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

GB/T 13299-2022

Replacing GB/T 13299-1991

**Determination of free cementite, pearlite and Widmanstatten
structure in steel**

钢的游离渗碳体、珠光体和魏氏组织的评定方法

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Table of Contents

1	Scope
2	Normative References
3	Terms and Definitions
4	Cutting and Preparation of Specimens
4.1	Cutting of Specimens
4.2	Preparation of Specimens...
5	Determination Method of Free Cementite
5.1	General Principle...
5.2	Comparison Method with Standard Rating Pictures
5.3	Quantitative Analysis Method with an Image Instrument
6	Determination Method of Pearlite
6.1	General Principle...
6.2	Determination Method
7	Determination Method of Widmanstatten Structure
7.1	General Principle...
7.2	Determination Method
8	Test Report
	Appendix A
	Appendix B

1 Scope

GB/T 13299-2022 is the Chinese national standard on determination of free cementite, pearlite and widmanstatten structure in steel, in the field of metallurgy. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 11 July 2022 by the State Administration for Market Regulation; Standardization Administration of China, and has been in force since 1 February 2023. Classification: ICS 77.040.99, CCS H24. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This document specifies the methods of the cutting, preparation and determination of free cementite, pearlite and Widmanstatten structure specimens in steel. This document is applicable to the determination of free cementite, pearlite and Widmanstatten structure in low-carbon and medium-carbon steel plates, steel strips and steel rods (billets). For other steel types, this document may be taken as a reference.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in this text. 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

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.2 Pearlite When the carbon content in iron-carbon alloy is greater than 0.025% and less than 6.67%, a metastable microstructure formed when local regions in austenite tend to be eutectoid. This structure is formed by slow cooling in the process of eutectoid transformation, which is an alternating lamellar structure formed by ferrite and cementite.

3.3 Free Cementite Free cementite refers to granular cementite that exists independently on the ferrite matrix or grain boundaries.

3.4 Pearlite Colony Pearlite colony refers to a bounded aggregate of sheets of the same phase with the same orientation.

3.5 Widmanstatten Structure Widmanstatten structure refers to a structure, in which, pearlite exists, in hypoeutectoid steel, when proeutectoid ferrite grows from the austenite grain boundary or within the grain along a certain grain plane of the austenite, and precipitates in the form of needles.

4.1 Cutting of Specimens

4.1.1 Cutting positions Under general circumstances, the specimens shall be cut from the steel (or intermediate billet) in the delivery state; the sampling method and sampling size shall comply with the stipulations of the product standards or technical conditions. If there is no special stipulation, the inspection surface of free cementite and pearlite specimens shall be parallel to the longitudinal axis of steel strips, steel plates and steel rods (billets); the inspection surface of Widmanstatten structure specimen shall be perpendicular to the longitudinal axis of steel strips, steel plates and steel rods (billets).

4.1.2 Sampling method of steel plate or steel strip The sampling of steel plate or steel strip is as follows:

4.1.3 Sampling method of steel rod or steel billet The sampling of steel rod or steel billet is as follows:

4.1.4 Method of specimen cutting The specimen shall be cut through a mechanical method in a cold state that does not affect the structure of the specimen. If gas cutting or hot cutting is adopted for the cutting, the melting zone, heat affected zone and plastic deformation zone shall be completely removed.

4.2 Preparation of Specimens The grinding and polishing of the specimens shall be carried out in accordance with the stipulations of GB/T 13298.4% nitric acid ethanol solution should be adopted for the etching of the specimens. The etching effect shall be subject to the clear display of structural characteristics.

5 Determination Method of Free Cementite

5.1 General Principle This method is applicable to the determination of free cementite in low-carbon annealed steel with a carbon content of less than or equal to 0.15%.

5.2 Comparison Method with Standard Rating Pictures

5.2.1 Place the specimen under the bright field of a metallographic microscope for observation; the magnification is 500 times. The diameter of the field of view of the magnified image is 80 mm. Observe the entire inspection surface; select the most serious field of view on the inspection surface. During the determination, compare the most serious field of view of free cementite on the inspection surface with the standard rating pictures in Appendix A for rating, so as to determine the level of the free cementite.

5.2.2 In accordance with the characteristics of the cementite, such as. shape, distribution and size, determine the rating of the free cementite.

5.2.3 In accordance with the structural characteristics, the rating pictures of free cementite are divided into three series.

5.2.4 The pictures of each series are from Level 0 to Level

5. Table 1 provides a detailed description of the structural characteristics of each level.

5.2.5 The determination results are expressed in levels, and the characteristics of the levels are between two adjacent levels, and half levels can be added. If necessary, a series of letters shall be marked, such as. 1.0A and 2.5B, etc.

5.3 Quantitative Analysis Method with an Image Instrument

5.3.1 The metallographic manual measurement method (grid cut point method and

microscope scale method) or metallographic image analysis software can be adopted to determine the area content of free cementite. The magnification shall adopt 500 times.

5.3.2 Calculate the standard deviation s of the results, the expanded uncertainty U_{95} and the relative expanded uncertainty U_{95rel} of the probability 95%. The relative expanded uncertainty is an estimate of the relative precision of the measurement mean; the change of the number of fields of view will affect the relative precision.

6 Determination Method of Pearlite

6.1 General Principle This method is applicable to the determination of pearlite in steel plates, steel strips and steel rods (billets) with a carbon content of 0.1% ~ 0.30%.

6.2 Determination Method

6.2.1 Place the specimen under the bright field of a metallographic microscope for observation; the magnification is 500 times. The diameter of the field of view of the magnified image is 80 mm. Observe the entire inspection surface; select the most serious field of view on the inspection surface for determination. During the determination, compare the most serious field of view on the inspection surface with the standard rating pictures in Appendix C for rating, so as to determine the level of the pearlite.

6.2.2 In accordance with the characteristics of the pearlite, such as. structure (granular, fine- grained pearlite colony or flaky), quantity and distribution, determine the rating of the pearlite.

6.2.3 In accordance with the structural characteristics, the rating pictures of pearlite are divided into three series.

6.2.4 The pictures of each series are from Level 0 to Level

5. Table 2 provides a detailed description of the structural characteristics of each level.

6.2.5 The determination results are expressed in levels, and the characteristics of the levels are between two adjacent levels, and half levels can be added. If necessary, a series of letters shall be marked, such as. 1.0A and 2.5B, etc.

7 Determination Method of Widmanstatten Structure

7.1 General Principle This method is applicable to the determination of Widmanstatten structure in steel plates, steel strips and steel rods (billets) with a carbon content between 0.15% ~ 0.50%.

7.2 Determination Method

7.2.1 Place the specimen under the bright field of a metallographic microscope for