Association Connecting Electronics Industries

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IPC-TM-650
TEST METHODS MANUAL

Number	
2.2.22	
Subject	
Noncontact Metallic Foil Surface Topography/ Texture	
Date	Revision
5/20	
Originating Task Group	
Metallic Foil Task Group (3-12a)	

1 Purpose This procedure establishes proper methods and practices for quantifying the surface topography/texture of metallic foil using a noncontact, optical or laser, 3-D surface measurement device. The primary reported values will include Sa, Sq and Sz (see 6.3 for further information on these parameters) where S values are 3-D measures.

2 Applicable Documents

2.1 IPC[1]

IPC-4562 Metal Foil for Printed Board Applications

2.2 International Standards[2]

ISO 16610 Geometrical Product Specifications (GPS) – Filtration

ISO 25178-2 Surface Texture: Areal – Part 2: Terms, Definitions and Surface Texture Parameters

3 Metallic Foil Sample Preparation

3.1 The samples tested will be a single-layer material taken from a representative location of metallic foil. The size of the physical sample will be determined based on the easiest method for obtaining a representative sample, but should be no larger than 50 mm x 50 mm [nominally 2 in x 2 in]. Operators of the measurement tool will orient the sample so the measurements are across the machine direction of the foil sample or the surface of the Physical NIST Traceable Standards.

3.2 The samples will be tested as received, but proper care must be taken to prevent scratches, dents or bending to insure the integrity of the surface. Operators of the measurement tool will orient the sample so that the measurements are across the machine direction of the foil sample.

4 Equipment / Environment

4.1 A noncontact 3-D tool will be used for this procedure and it will be calibrated according to the machine manufacturer's instructions.

Examples: Wyko-NT-1100, Zygo 5000, Zygo 600, Veeco NT-9300, Keyence VK-9700 or equivalent.

4.2 The tool will be placed on a lab bench or other sturdy table top and should be placed in an area away from machines that produce large amounts of noise/vibration. Follow test device manufacturer's recommendations for environmental conditions, including for vibration.

5 Procedure for testing upon metallic foil and physical NIST Traceable Standards

5.1 The operator will set up the measurement tool program to scan a minimum area of 200,000 square microns having a maximum length to width aspect ratio of 5:1 with an objective magnification of 50X for measuring the surface roughness of either a physical standard or a foil sample. Such specification requirements may necessitate stitching or ''step and repeating'' multiple images so as to obtain data from a properly sized area.

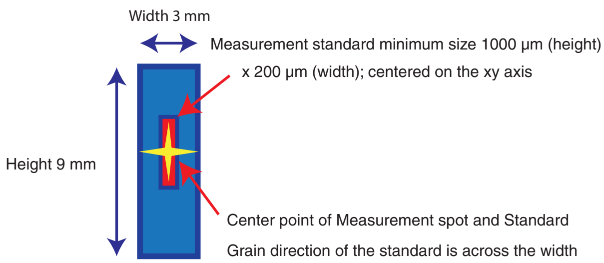
5.2 No filters shall be used with this test method.

5.3 Prior to measurement of metallic foil samples the tool operator will assure the 3-D tool is currently properly calibrated. Verification needs to be performed by testing the actual physical NIST Traceable Standards at least monthly on the 3-D measurement tool.

5.4 Physical Standards will be oriented so the measurement is perpendicular to the grain of the Standards. Operator will locate the measurement center point in the XY axis to match the XY center point of the specific patch being measured on the Standard set. This is done to assure the measurement always takes place in the same location upon the Standard surface.

1. www.ipc.org
2. www.iso.org

NIST Certified Standards



5.5 The test settings used for measuring the metallic foil samples **shall** be the same as used for measuring the NIST-certified standards.

6 Measurement Parameters and Machine setup

6.1 All measurements will be done using a saved set-up and measurement parameters (commonly termed ''a template'') to insure that all measurements are done using the exact same test method. Programs and procedures for each piece of specific equipment **shall** be saved and distributed to colleagues across the country so all facilities are taking the exact same measurements using the exact same test procedure. For example, procedures for laser or white light techniques will be different.

6.2 The equipment manufacturer should be consulted to define the specific measurement machine template needed to assure compliance with this measurement procedure.

6.3 The specifics of the surface measurements are listed below.

Primary Measurement Values: Sa, Sq, Sz

- **Sa** is defined as the average absolute value height in reference to the mean plane.
- **Sq** is defined as the root mean square (RMS) height in reference to the mean plane.
- **Sz** is defined as the absolute vertical distance between the highest peak and deepest valley.

