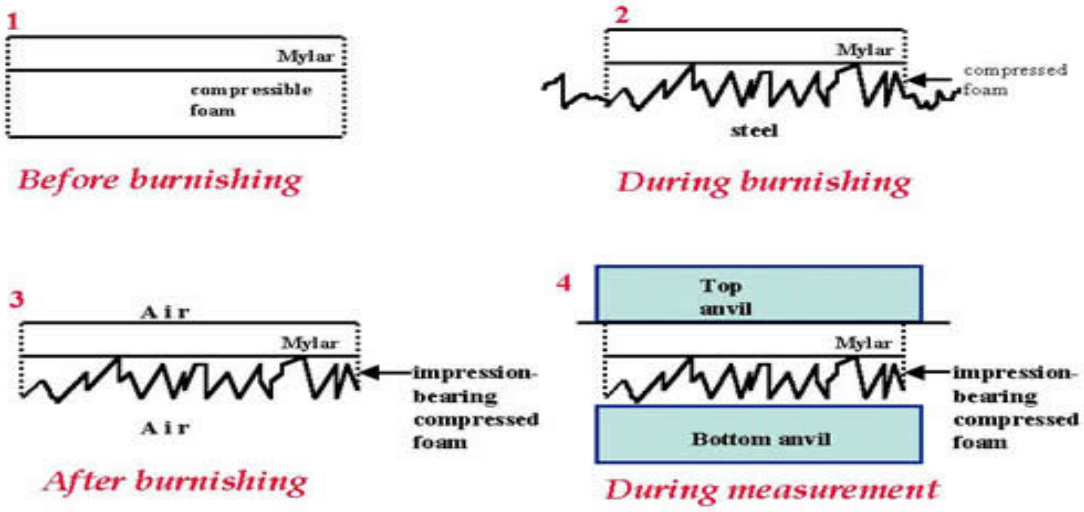
Instruction Manual – Dial Thickness Gauge Kit

How Replica Tape works

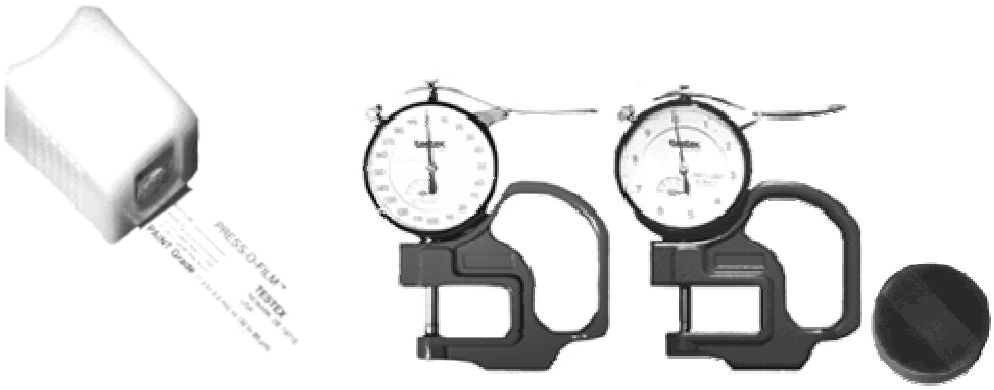
Replica tape consists of a layer of compressible foam affixed to an incompressible polyester substrate **(1).**

When pressed against a roughened (steel) surface, the foam collapses **(2),**



acquiring an impression of the surface **(3)**.

Placing the compressed tape between the anvils of a micrometric thickness gage, and subtracting the contribution of the incompressible substrate (50 micrometers or 0.002 inches), gives a measure of the surface profile **(4).**



Background

SOME BACKGROUND ON USING A MICROMETRIC GAGE TO MEASURE PROFILE

What replica tape is:

Testex Press-O-Film replica tape consists of a layer of crushable plastic microfoam coated onto polyester film of highly uniform thickness.

It is sold in a number of grades to accommodate measurements in different profile ranges.

