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**AUTOMOTIVE INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Metallographic examination for automobile carburized gears
(English Translation)**

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1 Scope

This document specifies the inspection methods for the metallographic structure of carburized, quenched, and tempered automotive steel gears, as well as the methods for detecting the effective hardened depth.

This document applies to the quality inspection of automotive gears with an effective hardened depth greater than 0.3 mm after all heat treatment processes have been completed.

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 230.1, Metallic materials -- Rockwell hardness test -- Part 1: Test method GB/T 4340.1, Metallic materials -- Vickers hardness test -- Part 1: Test method GB/T 7232, Metal heat treatment -- Terminology GB/T 9450, Determination and verification of the effective depth of carburized and hardened cases of steel parts GB/T 13298, Inspection Methods of Microstructure for Metals

3 Terms and definitions

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

3.1 Surface hardness

The hardness at the surface near the pitch circle in the middle of the tooth width, or the hardness measured at a distance of 0.10 mm from the surface.

3.2 Core hardness

The hardness at the intersection of the tooth centerline and the tooth root circle on the cross-section at the middle of the tooth width.

3.3 Effective hardened depth

The vertical distance from the working surface of the tooth to the specified hardness point in its vertical direction.

3.4 Non-martensitic structure

A black structure generated after quenching when a workpiece is heated, oxygen generated in the medium diffuses inward along the grain boundaries of the workpiece surface, causing oxidation of the alloying elements at the grain boundaries and reducing hardenability.

4 Requirements for specimens

4.1

The specimen shall be taken from a cross-section at the midpoint of the gear tooth width, including the entire area from the tooth tip to the tooth root. The test surface of the tooth-shaped specimen shall be on the normal section of the tooth.

4.2 When preparing the specimen, the test surface shall be perpendicular to the surface

of the infiltrated layer.

4.3 During specimen preparation, its structure and hardness must not be altered due to heating.

5.1 Metallographic inspection specimens are prepared according to GB/T 13298.A 4%

nitric acid-alcohol solution is used as the etching agent.

5.2 The classification of inspection items and inspection methods are shown in Table 1.

Table 1 -- Inspection items and inspection methods

5.3 The inspection locations are specified as follows.

- a) The inspection sites for martensite and retained austenite are both located at the pitch circle of the tooth, 0.05 mm~0.15 mm away from the surface of the diffusion layer;
- b) The detection site for carbon compounds is at the tip of the tooth in Figure 1, or according to process requirements;
- c) Unless otherwise specified, the surface hardness and effective hardened depth of gears are generally measured at the pitch circle of the tooth surface in Figure 1;
- d) The depth of non-martensitic structure on the surface is inspected at the transition surface between the pitch circle and the root of the tooth in Figure 1. Unless otherwise specified, the area at the bottom of the tooth groove may be excluded from the inspection;
- e) The core hardness and tissue inspection sites are located at the gear core position in Figure 1.

6 Metallographic structure grade assessment and technical

requirements

6.1 General

6.1.1

Metallographic microstructure grading includes the grading of martensite, retained austenite, carbides, core microstructure, surface oxidation depth, and surface non-martensitic structure depth. Grading charts are provided in Annexes A, B, C, D, and E.

6.1.2

The worst field of view shall be selected for the examination and evaluation of metallographic structures. If the highest grade is exceeded, a grade greater than 6 can be used.

6.1.3

The assessment of metallographic structures does not adopt intermediate (half-grade) grades.

6.2 Martensitic grade

The grade is determined based on the size of the martensitic needles. The assessment is conducted according to the grade images in Annex A. The assessment characteristics are explained in Table 2. Grades 1~5 are considered acceptable.

6.3 Residual austenite grade

The grade is determined based on the amount of retained austenite. It is assessed according to the grade images in Annex B. The assessment characteristics are explained in Table 3. Grades 1~5 are considered acceptable.