7 Measurement Results

7.1 The values for Sq, Sa and Sz will be used to quantify the overall surface texture/topography of various metallic foils and will be reported. These values were chosen as they provide the most up-to-date surface measurement capabilities using a noncontact 3-D surface measurement tool.

APPENDIX A

A.1 Surface Roughness Standard: ISO 25178-2 This ISO standard is grouped into six different categories and each of these values are reported in the ''Height Parameters'' section. The conventional ISO 4287:2001 was defined for contact-type tools and does not provide as much detail as the ISO 25178-2 standard.

A.1.1 Filter Type: Gaussian Filter This is used for determining the mean plane in surface metrology. This is defined by ISO 1661 and is applied to areal surface roughness measurements.

A.1.2 Surface Type: S-L Surface Defines a surface obtained after using the L-Filter. This filter removes undulations and other surface variations, allowing for the measurement of only the surface topography/texture without geometric influence.

A.1.3 S-Filter This is chosen based on the specifications of the objective lens used to capture the data. This filter eliminates the smallest scale elements from the surface, shortest wavelength filter. S-filter should be no smaller than the spot size multiplied by 2.5.

A.1.4 F-Operation: Plane Correction Chosen based on the planar features of the surface of metallic foils.

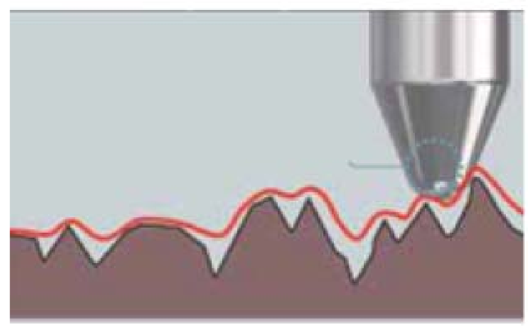
A.1.5 L-Filter This is chosen based on the area of the total minimum scanned section (1000 µm X 200 µm). This filter eliminates the largest scale elements from the surface, longest wavelength filter. L-filter should be no larger than entire scan length divided by 5.

A.2 Filter Selection and Filter Explanations

A.2.1 The main differentiator between the ISO 4287 and ISO 25178 is how the acquired data set is processed to maximize the accuracy of the calculated roughness values. The old standard used terms like λs and λc to account for the stylus tip size and total evaluation length, which are specific towards contact profilers. The newest standard uses filters to account for similar features of noncontact 3-D profilers: the objective lens used for analysis and total XYZ coverage area. Listed below is additional detail to describe how the S-filter, F-operation and L-filter are defined.

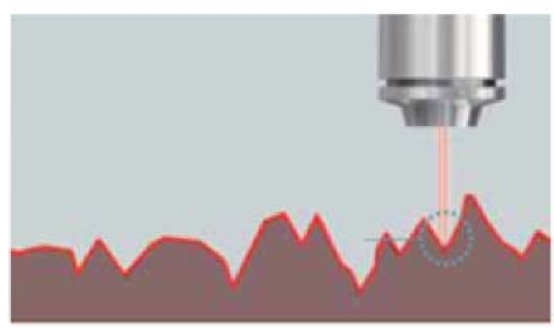
S-Filter:

- Commonly known as a low-pass filter.
- This filter is equivalent to λs for line roughness defined by ISO 4287.
- Eliminates noisy data that varies based on the size of beam spot. This will vary based on the objective lens chosen for the analysis. (see below for explanation)



Low mag lens, larger beam spot, high S-filter value

Vs.



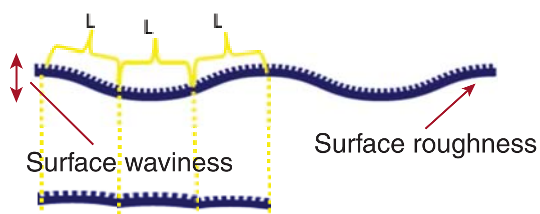
High mag lens, smaller beam spot, low S-filter value

F-Operation

- A filter for removing surface shapes (i.e., Plane tilt, curved surface).
- Insures that the geometry of the sample surface does not affect the magnitude of the measured roughness value.
- Eliminates the user from having to place the sample perfectly flat during the scan.

