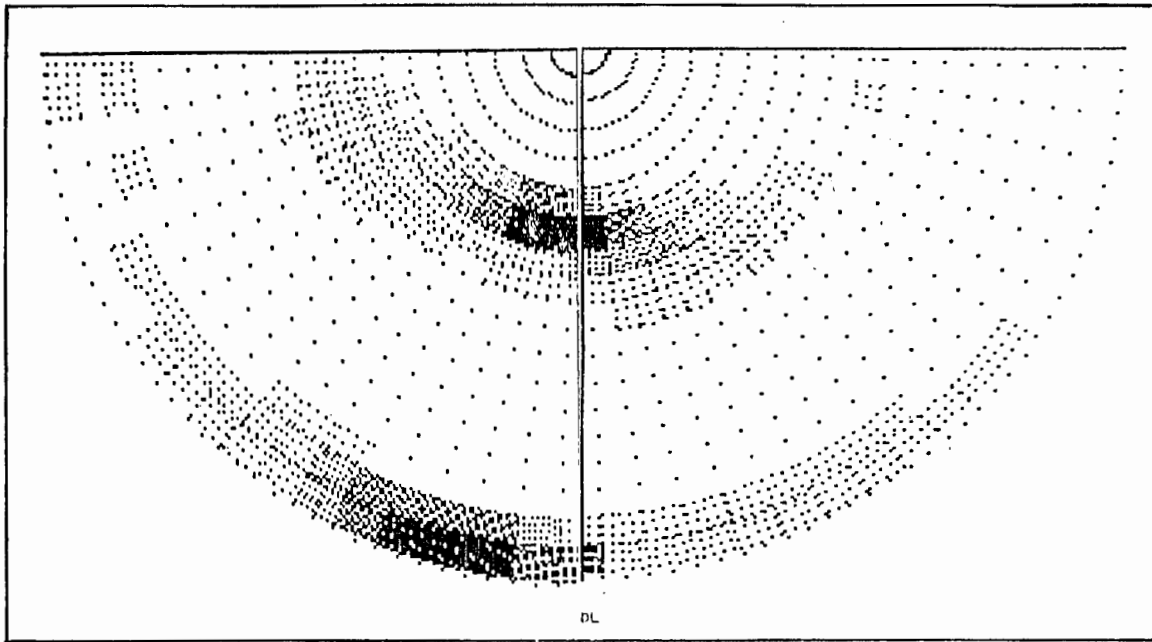


Figure 3 - Pole Figure Obtained to the Maraging Steel Sample. Crystallographic Plane (110).

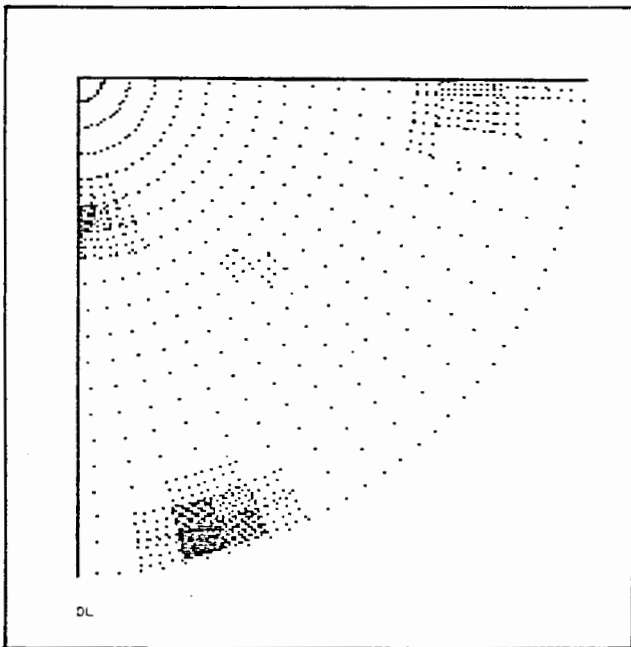


Figure 4 - Pole Figure Obtained to Aluminium Sample Rolled to 98%. Crystallographic Plane (111).

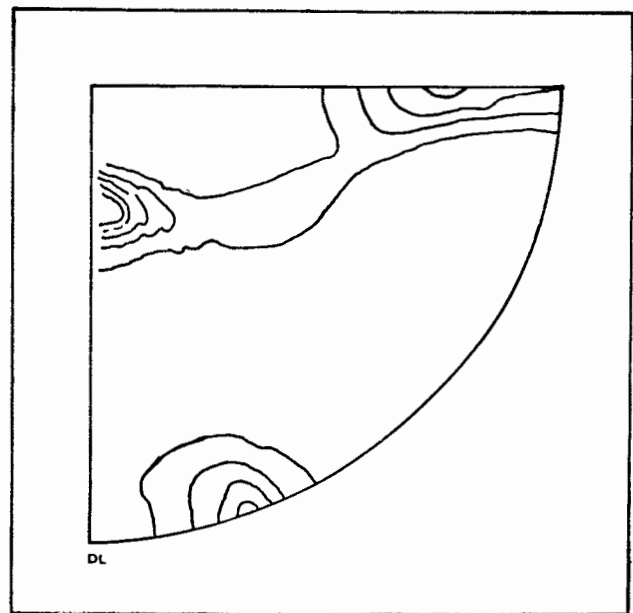


Figure 5 - Pole Figure Obtained in Literature. Rolled Aluminium to 90%. Crystallographic Plane (111).