Texture analysis of low-carbon packing sheets with high energy synchrotron radiation

P. Ignath[1], J. Bednarcik[2], S. Niznik[1]

[1]Technical University, Faculty of Metallurgy, Letna 9, 042 00 Košice, Slovakia

[2]Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, D-22603 Hamburg, Germany

Introduction

Packing high-quality steel belong to the progressive types of steel. From other commonly manufactured steel products differ not only by their low thickness, the characteristic mechanical properties, types of plating, but also by their specific industry and market requirements such as high production speed requirements for the design and so on. Modern packing sheets can be used by manufacturers for the purpose of low-carbon aluminum-killed steel, effervescent. In a case of the packing sheet it is desirable to achieve the texture in which the normal of the (111) planes coincides with the normal of the sheet. Such texture ensures ideal conditions for further processing, especially pressing or deep drawing. On the other hand when the texture (100) is formed the plastic properties are very wrong. The preferred orientation that is produced by sheet rolling is called a deformation texture. Cold rolling should be usually followed by recrystallization annealing which yields specific microstructure ensured desired properties.

Experiment

Samples used in this study were from slabs hot rolled at the temperature (Tfin = 870 ° C) and coiled at (Tcoiling= 720 ° C). Definitely we can say that the high temperature causes the precipitation of AlN during the coiling process. Hot rolling was followed by pickling the sheets. Pickled hot bands were cold rolled on the five-stand tandem with the overall reduction of more than 90% due to final thickness 0.2 mm. The chemical composition of experimental low carbon Al-killed steel is given in Table 1.

Tab. 1: Chemical composition [wt %]

C	Mn	Si	S	P	Al	N
0.02	0.253	0.008	0.0069	0.008	0.043	0.0034

Experimental samples were taken in the rolling direction with the dimensions 40 x 20 x 0.2 mm. Recrystallization annealing was carried out under laboratory conditions in a resistive crucible furnace brand ESA Prague type K59 in non-toxic salt mixture-type NETOX SZ 600. working in the form of melt in the temperature range 540 to 800 °C. The course of the recrystallization process has been studied in isothermal conditions (600°C, 700°C, 800°C) and different annealing time intervals. The texture measurement experiments were carried on six sheets which were annealed at different temperatures and times. As a reference cold rolled sheet was used. Synchrotron radiation at the BW5 station with beam energy 80 keV equals to the wavelength λ = 0.155 Å was used. During measurement the samples to detector distance was fixed to 747 mm. In order to determine the texture of rolled sheets X-ray diffraction patterns were collected upon rotation of the sample around vertical axis which denotes its rolling direction. The ω was scanned in the range between -80° and +80° with the step of 2°. The ω = 0° refers to the situation when beam hits the sheet perpendicularly. Since we used two-dimensional detector there is no need to rotate the sample around the beam as denoted by angle φ.

Results

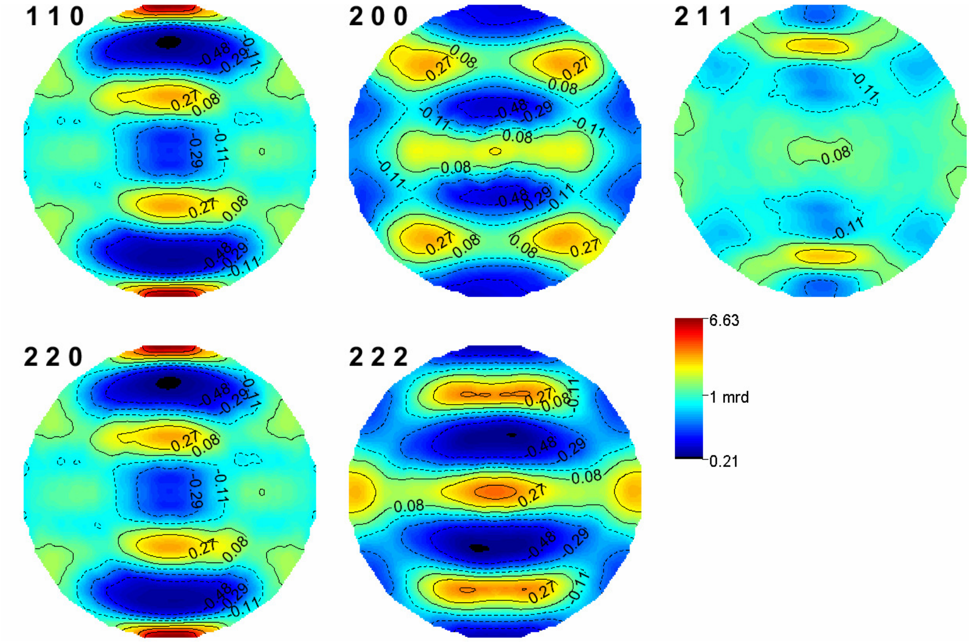

Figure 1: Pole figures for selected Bragg reflections of bcc-Fe in case of rolled sheet prior annealing.

X-ray diffraction using high-energy photons was used to study the texture of rolled and annealed sheets. All samples reveal relatively large extent of texture. Pole figures were calculated using a MAUD software package [1]. But, on the basis of pole figures analyses can be found substantial differences in the texture of samples after cold deformation and recrystallization annealing. After cold deformation typical deformation texture appears, which consists mainly of rolling texture component {200}. Samples after recrystallization annealing, depending on the annealing time, show increasing deviation from the main orientation (200). The recrystallisation texture orientation is formed from {111} component, whose intensity increases with annealing time. After complete recrystallization annealing process, we observe a strong texture with orientation {111}. However, it can be note that the orientation {200} is in the recrystallisation texture, too. This question obviously relates to the kinetics of recrystallization process and its relationship with precipitating characteristics and is a subject of further research.

References

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