L-Filter

- Commonly known as a high-pass filter.
- This filter is equivalent to λc for line roughness defined by ISO 4287.
- Removes waviness and other nonuniform surface shapes to extract surface roughness data (normalization filter).



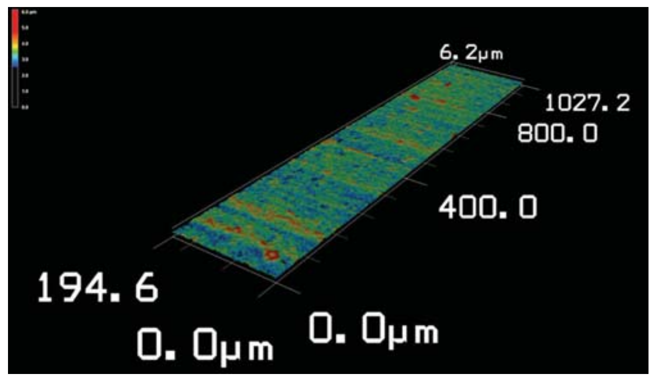
A.2.2 As described in Section V, the proper filter values that properly align with the ISO 25178 for this specific procedure (50X objective with 0.95 NA, 200 µm X 1000 µm scanned area) are:

- S-filter: 2 µm
- F-operation: Plane Correction
- L-filter: 0.2 mm

A.3 Sample Measurements Examples

A.3.1 Shown below are examples of what the user should expect from a successful analysis with a 3-D measurement tool. The first picture shows a qualitative 3-D rendering of the metallic foil surface from a laser confocal microscope tool.

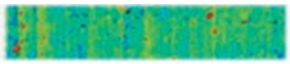
A.3.2 A laser confocal microscope, or similar noncontact 3-D surface measurement tool should be able to provide enough resolution in both the XY and Z direction to provide an accurate representation of the material.



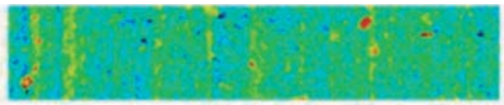
A.3.3 **Once** the 3-D model is obtained, the surface will then be quantified using the ISO 25178 Surface Roughness module.

A.3.4 **An** example of how the data could be outputted is shown below. Other similar forms of data outputs would be provided to the user by other noncontact 3-D measurement tools.

Main image (Height)

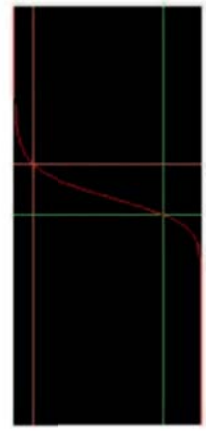


S-L surface

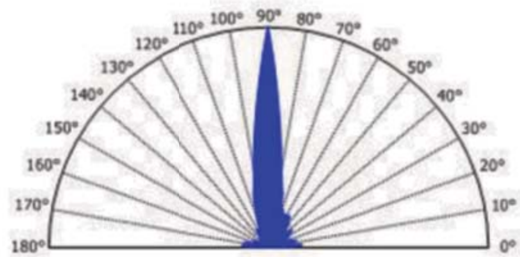


Material ratio curve

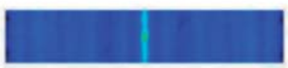
2.66um



Angular spectrum



Autocorrelation function



Height parameters						
Sq	0.366um		Ssk	0.7338		
Sku	6.1895		Sp	2.666um		
Sv	3.255um		Sz	5.921um		
Sa	0.274um					
Spatial parameters						
Sal	10.318um	s = 0.20	Str	0.1160	s = 0.20	
Std	90.0deg					
Hybrid parameters						
Sdq	0.2454		Sdr	0.0297		
Spd	74217.9651mm-2		Spc	388.3438mm-1		
Functional parameters						
Sk	0.812um		Spk	0.553um		
Svk	0.309um		Smr1	12.4534%		
Smr2	90.7502%		Sxp	0.840um	p = 2.5%	q = 50.0%
Functional volume parameters						
Vvv	0.0350ml m-2	p = 80.0%	Vvc	0.4309ml m-2	p = 10.0%	q = 80.0%
Vmp	0.0280ml m-2	p = 10.0%	Vmc	0.2919ml m-2	p = 10.0%	q = 80.0%

ISO 25178-2:2012, ISO/DIS 25178-3.2

Filter: S-filter 2um, F-operation Plane tilt (auto), L-filter 0.2mm