



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Determination of Banded Structure of Steel - Part 2:
Quantitative Method**

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1 Scope

This Part of GB/T 34474 stipulates the qualitative description, classification and quantitative determination methods for banded structure of steel.

This Part is applicable to the determination of banded structure of steel, including the determination of parameters, such as: orientation degree, anisotropy index, the number of banded structures per unit length, and the distance among banded structures, etc. Other oriented structures may take this as a reference.

2 Normative References

The following documents are indispensable to the application of this document. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 13298 Inspection Methods of Microstructure for Metals

GB/T 15749 Measuring Method in Quantitative Metallography

GB/T 30067 Standard Terminology Relating to Metallography

GB/T 34474.1 Determination of Banded Structure of Steel - Part 1: Micrographic Method Using Standards Diagrams

3 Terms and Definitions

What is defined in GB/T 30067, and the following terms and definitions are applicable to this document.

3.1 Feature Interceptions

Feature interceptions refers to the number of banded structures crossed by the measurement grid lines (see N_1 and N_2 in Figure 1).

3.2 Feature Intersections

Feature intersections refers to the number of banded structure boundaries crossed by be used to count and quantify the banded structure images with scale.

6 Sampling

6.1 Under general circumstances, samples shall be intercepted from products under the delivery state.

6.2 In terms of plates, samples shall be intercepted at 1/4 of the plate width.

6.3 The inspection area of the samples is approximately 200 mm² (20 mm × 10 mm).

The inspection surface shall be parallel to the main deformation direction of the rolled steel.

6.4 Sampling methods and sampling size shall comply with the stipulations of product standards or technical conditions. If they are not specified in product standards or technical conditions, then, comply with GB/T 34474.1.

7 Sample Preparation The grinding and erosion of sample shall comply with the stipulations of GB/T 13298.

After grinding and polishing, the observation surface of the sample shall reach mirror finish and manifest no stains or scratches. After the polishing, use 4% nitric acid alcohol to erode the sample for 10 s ~ 15 s. Then, blow dry it for later usage.

8 Analytical Procedures

8.1 Image Acquisition Place the prepared sample on the object stage; adjust the sample, so that the banded structures are in the horizontal direction. Generally speaking, 5 X ~ 20 X objective lens are selected. Under the condition that the phase structures can be clearly distinguished, and the grain boundaries are clear, select the magnification as small as possible for observation. In accordance with the agreement between the demand-side and the supply-side, objective lens of other magnifications may also be selected. Under general

circumstances, the distribution, the degree of aggregation and the width of banded structures vary greatly in the longitudinal section. Thus, the evaluation location of banded structures shall be specified in product standards or the agreement between the demand-side and the supply-side. At the evaluation location, randomly collect more than 5 field-of-view photos.

8.2 Qualitative Description and Classification

8.2.1 General rules not be selected with deflection. Avoid measurement lines that are merely distributed in the local matrix phase of the field of view, or merely on two limited banded structures.

8.3.3 Counting of feature interceptions and intersections When two or more adjacent grains in the banded structure are crossed by the measurement line, in other words, there is no other phase between the grains, then, it shall be recorded as one interception ($N = 1$) or two intersections ($P = 2$). When the measurement line is tangent to the banded structure, it shall be recorded as a half interception ($N = 0.5$) or one intersection ($P = 1$). If the measurement line ends within the banded structure, it shall be recorded as a half interception ($N = 0.5$) or one intersection ($P = 1$). If the measurement line is completely within the banded structure (this circumstance sometimes occurs in the counting of the parallel direction of highly banded structures), it shall be recorded as a half interception ($N = 0.5$) or zero intersection ($P = 0$). It is feasible to merely count the number of feature interceptions or feature intersections. Or, the counting of feature interceptions and feature intersections may be simultaneously conducted. The number of feature interceptions and feature intersections shall be respectively counted for the measurement line parallel to the deformation direction and perpendicular to the deformation direction.

8.3.4 Calculation of feature interceptions and (or) intersections per unit length Respectively measure the total length L_t of the inspection line parallel to the deformation direction and the total length L_t of the inspection line perpendicular to the deformation direction in a single field of view. In accordance with Formula (1) ~ Formula (4), calculate NL , NL , PL , PL .

8.3.5 Calculation of average value of multiple fields of view Calculate the average value of feature interceptions and feature intersections of multiple fields of view (n): NL , NL , PL , PL . In terms of highly banded microstructure, NL approximately equals to a half of PL .

8.3.6 Calculation of standard error S In accordance with Formula (5), calculate the standard error of each measured value when %RA is not more than 30%, the measurement result is valid. If %RA is more than 30%, the number of fields of view shall be increased, till %RA is not more than 30%.

Generally, the relative accuracy of the measurement results in the parallel deformation direction is worse than that in the vertical deformation direction. When the number of fields

of view is fixed, the statistical accuracy of coarse-grained structure is usually better than that of fine-grained structure. The accuracy of isotropic structure is better than the statistical accuracy of highly banded structure.

8.3.9 Calculation of average band spacing (SB?)

It is the average distance from the center of banded structure to the center of adjacent banded structure. It may be determined through the reciprocal of $\overline{NL}$ [Formula (8)]:

8.3.10 Calculation of mean free path (??)

Mean free path (the distance from the edge of banded structure to the edge of adjacent banded structure) ?? may be calculated in accordance with Formula (9):

In Formula (9), VV is the volume fraction of banded structure, which needs to be determined through grid point method (comply with GB/T 15749) or other applicable methods.

In accordance with the difference between the average band spacing and the mean free path, the width of banded structure may be estimated. In terms of highly banded structure, $SB?$ and $??$ may be calculated.

8.3.11 Calculation of anisotropy index AI Calculate anisotropy index AI in accordance with Formula (10). If the tangent of the banded structure to the grid line, and the counting error are neglected, PL shall be approximately twice NL . Therefore, the AI values respectively calculated in accordance with feature interceptions and feature intersection are approximately equal. The anisotropy index AI of randomly distributed, non-oriented structures is 1. As the degree of banding becomes aggravated, the anisotropy index AI gradually increases.

or

8.3.12 Calculation of orientation degree $\overline{\theta}_{12}$ Calculate orientation degree $\overline{\theta}_{12}$ in accordance with Formula (11). If the tangent of the banded structure to the grid line, and the counting error are neglected, PL shall be approximately twice NL . Therefore, the $\overline{\theta}_{12}$ values respectively calculated in accordance with feature interceptions and feature intersection are approximately equal.

Orientation degree $\overline{\theta}_{12}$ varies between 0 (completely random distribution) and 1 (completely banded).

8.3.13 Example

Appendix A provides an example of quantitative analysis.

9 Test Report

9.1 The report shall record the designation, sampling location, status, date of analysis,