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Determination of nitrided case depth and metallographic microstructure examination for steel and iron parts

钢铁零件 渗氮层深度测定和金相组织检验

- GB/T 11354-2005**
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Foreword

This Standard is an amendment to GB/T 11354-1989 *Steel-iron parts - Determination of nitrided case depth and metallographic examination of nitriding structure*. The main content of this Standard consists of the following parts::

- examination of original structure before nitriding (5 levels);
- determination of nitrided case depth (Hardness Method and Metallographic Method);
- examination of brittleness of nitriding case (5 levels);
- examination of porosity of nitriding case (5 levels);
- examination of nervation and wave like nitride in nitriding diffusion case (5 levels).

According to requirements of GB/T 1.1-2000 *Directives for standardization-Part 1: Rules for the structure and drafting of standards*, this Standard made corresponding modifications in structure, layout format, text description. For example:

- added Table of Contents, Foreword;
- simplified the home page format and adjusted the format of the other content;
- modified "Subject content and scope of application" to "Scope", "References" to "Normative references";
- added English names of relevant terms in "Terms and definitions";
- added title of the first level of entry to each clause;
- added Annex B to provide performance data tables related to the standard level.

This Standard replaces GB/T 11354-1989 *Steel-iron parts - Determination of nitrided case depth and metallographic examination of nitriding structure*.

Annex A, Annex B of this Standard are informative.

This Standard was proposed by China Machinery Industry Federation.

This Standard shall be under the jurisdiction of National Technical Committee on Heat Treatment of Standardization Administration of China.

Determination of nitrided case depth and metallographic microstructure examination for steel and iron parts

1 Scope

This Standard specifies determination method of nitrided case depth, examination method and technical requirements for metallographic microstructure before and after nitriding.

This Standard is applicable to the determination and evaluation on nitrided case depth, brittleness, porosity and nervation and wave like nitride on the surface of steel and iron parts which are treated by gas nitriding, ion nitriding, nitrocarburizing treatment.

2 Normative references

The following standards contain the provisions which, through reference in this Standard, constitute the provisions of this Standard. For dated references, subsequent amendments (excluding corrections) or revisions do not apply to this Standard. However, the parties who enter into agreement based on this Standard are encouraged to investigate whether the latest versions of these documents are applicable. For undated reference documents, the latest versions apply to this Standard.

GB/T 7232 *Terminology of metal heat treatment*

GB/T 9450 *Steels - Determination and verification of the depth of carburized and hardened cases* (ISO 2639:2002, MOD)

GB/T 9451 *Determination of total or effective thickness of thin surface hardened layers of steel parts* (ISO 4970:1979, MOD)

3 Terms and definitions

For the purposes of this Standard, terms in GB/T 7232 and the following terms and definitions apply.

3.1 prior metallographic structure (original structure)

overheated; the edges are not allowed to have chamfering and flaking.

5.3 Specimen requirements for examination of brittleness of nitrided case

The roughness of specimen surface for examination of brittleness of nitrided case is required to be: $R_a \leq 0.25 \mu\text{m} \sim 0.63 \mu\text{m}$. The compound layer is not allowed to be worn away.

6 Determination method for nitrided case depth

6.1 Hardness method

This Standard Vickers hardness. The test force is specified to be 2.94 N (0.3 kgf). The vertical distance measured from the surface of the specimen to a height of 50 HV higher than the Vickers hardness of the substrate is the depth of the nitrided case.

The hardness value (at least take the average of 3 points) measured at 3 times the depth of the nitrided surface from the surface is taken as the measured matrix hardness value.

For steel parts of which nitrided case hardness change is very smooth (such as carbon steel or low carbon low alloy steel parts), the nitrided case depth shall be measured from specimen surface along with vertical direction to the height of 30 HV higher than the Vickers hardness of the substrate.

When the nitrided case depth does not suit indentation size, it shall use test force within 1.96 N (0.2 kgf) ~ 19.6 N (2 kgf) based on agreement between parties. An indication shall be made after HV: for example, HV0.2 which means a test force of 1.96 N (0.2 kgf) is used.

The nitrided case depth is denoted by the Latin alphabet D_N , in millimeters, taking the two decimal places, for example, 0.25 D_N (300HV0.5) means that when boundary hardness is 300HV, the test force is 4.903 N (0.5 kgf), the nitrided case depth shall be 0.25 mm.

6.2 Measurement steps and results

The measurement steps and results shall comply with requirements of GB/T 9450 and GB/T 9451.

