Designation: A 561 – 71 (Reapproved 1999)

Standard Practice for Macroetch Testing of Tool Steel Bars[1]

This standard is issued under the fixed designation A 561; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice for macroetch testing has been found to be a useful and reliable method for evaluating the quality of tool steel bars. It is used as a quality control and inspection test to reveal by deep acid etching the macrostructure in specimens cut from bars and to show the presence of such conditions as pipe, cracks, porosity, segregation, or foreign material. The etched surface is generally examined visually, but magnification up to about 10× is occasionally employed.

2. Apparatus

2.1 *Etching Containers*—Macroetching may be performed in a vessel of borosilicate glass, porcelain, corrosion-resistant metals, or some other acid-resisting material.

3. Reagent

3.1 *Etching Reagent*—A solution of equal volumes of concentrated hydrochloric acid (HCl, sp gr 1.19) and water is commonly used for macroetching tool steels. This solution must be used under a ventilating hood because HCl is volatile and the fumes are corrosive and irritating, although nontoxic. The solution may be reused within limits. With use, the concentration of dissolved iron and other metals increases and the acidity of the solution decreases retarding the etching action. Spent solution shall be replaced with fresh solution, not replenished with concentrated acid.

4. Sampling

4.1 The selection of specimens for macroetch testing must be done with care for interpretations to be of value.

4.1.1 Specimens are usually cut from hot-rolled annealed bars, but may be cut from machined or ground bars if the bars are to be finish machined or ground.

4.1.2 The specimen should be located at a sufficient distance from the end of the bar to avoid end effects.

4.1.3 For ease in handling, use specimens ¼ to ½ in. (6.35 to 12.7 mm) thick.

4.1.4 Cut specimens to expose a transverse section of the bar; however, the test is occasionally performed on a longitudinal section.

4.1.5 Specimens may be taken from one or both ends of a bar. Each bar may be sampled, or a few typical specimens may be tested as representative of a large number of bars.

5. Specimen Preparation

5.1 In all cutting and grinding operations on the specimen, care must be excercised to avoid heating the surface to an excessively high temperature. Specimens are cut from bars by sawing, machining, abrasive wheel cutting, or other means. Cutting should be controlled to prevent smearing the cut face and masking the structure.

5.1.1 The "as-cut" surface of a specimen may be sufficiently smooth to reveal the defects for which the examination is conducted. No additional surface preparation may then be necessary.

5.1.2 Additional surface preparation may be required to remove cutting marks and to allow details to be revealed by etching. In such circumstances, machining, grinding, or polishing may be necessary. Generally, the degree of surface smoothness required is greater the finer the detail that must be resolved. When the action of the etchant is drastic, a coarser surface finish may be used.

5.1.3 The surface must be free of adhering grease and oil. There should be no scale or oxide on the surface which will be examined after etching.

6. Procedure

6.1 *Temperature for Macroetching*—Etching characteristics are influenced markedly by the temperature of the etchant. Thus, the reagent temperature should be controlled for macroetching if comparative results are desired. Tool steels are generally macroetched at about 160°F (71°C). At this temperature, the etching reaction is vigorous and solution losses through evaporation are not excessive. The solution may be heated on a gas or electric hot plate, by an acid-proof immersion heater, or by steam.

6.2 *Etching Time*—The etching time should be sufficiently long to completely reveal the structure in the specimen, yet should not be so long as to develop artifacts such as etch pits or to obscure or obliterate the structure. Generally, etching

[1] This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.29 on Tool Steel.

Current edition approved Oct. 25, 1971. Published December 1971. Originally published as A 561 – 66. Last previous edition A 561 – 66.