Micro-Metrics Company
OG204 Tooke Paint Inspection Gage
(old-style metric microscope)
Technical Data Sheet
www.micro-metrics.com

Description and uses

Designed especially for use in the field as well as in the lab and 'on the line,' the Tooke Paint Inspection Gage has a unique capability of direct measurement of total coating thickness and the thickness of individual coats of paint. This precision tool is designed for inspection and thickness measurement (in accordance with ASTM D4138) of single or multiple coats on any substrate, and microscopic observation and measurement of substrate and film defects. In addition to routine use, it often serves as a "referee" instrument to calibrate indirect or non-destructive thickness measuring instruments. It is virtually the only tool for measuring paint on plastics.

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 contamination and wettability can be effectively visualized with the illuminated microscope. The Tooke Gage also has been used to assess sandblast cleaning work; to measure plating and paint thickness on ceramics, metal, wood, and concrete; and even to measure protective backing thickness on mirrors.

One of three included cutting tools (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.

Construction

The gauge body is polycarbonate plastic and contains a 50× microscope, lamp, batteries, and the groove-cutting tungsten-carbide cutting tips mounted on the narrow side. Two adjustable threaded 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.

Specifications

Material:	Polycarbonate plastic body
Gauge dimensions:	4.5" x 3.5" by 1" (11.4cm x 8.9cm x 2.5cm)
Microscope:	50-power, 45-degree, illuminated
Power:	Two 1.5V AA dry cells
Lamp:	LED #222 bulb, plus a spare
Cutting tips:	Tungsten-carbide 0.62" x 0.125" x 0.625" (1.6cm x 0.3cm x 1.6cm)

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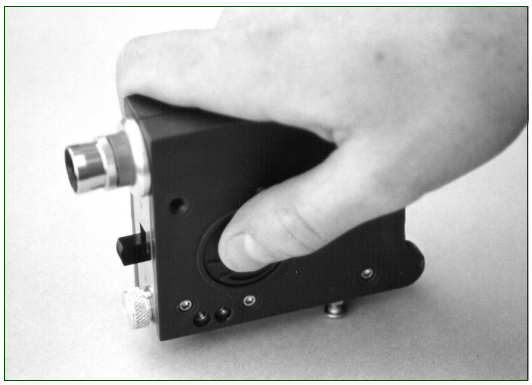
Measurement procedure



For field use, secure the safety lanyard to your wrist to prevent accidental dropping. 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 2× tip (center position) should be in working position, protruding from the case so the body of the gage is parallel to the work surface and the cutting tip perpendicular to the work surface. In general, this is the correct configuration for making an initial measurement on a film. The 1× and 10× tips will be bottomed in the tip slot.

Make a small mark with the marking pen at the desired measurement location on a painted/coated surface. Grasp the instrument with the cutting tip down as shown above. 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. In this operation, the cutting tip trails midway between the two guide studs, and continuous 3-point surface contact should be maintained to ensure precise vertical alignment of the groove. Excessive pressure on the guide studs should be avoided.

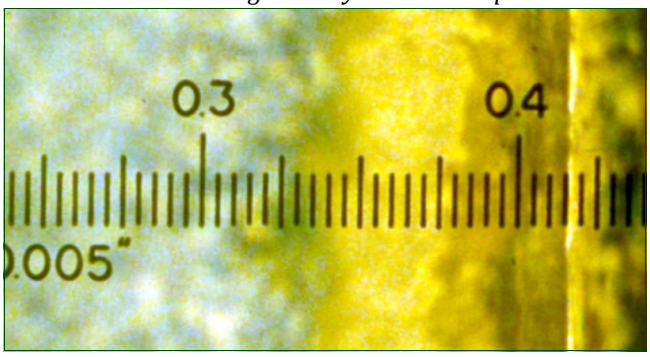
Cutting tip designations and appropriate film thickness ranges

Cutting tip designation	Maximum coating thickness in:		Precision of thickness determinations in:		1 division on reticle represents in:	
	mils	microns	mils	microns	mils	microns
1×	100	2500	± 0.25	± 5	1.0	20
2×	20	500	± 0.13	± 2.5	0.5	10
5×	6	150	±0.05	± 1	0.2	4
10×	3	75	± 0.025	± 0.5	0.1	2

Viewing the incision

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

View through old-style metric scope

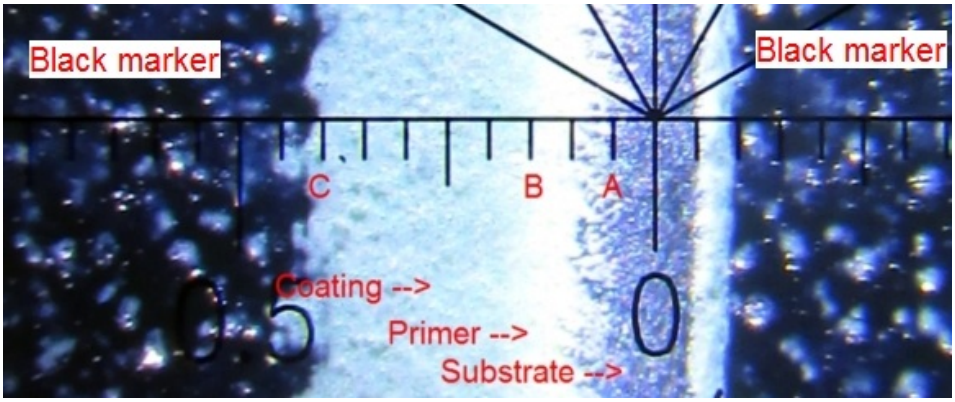


With the microscope focused, view the intersection of the mark and the cut as shown at right. Position the microscope as required to align the edge of the cut with any convenient long line of the reticle and begin counting the small gradation until the next layer or the substrate is reached. If the result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

