



## Standard Test Method for Scratch Hardness of Materials Using a Diamond Stylus<sup>1</sup>

This standard is issued under the fixed designation G 171; 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.

### 1. Scope

1.1 This standard describes laboratory procedures for determining the scratch hardness of the surfaces of solid materials. Within certain limitations, as described in this guide, this test method is applicable to metals, ceramics, polymers, and coated surfaces. The scratch hardness test, as described herein, is not intended to be used as a means to determine coating adhesion, nor is it intended for use with other than specific hemispherically-tipped, conical styli.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

E 177 Practice for Use of the Terms Precision and Bias as Applied to Measurement of a Property of a Material<sup>2</sup>

E 178 Practice for Dealing with Outlying Observations<sup>2</sup>

G 40 Terminology Relating to Wear and Erosion<sup>3</sup>

G 117 Guide for Calculating and Reporting Measures of Precision Using Data from Interlaboratory Wear or Erosion Tests<sup>3</sup>

### 3. Terminology

3.1 **Definitions**—For definitions of terms applicable to this standard see Terminology G 40.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 **scratch hardness number,  $n$** —a quantity, expressed in units of force per unit area, that characterizes the resistance of a solid surface to penetration by a moving stylus of given tip radius under a constant normal force and speed; namely,

$$HS_P = \frac{kP}{w^2}$$

where:

$HS_P$  = scratch hardness number,

$k$  = a geometrical constant,

$P$  = applied normal force, and

$w$  = scratch width.

NOTE 1—The constant  $k$  may be chosen to include conversion factors for expressing  $HS_P$  in units of GPa. For  $HS_P$  in GPa,  $P$  in grams-force, and  $w$  in  $\mu\text{m}$ ,  $k = 24.98$ .

3.2.2 **scratching force,  $n$** —the force that opposes relative motion between a moving stylus and the surface that is being scratched by that stylus, and which is perpendicular to the normal force exerted by the stylus.

3.2.3 **stylus drag coefficient,  $n$** —in scratch testing, the dimensionless ratio of the scratching force to the normal force applied to the stylus; namely,

$$D_{sc} = \frac{F_{scr}}{P}$$

where:

$D_{sc}$  = stylus drag coefficient,

$F_{scr}$  = scratching force, and

$P$  = normal force.

### 4. Summary of Test Method

4.1 This test involves producing a scratch in a solid surface by moving a diamond stylus of specified geometry along a specified path under a constant normal force and with a constant speed. The average width of the scratch is measured, and that value is used to compute the scratch hardness number in units of pressure.

4.2 As an option, the scratching force may be measured during this test and used to compute a stylus drag coefficient, which is a dimensionless measure of the resistance of the test surface to deformation by a tangentially-moving stylus.

4.3 This test is usually conducted under unlubricated conditions and at room temperature; however, it is possible to conduct scratch hardness tests under lubricated and elevated temperature conditions. The provisions of this standard allow testing under both conditions provided that requirements for valid scratch hardness testing are met and that the testing conditions are fully reported.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.30 on Abrasive Wear.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>3</sup> Annual Book of ASTM Standards, Vol 03.02.