Micro-Metrics Company

H-501 Pencil Hardness Gage

Technical Data Sheet

Description and Uses

The Micro-Metrics H-501 Pencil Hardness Gage is practical for use in the laboratory, on the production line, or in the field to assess quantitatively the rigidity or firmness (elastic modulus) of organic coatings applied to rigid substrates such as metal. Hardness values may define requirements for particular coatings applications or may be used to evaluate state-of-cure or aging of coating.

Principle

When two materials of different degrees or hardness or rigidity are forced against each other, one of the materials either yields or crumbles, while the other is unaffected. Thus a scale of relative hardness can be established on the basis of the ability of one material to scratch or deform another. This principle has long been used in the mineralogy field where it is known as the Mohs Hardness Scale (F. Mohs, 1820). Thus, the hardest material, diamond, is arbitrarily given a hardness value of 10, and other materials range downward through Corundum–9, Quartz–7, Apatite–5, Calcite–3, and Talc–1.

Mechanical drawing pencil leads of available grades cover the hardness spectrum of useful organic coatings. The crumbling mode of failure is an essential characteristic of the drawing leads, making them suitable for this application.

In this test, pencil leads of decreasing hardness values are forced against a coated surface in a precisely defined manner until one lead fails to mars the surface. Surface hardness is defined by the hardest pencil grade that just fails to mar the painted surface.

The Micro-Metrics H-501 Pencil Hardness Gage is unique in that it provides a compact single unit for performing the testing, rather than a set of easily lost individual lead holders. The importance of this difference should not be discounted, especially when several individuals may be working with a single instrument, or when the testing must be done in awkward or difficult situations, where swapping out single lead holders may result in dropping one.

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Construction

The gage is composed of a set of eight mechanical drawing lead holders (pencils)with (all-metal barrel) permanently mounted in a circular array in a plastic cylinder. A small metal tube through the center of the cylinder provides storage for spare leads, and is a guide for positioning pencils for a test. Pencil positions are identified by the numbers 1 through 8 stamped into the plastic cylinder. Five small circular pieces of 400-grit carborundum paper mounted on a plastic dressing disk are provided to allow for dressing the lead points while they are in place in the gage.

Fourteen leads are supplied in a plastic case with the Micro-Metrics H-501 Pencil Hardness Gage; from softest to hardest they are:

6B, 5B, 4B, 3B, 2B, B, HB, F, H, 2H, 3H, 4H , 5H, 6H

Measurement Procedure

Preparation

Before the first use, choose the eight leads most used and insert them into the lead holders. The other leads should be left in the plastic case for easier identification later. Remove the gage and dressing disk from the carrying case. Using the disk face as a guide, adjust the exposed length of lead uniformly to approximately 1/8 inch. Square the ends of the leads, four at a time, by **gently** rotating an abrasive paper supported by the plastic disk until all squared edges of the leads are sharply defined. This completes the preparation for testing.

Testing

Begin testing using the hardest lead. Grasp the holder firmly and bring the metal guide tube end down onto the test surface. Rotate until the selected pencil is nearest the operator and then incline the assembly downward until the lead point and the tube end are simultaneously in contact with the surface. This defines the correct lead angle of 45° to the surface. Push the gage forward (away) about 1/2 inch (1.3 cm).

Observe the pencil track. Sufficient pressure must be applied to either cut or mar the film, or to crush the sharp corner of the lead. If neither

marring nor crushing is observed, repeat the test with greater pressure applied until a definite observation is made.

If crushing of the hardest lead should occur, the film is extremely hard, and is beyond the measuring range of the device. If scratching or marring of the film occurs, proceed with the next softer lead grade and repeat the testing procedure until a test lead is found that crushes and does not mar the film. Confirm the result with duplicate observations of the last (crushing) lead, and the next hardest (marring) lead.

In addition to the mar or scratch hardness described above, some specifications (ASTM D3363) define a "Gouge Hardness" as "the hardest pencil that will not cut through the film to the substrate for a distance of at least 1/8 inch." This severe test is more applicable as a service simulation of coatings expected to receive heavy mechanical abuse.

Calibration and Precision

Selected lead manufacturers have been found to supply a very uniform quality of hardness from item to item and batch to batch. Individual leads are not checked for hardness compliance. Round robin precision tests (ASTM D3363) indicate that the results of two operators should be expected to differ by more than one lead grade only once in twenty tests.

Shipping Unit

The H-501 Pencil Hardness Gage comes complete with the hardness gauge, fourteen leads in a plastic case, dressing disk with five sheets, a vinyl carrying case and this technical data sheet. The lead holders have all-metal barrels.

Specifications

Unit material:	Delrin plastic cylinder with eight mechanical drawing lead holders (all-metal barrels)
Size:	Diameter: 1.75" (4.5cm); Length overall: 7.50" (19cm)
Weight:	7 oz (199 g)
Lead material:	Blends of graphite, clay and binders
Lead grades:	6B, 5B, 4B, 3B, 2B, B, HB, F, H, 2H, 3H, 4H, 5H, 6H
Carrying case:	Cylindrical padded vinyl with snap top

References

1. Smith, W.T., "Standardization of the Pencil Hardness Test," *Official Digest*, 28, p. 232 ff (1956).
2. ASTM D3363, Method of Test for Film Hardness by Pencil Test.
3. Pencil Hardness Tests. Sherwin Williams Industrial Test Data Sheet TD-11.
4. NACE, TPC Publication No. 2, "Coatings and Linings for Immersion Service," p. 22 (1972).

Micro-Metrics Company
Products

Tooke Paint Inspection Gage OG204 and OG202

OG204

Precision tool for inspection and thickness measurement (ASTM D4138) of single or multiple coats on any substrate, and for microscopic observation and measurement of substrate and film defects. Uses an illuminated 50-power microscope with a "universal" measuring reticle that measures in mils, microns, and millimeters; and mounts tungsten carbide cutting tips for precise incision of the work surface.

Available in these configurations:

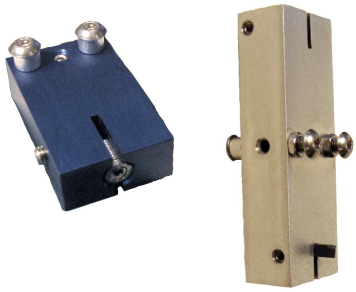
- ❏ OG204 polycarbonate plastic
- ❏ OG202 anodized machined aluminum

OG202

Optional accessories

CTH01 (single) and CTH02 (double) cutting tip holders

Cutting Tip Holders allows easy use of one (or two) cutting tip(s) without having to manipulate the Tooke Gauge to make the incision and then manipulate it again to view the incision through the microscope.



MG402 Microgroover

The Microgroover is a major accessory tool for creating coating incisions for film thickness measurements with the Tooke Paint Inspection Gauge. This tool greatly extends the range of the measuring technique to include almost any coating on any substrate.

The Microgroover is especially effective on hard and brittle (concrete) materials, as well as soft or elastomeric (rubber) substances. In addition, fibrous composites are incised easily and cleanly. This device eliminates the deformations of coating and substrate that may occur when conventional gage cutting tips are used.

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