Measuring accuracy in the field

Micro-Metrics Company OG212 and OG214 Tooke® Paint Inspection Gage (with Dual-Measure scope)

Description and Uses

The Tooke® Paint Inspection Gage is a precision tool for inspection and thickness measurement (in accordance with ASTM D4138) of single or multiple coats on any substrate, and for microscopic observation and measurement of substrate and film defects.

Direct measurement of total coating thickness / thickness of individual coats of paint is a unique capability of the Tooke Paint Inspection Gage. Thus, it often serves as a "referee" instrument to calibrate indirect or non-destructive thickness measuring instruments.

Other uses include assessment of substrate conditions and coating adhesion, and observation of microscopic cracking, tendency for brittleness, cratering, or other microscopic film symptoms. Surface cont-amination and wettability can be effectively visualized with the illuminated microscope.

The Tooke Gage has been used to assess sand-blast cleaning work; to measure plating and paint thickness on ceramics, metal, wood, and concrete; and even the protective backing thickness on mirrors. It is virtually the only tool for measuring paint on plastics and drywall.

One of three tungsten-carbide cutting tips is used to incise a small precision V-groove through the paint film and into the substrate. This V-groove is observed vertically with an illuminated microscope bearing a measuring reticle (scale).

Construction

The gauge body is molded polycarbonate plastic or milled aluminium with the groove-cutting tungsten-carbide cutting tips mounted on the narrow side. Two guide studs project from the body on the same side as the cutting tips. The tripod thus formed by the three legs (guide studs and cutting tip) provides precise alignment of the tool with the surface to be incised. A lanyard with keeper secures the instrument to the inspector's wrist to prevent accidental dropping. The entire unit is designed for convenience and completeness in field inspection tasks.

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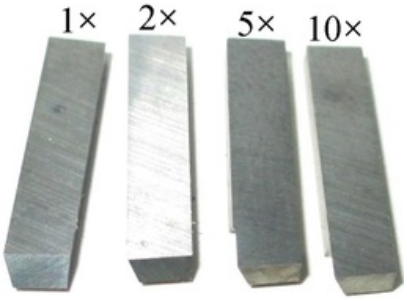
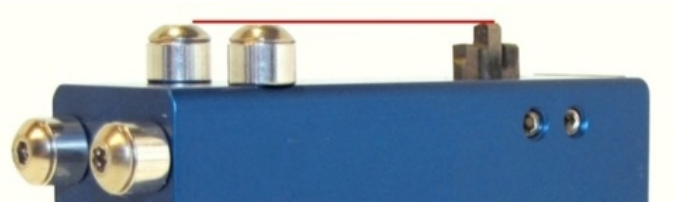
Measurement Procedure

Check the position of the cutting tips. As originally supplied, the cutting tip positions will be from top to bottom: 1×, 2×, and 10×. The numerals 1, 2 and 10 are incised in the body alongside each tip respectively. The chosen tip should be in working position, extended above the other tips so the body of the gauge is parallel to the work surface and the cutting tip perpendicular to the work surface.

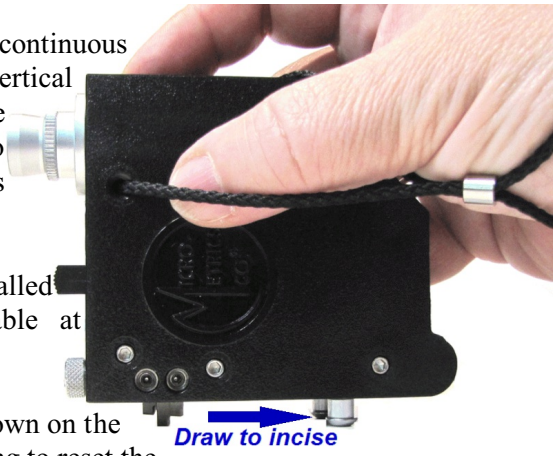




This is, in general, the correct configuration for an initial measurement. The other tips will be secured, bottomed in the tip-slot.

Make a small mark with the marking pen at the desired location on a painted surface. Grasp the instrument with the cutting tip. Place the cutting tip and guide studs in firm contact with the surface with the tip slightly above the mark and aligned to scribe across the mark. Align your forearm with the intended cutting direction to ensure a straight cut. Draw the cutting tip straight across the mark, applying only sufficient pressure at the tip to cleanly penetrate through the film to the substrate.

The cutting tip trails midway between the two guide studs and a continuous 3-point surface contact should be maintained to ensure precise vertical alignment of the groove. Avoid excessive pressure on the guide studs. Tip should be mounted with the "relief cut" (see photo above) facing the guide studs, so the 'curl' of incised coating is directed up and away from the cut.