Why determination of profile is important:

Industrial steel in bridges, ships, railcars, etc., is almost always painted or otherwise coated to prevent corrosion. Before they can be painted, these metal surfaces must be cleaned and roughened to insure that the paint adheres. This is usually done by grit or shot blasting the surface. If the resulting surface is too smooth, the paint or coating will not stick. If the surface is too rough, the peaks poke through the coating and rusting occurs.

How replica tape allows field (gage) measurement of profile:

When compressed, by “burnishing,” against a surface, the foam collapses to about 15% of its pre-collapse thickness. After compression, the foam acquires an impression of the surface against which it is burnished. The highest peaks on the original surface displace the fully compressed foam and come to rest against the polyester backing. The deepest valleys on the original create the highest peaks in the replica. Consequently, the thickness of the compressed tape equals the average maximum peak-to-valley profile plus the thickness of the incompressible polyester substrate. A spring-loaded micrometer gage is used to measure the thickness of the replica.

Characteristics of the spring micrometer gage:

All characterization of replica tape profile measurements has been performed with a gage having a measurement accuracy of 0.2 mil (5 microns), closing force of 4 ounces (1.5 N) and at least one anvil having a circular diameter of 0.25 inch (6.3 mm). Suitable inch and metric unit gages are available from Testex and other companies but great care should be taken to assure that they are specifically designed to be used with replica tape.

Using the proper gage is essential to obtaining correct profiles.

TAPE GRADES

Testex Press-O-Film replica tape is available in a variety of thicknesses to facilitate profile measurement in differing ranges:

Grade (descriptive)	Range When Used With Gage (mils) / (microns)
Fine / Medium	not applicable
Coarse Minus	0.5 to 1.0 / 12 to 25
Coarse	0.8 to 2.0 / 20 to 50
X-Coarse	1.5 to 4.5 / 40 to 115
X-Coarse Plus	4.0 to 5.0 / 100 to 125

Testex replica tape can be used with a gage to measure the surface roughness ("profile") of blast-cleaned steel in the roughness range 0.8 to 4.5 mils (or 20 to 115 micrometers). Because inspectors, as a rule, have a target profile in mind. it is always best to start measurements with the grade of tape that has the target profile closest to the center of it's range.

Each grade of replica tape is most accurate near the center of its specified range.

Always confirm measurements near the ends of a given grade's range using the next higher or lower grade of tape.

Testex' lowest grade (thinnest) tape, **Coarse Minus**, should be used only to check measurements at the lower end of the next higher grade, **Coarse**, while our highest grade tape, **X-Coarse Plus**, should only be used to check measurements at the high end of the **X-Coarse** grade range.

Further information (pdf format) on **X-Coarse Plus** grade tape is available here.

Compress tape with the smoothest surface on the rubbing tool provided, applying sufficient pressure to produce a replica with a uniform pebblegrain appearance. You should just feel the roughness as you burnish.

Fine/Medium grade material is commonly used in applications in which the replica is analyzed using precision laboratory techniques. This grade is not suitable for use with a "dial thickness gage." Fine grade tape (rarely used) has a thin Gold coating to facilitate electron microscopy. Medium grade ("metallized") tape has a thin Indium coating to facilitate optical interferometric measurement. Fine and Medium grades have the same foam thickness. Only the vapor-deposited metallic coatings differ.

All grades are coated onto a tough polyester substrate 2.0 mils (50 microns) in thickness.

Because implicit definitions of "roughness" vary between methods, numerical profiles determined using different techniques (replica tape, interferometer, confocal microscope, stylus) may yield different values. Always specify the technique used.

Accuracy

REPRODUCIBILITY AND ACCURACY OF MEASUREMENT

Reproducibility (ASTM): ASTM standard 4417-93 cites levels of reproducibility for both “X-Coarse” and “Coarse” grade replica tape.

For X-Coarse grade replica tape:

“Two results, each the mean of four replicates, obtained by operators in different laboratories should be considered suspect if they differ by more than 37%.”

For Coarse grade replica tape, the equivalent level of reproducibility is cited as 28%.

