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Spheroidite examination and grading for low and medium carbon steels

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Spheroidite examination and grading for low and medium carbon steels

1 Scope

This Standard specifies structural examination and grading after spheroidizing annealing for low carbon steel, low carbon alloy steel, medium carbon steel, medium carbon alloy steel.

This Standard is applicable to structural examination and grading before cold forming such as cold heading and cold extrusion and after spheroidizing annealing for low and medium carbon steels.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 7232, *Terminology of metal heat treatment*

GB/T 15749, *Measuring method in quantitative metallography*

GB/T 30067, *Standard Terminology Relating to Metallography*

GB/T 34895, *General rules for metallographic examination of heat treatment*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 7232, GB/T 30067 as well as the followings apply.

3.1 spheroidized carbide

Carbide particles with a ratio of length to width less than 5.

3.2 pearlite spheroidizing rate

Percentage of the total area converted into spherical carbides in the matrix structure of the steel material to the total area of carbides in the matrix.

3.3 fine spheroidite

Point-like fine spherical carbides at 500 times magnification.

4 Specimen

4.1 The specimens for the examination and grading of the spheroidizing structure are generally intercepted directly on the workpiece, or according to the requirements specified in the relevant technical documents.

4.2 The intercepted specimens are prepared step by step according to the requirements of GB/T 34895. Use 3%~5% nitric acid ethanol solution to etch. The effective test area of the specimen shall meet the requirements of 5.2.

4.3 The preparation of specimens and the storage of nitroethanol reagents shall meet the relevant requirements of GB/T 34895.

4.4 For examination and evaluation of spheroidizing process, the specimen shall be selected at a representative location in the heat treatment furnace. Generally, take 3~5 specimens according to the size of the effective heating area of the heating furnace.

5 Calculation of pearlite spheroidizing rate

5.1 Calculation of spheroidizing rate

The pearlite spheroidizing rate, R_{ps}, is calculated according to formula (1):

$$R_{ps} = \frac{\sum A_1}{\sum A_1 + \sum A_2 + 0.22 \sum A_3} \times 100\% \qquad \cdots\cdots (1)$$

Where,

R_{ps} - Pearlite spheroidizing rate;

A_1 - Spherical carbide area, in square millimeter (mm^2);

A_2 - Independent carbide area with a ratio of length to width greater than or equal to 5, in square millimeter (mm^2);

A_3 - Area of flake pearlite mass, in square millimeter (mm^2).

5.2 Pearlite and carbide area measurement statistics

When the magnification is 500 times, in the field of view with a diameter of

Φ75mm or a field of view not less than this area, calculate the area of pearlite and carbide according to GB/T 15749. For flake pearlite cluster cut to the boundary of the field of view, it shall be calculated according to the actual area within the boundary. Spherical carbides fully covered by the boundary of the field of view are not counted. Spherical carbides not fully covered are included in the total. Distinguish between spherical carbide and non-spherical carbide according to the definition of 3.1.

5.3 Method for measuring area of pearlite and carbide

Measure the area of pearlite and carbide according to the microscope micrometer eyepiece measurement method or image analyzer measurement method in GB/T 15749. For fine spheroidite, it can increase magnification to more than 500 times to count carbide area then convert to the area of 500 times.

6 Grading and grading methods for spherical structure

6.1 Grading of spheroidizing structure

This Standard divides the spheroidizing structure into 6 levels according to the spheroidizing rate. Develop three sets of standard maps, corresponding to different steel types:

a) The standard atlas of spheroidizing structure for low carbon steel and low carbon alloy steel is shown in Figure 1. See Table 1 for grading description of spheroidizing structure;

b) The standard atlas of spheroidizing structure for medium carbon steel is shown in Figure 2. See Table 2 for grading description of spheroidizing structure;

c) The standard atlas of spheroidizing structure for medium carbon alloy steel is shown in Figure 3. See Table 3 for grading description of spheroidizing structure.

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