(Note: If the reticle seems out of focus, you may unscrew or tighten the chrome eyepiece of the microscope slightly, until the reticle sharpens.)

A measuring demonstration

*Measurement with a Tooke Gage is a function of the **cutting tip** and NOT of the microscope.*



The "zero-line" of the reticle shown at right is **not** lined up with the edge of a coating (nor does it need to be; any hashmark will do). The zero-line is approximately centered in the substrate (the silver-gray line). A cutting tip was used to draw the incision through the black marked line.

- Line A is on the edge between the substrate and the primer-coat (the white line to the left of the zero-line): begin your measurement there.
- Line B marks the top of the primer coating/beginning of the (light blue) top coat.
- Line C is the end of the incision at the top coat, made easier to see by using the black marker provided with the Tooke Gage.

So, in the photo above (viewing an incision through the universal scope):

If hashmarks are counted using the old-style metric scope: the thickness calculated for each tip equals:

Coating	0.02mm (20 µm) /hashmark space	1× tip	2× tip	5× tip	10× tip
White primer	2 hashmark spaces	40 µm	20 µm	4 µm	2 µm
Blue topcoat	5 hashmark spaces	100 µm	50 µm	20 µm	10 µm

The geometry of the Tooke Gage

The observed horizontal projection of the film in the groove wall is related to the film thickness by the equation:

$$A = A' \tan\theta$$

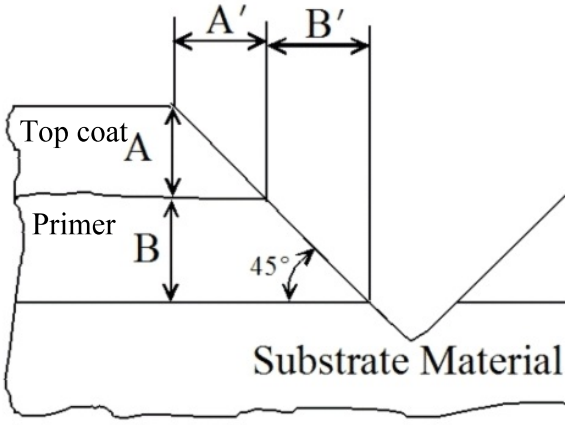
Example: The 1× tip cuts a 45° incision (which make an equilateral triangle), where A (the *coating thickness*) = A′ (the *distance measured* through the scope across the cut); therefore, the ratio for the 1× tip is 1 : 1, as shown:

Thus (using the 1x tip): A : A′ = 1 : 1

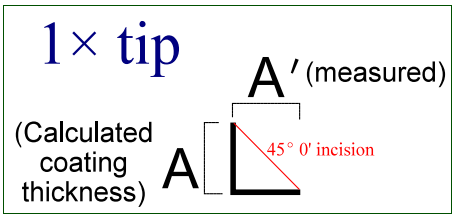
At a 45° groove angle: $\tan\theta = 1$

And, so (using the 1× tip): $A = A'$

Visualization of an incision made using a 1× (45°) cutting tip



A more-detailed explanation called "Measuring: the Geometry of the Tooke Gage" is available at the Micro-Metrics website.



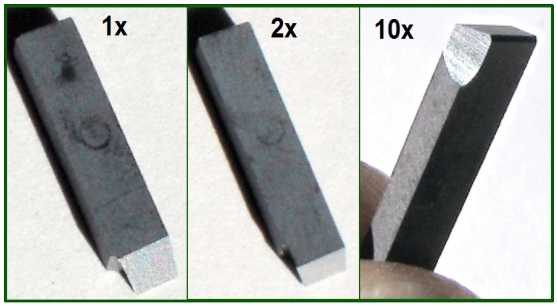
Suggestions to users

- 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.
- 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.
- With some coatings, improved cuts can be achieved by wetting the surface, or by speeding or slowing the cutting rate.
- 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.")

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.

For convenience, always keep the tips in their designated locations: 1× in the top of the slot; 2× in the middle; and 10× in the bottom. Note also that the narrow face of the tip bears an angular grind (the "cut-out") that should face toward the guide studs.



(5× tip not shown)

Calibration

Original factory calibration is accomplished by setting the cutting tips in precise geometric alignment with the guide studs. Checks are also made with precision-applied film standards. For highest precision work, the user is advised to maintain painted panels of known thickness, and to check and calibrate the instrument measurements periodically.

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.