A measuring demonstration is provided in the (printable) paper called "Measuring, the Geometry of the Tooke® Gage," available at http://www.micro-metrics.com/TechData/M-M_Geometry.pdf.

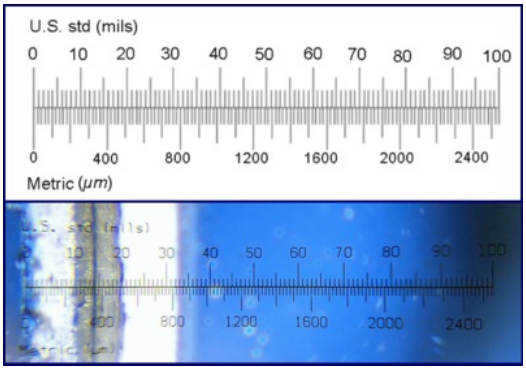
If multiple tip faces are regularly used, a cutting tip holder, as shown on the next page, allow immediate use of the different tips without having to reset the tips mounted in the gauge body for each incision.

Suggestions to users

- On wood or other directional material, make incisions in the grain or "machine" direction to avoid ragged cuts.
- Soft or elastic materials can sometimes be cooled or frozen with ice or dry ice to obtain good cutting characteristics. With some coatings, improved cuts can be achieved by wetting the surface, or by speeding / slowing the cutting rate.
- Dyes or indicator solutions such as phenolpthalein are sometimes helpful to develop appearance contrast between metals (iron-galvanizing) or paint coats.
- Liquid erase, such as White-Out® may be useful as a benchmarker on dark surfaces.
- Coatings with poor adhesion will exhibit a ragged line at the substrate interface. In these cases, read the thickness from the left incision edge in the **substrate**. (See reference: "Coatings Adherence Measurement by an Angular Scribe-Stripping Technique.")

(New!) Dual-Measure microscope

The new OG214 and OG212 are equipped with the enhanced Dual-Measure scope with a reticle marked in mils and µm. Above the line, 1 mil per hashmark space, running from 0 to 100 mils. Below the line the reticle is marked in microns (20µm per hashmark space).



Viewing the Groove

Turn on the microscope lamp with the slide switch on top of the gage next to the eyepiece. Center the microscope over the scribed line with the mark slightly inside the foot, directly under the microscope objective. Focus as needed by turning the focus screw in the body below the microscope.

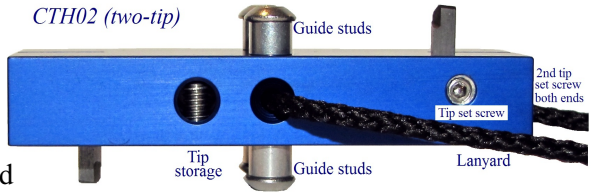
With the microscope focused, view the intersection of the mark and the cut. Position the microscope as required to align the edge of the cut with any convenient long line of the reticle and begin counting the small gradation inwardly until the next layer or the substrate is reached. If the result should be less than 2 mils or more than 20 mils, you may wish to use the 10× or 1× tips respectively.

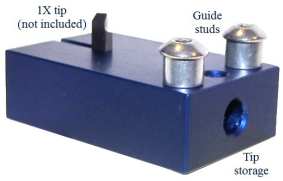
Tip changes

To change the cutting tip, use the hex wrench provided in the case to loosen the cutting tip set screws. Allow the three tips to bottom in their slots, then pull the selected tip out so that the body of the gage will be parallel with the work surface when applied thereto and re-tighten all the tips with moderate finger pressure. The narrow face of the tip bears an angular grind (the "cut-out") that should be oriented toward the guide studs.

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

Cutting Tip Holders allows easy use of a cutting tip without having to manipulate the Tooke Gage to make the incision and then manipulate it again to view the incision through the microscope.