According to these ASTM criteria, the following errors are the maximum that should be expected:

PROFILE (mils) (microns)	ERROR ("COARSE") (mils) (microns)	ERROR ("X-COARSE") (mils) (microns)
1.0 / 25	0.3 / 8	not applicable
2.0 / 50	not applicable	0.8 / 18
3.0 / 75	not applicable	1.1 / 27
4.0 / 100	not applicable	1.5 / 37

Accuracy (NACE): NACE Standard RP0287-95 addresses the issue of accuracy of measurement, reporting the results of round robin tests in which 14 blasted panels were measured by 7 laboratories. Replica tape and focusing microscope measurements agreed within their 95% confidence limits in 11 of 14 cases. The average difference between the two types of measurement was 0.2 mils (5 microns).

Reproducibility and Accuracy (Testex): By using a series of surfaces machined to known roughness, it is possible to test the accuracy and reproducibility of profile measurements made with replica tape and a micrometer gage. The surfaces used in Testex' internal testing were produced by making casts of grooves of known depth. The casts then consist of sharp-topped parallel "V-shaped" ridges of known height.

A blasted surface is highly irregular, unlike the regular grooved structure used in our tests. For this reason, the proper way to assess the accuracy of replica tape for evaluation of blasted surfaces is via the techniques used by the standards organizations concerned with such surfaces. In general, measurements of profile for highly irregular surfaces will be a strong function of the methods used to measure them.

Nevertheless, tests using casts of machined (as opposed to blasted) surfaces show micrometer gage measurements of Press-O-Film to have an accuracy and reproducibility of 0.3 mil (8 micrometers), across the ranges of Coarse and X-Coarse material. The casts of machined surfaces were measured with a light section microscope. These represent relatively idealized circumstances. Agreement between methods may or may not be as good for the case of blasted surfaces.

Replica tape is most accurate near the middle of its specified range. Readings near the edges of this range should be checked with the next higher or lower grade. Apply sufficient pressure to produce a replica with a uniform pebblegrain appearance. You should

just feel the roughness as you burnish. Always identify the grade of tape used in any record of profile.

Sources Of Error In Gage Profile Measurement

A human hair is about 2 mils (50 microns) thick and individual bacteria are 0.1 mil (2.5 microns) in size. Field profile measurements to accuracies in this range will be influenced by very subtle effects.

The four major sources of error in determining the profile of a blasted surface using replica tape and a micrometer gage are:

1) Inherent variation in point-to-point profile over the surface being measured,

SSPC - The Society for Protective Coatings, recommends a minimum of three measurements of profile per 100 square feet (10 square meters).

2) presence of particles of dirt on either the replica tape or gage,

Reasonable care should be taken to keep the gage anvils free of dirt or grit. Questionable measurements should be double checked.

3) gage accuracy,

Good micrometer snap gages commonly cite an accuracy of ±0.2 mil (5 microns). In addition to gear errors of this magnitude, we have observed that they commonly read approximately 0.1 mil high at room temperature and 0.1 mil low at freezing.

4) rubbing technique,

including excessive or inadequate burnishing force.
See "Rubbing Technique" section of "Instructions"

Bear in mind that “profile” is always a function of how it’s defined (Ry, Rz, Rt, evaluation length, sampling length, deadband, how curvature is handled, etc.). Just as it’s important to specify these parameters, tape users should always indicate the grade they used to obtain a measurement.

Standards Compliance

STANDARDS GOVERNING USE OF REPLICA TAPE TO MEASURE PROFILE

ASTM - (American Society for Testing and Materials) D 4417:

Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

NACE - International (National Association of Corrosion Engineers) RP0287-95:

Standard Recommended Practice: Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape

SSPC - the Society for Protective Coatings: SSPC-SP 5, SP 6, SP 10, SP11-87T

ISO - International Organization for Standards: Draft Standard ISO8503-5

Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 5: Replica tape method for the determination of the profile

In cases where standards compliance is required, the full original current standard should be consulted.