

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J418

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Grain Size Determination of Steels

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format. References were added as Section 2. All other section numbers have changed accordingly.

[This SAE Recommended Practice is based on ASTM E 112, Standard Methods for Estimating the Average Grain Size of Metals. It is published here with permission of the ASTM for convenience of SAE Handbook users.]

1. **Scope**—This classification for grain size comprises three sets of comparison charts to be used for determining grain size. These charts are presented in three categories as follows:¹

Plate I - Untwinned grains (flat etch)

Plate II - Twinned grains (flat etch)

Plate IV - Austenite grains in steel (McQuaid-Ehn test or other test)

Table 1 lists a number of materials and the comparison charts that are suggested for use in estimating their grain size by the comparison method.

NOTE—The suggestions in Table 1 are based upon the customary practices in industry. For specimens prepared according to special techniques, the appropriate comparison chart should be selected on a structural appearance basis as described in the Scope.

TABLE 1—SUGGESTED COMPARISON CHARTS

Material	Plate No.	Basic Magnification
Austenitic	II or IV	100x
Ferritic	I	100x
Carburized	IV	100x
Stainless	II	100x
Super-Strength Alloys	I or II	100x

1. Plates I, II, and IV of ASTM E 112 may be obtained from ASTM Headquarters, 100 Barr Harbor Street, West Conshohocken, PA 19428-2959 at a nominal cost. Examples of grain size standards from Plates I, II and IV are shown in Figures 1, 2, and 3.

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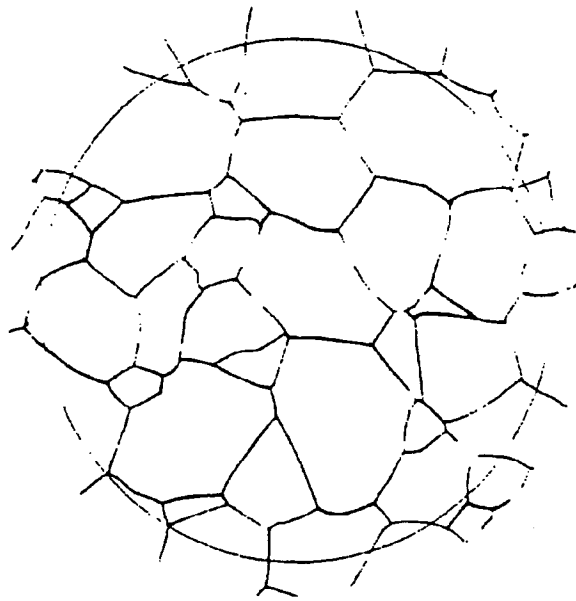


FIGURE 1—EXAMPLE OF UNTWINNED GRAINS (FLAT ETCH) FROM PLATE I.
GRAIN SIZE NO. 3 AT 100X

2. References

2.1 **Applicable Publication**—The following publication forms a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM E 112—Standard Methods for Estimating the Average Grain Size of Metals

3. **Establishing Ferrite Grain Size**—Ferrite grain size is already established in the sample to be examined by prior processing.

In hot worked material, a specimen representing a plane transverse to the direction of working is generally suitable. However, on flat rolled material, or any other in which elongation is likely to be encountered, both a transverse plane and one parallel to the direction of working should be examined.

3.1 **Revealing the Ferrite Grain Size**—The specimen may be prepared by appropriate polishing and etching with a 5% nital solution for 10 s (more for alloy steels) which generally produces good grain boundary delineation.

4. **Establishing Austenite Grain Size**—Numerous methods are in use for establishing austenite grain size, and a knowledge of grain coarsening behavior is helpful in deciding which method to use. The size of austenite grains, in any particular steel, depends primarily on the temperature to which that steel is heated and the time it is held at the temperature. It should be remembered that the atmosphere in heating may affect the grain growth behavior at the outside of the piece.

Austenite grain size is influenced by most previous treatments to which steel may have been subjected, as, for example, quenching, normalizing, hot working, and cold working. It is therefore advisable, when testing for austenite grain size, to consider the effects of prior or subsequent treatments on the precise piece (or typical piece) which is under consideration.

As may be agreed upon between the manufacturer and the purchaser, austenite grain size shall in this classification be established by either of the following:

- a. Carburizing at 925 °C (1700 °F) for 8 h (the McQuaid-Ehn test), which is recommended for carburizing grades, and often employed for other grades as well.
- b. Heating at a temperature not over 28 °C (50 °F) above the normal heat treating temperature and for not over 50% more than the normal heat treating time, the normal values being those mutually agreed upon.

The rate of cooling depends on the method of treatment, as will be evident from the methods described in the following paragraphs.

4.1 Revealing the Austenite Grain Size—For revealing austenite grain size the following methods are generally used:

1. Outlining the grains with cementite, as in carburizing (McQuaid-Ehn test) or as high carbon steels. In the hypereutectoid zone of a McQuaid-Ehn test, or in hypereutectoid steels cooled slowly from the austenitic condition, the austenite grain size is outlined by the cementite which precipitated in the grain boundaries. It is therefore possible to read the grain size by etching the micrographic specimen with a suitable etchant, such as nital or picral, or alkaline sodium picrate.

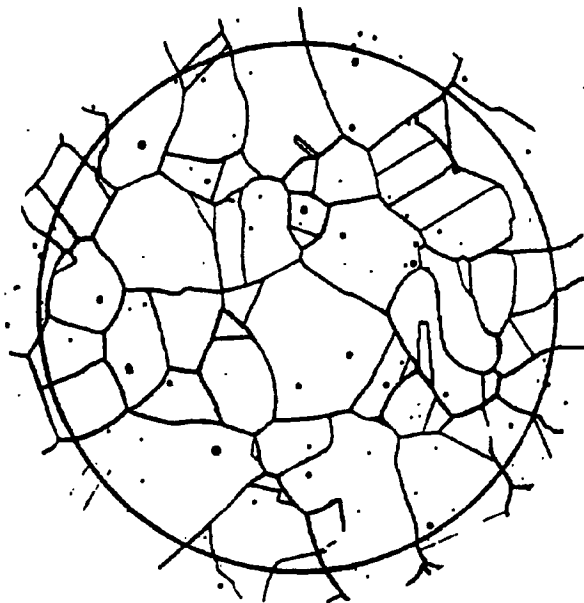


FIGURE 2—EXAMPLE OF TWIN GRAINS (FLAT ETCH) FROM PLATE II.
GRAIN SIZE NO. 3 AT 100X