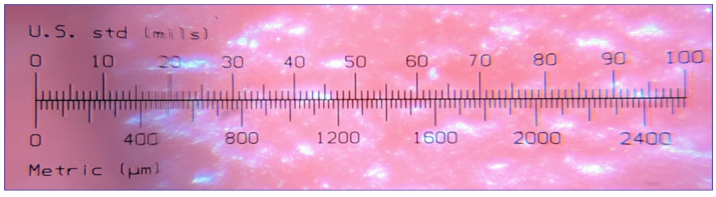


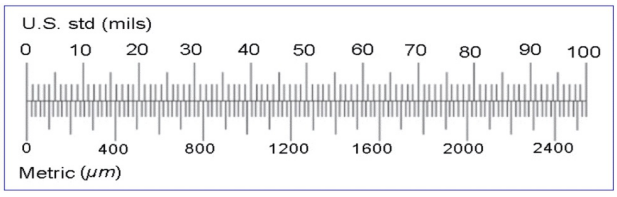
References

- "A Paint Inspection Gage," by Raymond Tooke, Jr. *Official Digest*, July 1963, 35, pp 691–698.
- "Coatings Adherence Measurement by an Angular Scribe-Stripping Technique," W.R. Tooke and J. Montalvo, *Journal of Paint Technology*, January 1968, 38, pp 18–28.
- "Development of Specifications for Measurement of Paint Thickness on Structural Steel," J.D. Keene and T.L. Shoemaker, *Journal of Paint Technology*, 45, No. 585, October 1973, pp. 46–47.
- "How Instruments Boost Coatings Application Productivity," W.R. Tooke, Jr., *Professional Decorating and Coating Action*, October 1976, pp 16–18.
- "Standard Method of Measurement of Dry Film Thickness of Protective Coatings Systems by Destructive Means," Designation: D4138-82, *1988 Annual Book of ASTM Standards*, pp. 695–697.
- "Method and Device for Measuring the Thickness of Films," W.R. Tooke, U.S. Patent No. 3,340,615.

Specifications / shipping unit

Material:	Polycarbonate or milled aluminum body	Case:	Polypropylene carrying case
Dimensions:	4.5" x 3.5" by 1" (11.4 x 8.9 x 2.5cm)	Power:	Two 1.5V AA dry cells
Microscope:	50X, 45-degree, illuminated	Shipping:	1.5 lbs (0.7 kg)
Reticle:	New! Dual-Measure: 1mil or 20μm per hash	Spares:	Hex wrench, marker, batteries, and LED bulb
Cutting tips:	Three; standard: 1×, 2×, and 10×		
Lamp:	LED #222 bulb		





Tooke Gage Geometry

As shown in the diagrams below, A′ and B′are the observed / measured cut width of the coating in the incision and are related to the coating thickness by the equation: $A = A' \tan\theta$

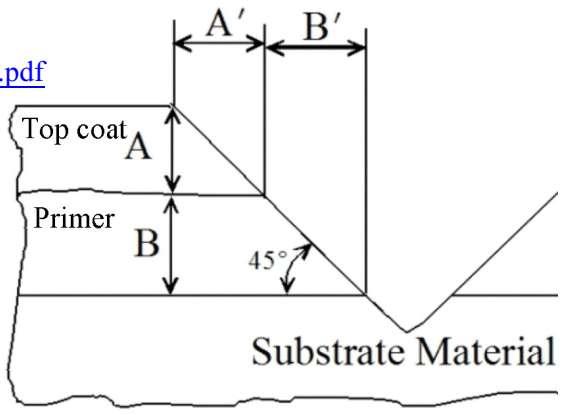
At a 45-degree (1× tip) incision angle: $\tan\theta = 1$

And A, the coating thickness, equals A′, the measured cut width : $A = A'$

For details of cutting tip use and geometry, see: "Measuring: the Geometry of the Tooke® Gage" http://www.micro-metrics.com/TechData/M-M_Geometry.pdf

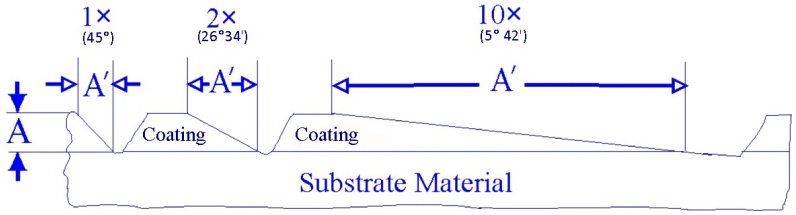
For each incision, a right-angle triangle is created. The measured cut widths, A′ and B′at right, are one leg of the triangle.

In an incision using the 1× tip (45° face), the triangle created is an equilateral one, so the ratio of coating depth is equal to the measured cut width; the ratio is 1 : 1. So, with the 1× tip: the calculated coating depth equals the measured cut width: A = A′ (and B = B′).



Geometry of Thickness Measurement

Approximation of 1× , 2× , and 10× tip incisions



Cutting tip ratios: A : A′

Tip	*Face angle*	*Ratio*
1×	45° 0'	A : A' = 1 : 1
2×	26° 34'	A : A' = 1 : 0.5
5×	11° 18'	A : A' = 1 : 0.2
10×	5° 42'	A : A' = 1: 0.1

Incision diagrams