6.3 Metallographic method

Under magnification of 100 or 200 times the microscope, measure the depth as shown in Figure 2 ~ Figure 6. The distance measured from specimen surface along with vertical direction to the height which has clear boundary with matrix

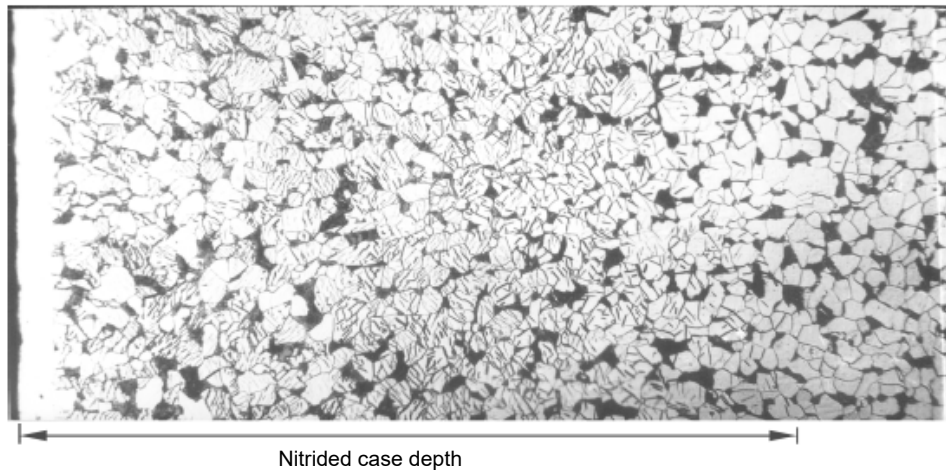


Figure 6 20 Steel nitrocarburizing 300°C tempering 1h (4% nitric acid ethanol solution corrosion) ×200

7 Examination of brittleness of nitrided case

7.1 Grating of brittleness of nitrided case

The brittleness level of nitriding case, according to the degree of embrittlement of Vickers hardness indentation angle, is divided into 5 levels, as shown in Figure 7 and Table 2.

7.2 Examination method

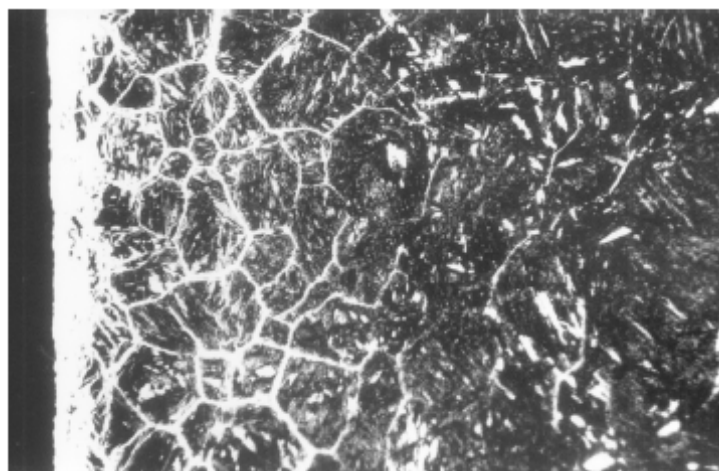
The examination of brittleness of nitrided case shall use Vickers hardness tester. The test force is determined as 98.07 N (10 kgf). The loading must be slow (within 5 s ~ 9 s). Remain for 5 s ~ 10 s after loading is completed then remove the load. In case of special circumstances, the test force of 49.03 N (5 kgf) or 294.21 N (30 kgf) may also be used based on agreement by the parties concerned. But it must be converted according to values in Table 3.

7.3 Examination requirements

The Vickers hardness indentation shall be examined at a magnification of 100 times (see Figure 7 for rating level). It shall at least examine 3 points for each workpiece. When more than 2 points are at same level, the rating shall be carried out, otherwise it shall repeat the examination.

7.4 Requirements for brittleness of nitrided case of nitriding pieces

The brittleness of the nitriding case shall be examined at the working site of the part or the surface of the furnace specimen. Qualification assessment: 1~3 levels for general parts, 1~2 levels for important parts. For parts with grinding left after nitriding, it shall also be examined on the surface after machining



e) Level 5

Figure 9 Nitrides in nitrided case level chart (4% nitric acid ethanol solution corrosion) ×500

Figure 9 Description of nitrides level

Level	Description of nitrides level	Figure No.
1	A very small amount of nervation and wave like nitrides in the diffusion layer	9a)
2	A small amount of nervation and wave like nitrides in the diffusion layer	9b)
3	Many nervation and wave like nitrides in the diffusion layer	9c)
4	Severe nervation and wave like nitrides and a small amount of mesh distributed nitrides in the diffusion layer	9d)
5	Continuous mesh distributed nitrides in the diffusion layer	9e)

10 Examination report

The examination report shall contain the following information:

- part reference number, part name, material and nitriding process;
- part inspection position or specimen and reference number as well as amount for examination;
- examination method;
- examination results;
- date of examination and signature of inspector.

1050°C × 20 min oil quenching, 670°C × 2 h nitriding treatment after tempering: (500 ~ 505)°C × 72 h, ammonia decomposition rate of 18% ~ 25%	1206	$\epsilon + \gamma'$	-	14562.8 (1485)	0.553	Three indentation edges are crack; brittle; Level 4
890°C × 20 min furnace cooling, annealing decarburization, nitriding treatment: (500 ~ 505)°C × 72 h, ammonia decomposition rate of 18% ~ 25%	1132	$\epsilon + \gamma'$	2.85×10^{-2}	7825.7 (798)	0.364	Four indentation edges are crack; very brittle; Level 5
890°C × 20 min furnace cooling, annealing decarburization, nitriding treatment: 520°C × 40 h, ammonia decomposition rate of 28% ~ 35%	1132	$\epsilon + \gamma'$	-	Very brittle	0	Four indentation edges are crack; very brittle; Level 5
NOTE The above data are the average of four specimens.						

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