The Institute for Interconnecting and Packaging Electronic Circuits
2215 Sanders Road • Northbrook, IL 60062-6135

IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.18	
Subject	
Tensile Strength and Elongation, Copper Foil	
Date **8/80**	Revision **B**
Originating Task Group	
Printed Board Test Methods (7-11d)	

1.0 Scope To determine the tensile strength (in PSI) and the elongation (in percentage) of copper foil at ambient and elevated temperatures by mechanical force testing.

2.0 Applicable Documents

ASTM-E-345 Tensile Strength

3.0 Test Specimens Copper foil sufficient in size to permit cutting or etching of five specimens 10 inches x ½ inch. Specimens must be clean cut and free of burrs and nicks.

4.0 Apparatus

4.1 Constant strain rate tensile tester capable of pulling at rate of 0.050 and 2.0 inches/minute.

4.2 JDC #50 sample cutter ½ inch wide x 10 inches long.

4.3 A shear to cut 10 inches long sample to 6 inches long.

4.4 Mettler Balance type P120 or equivalent.

4.5 Elevated temperature chamber or fixture, attachable to the tensile tester, capable of reaching and maintaining a temperature of 180°C ±10°C during sample testing.

5.0 Procedure

5.1 Preparation of Samples

5.1.1 The sample should be smooth and undistorted (wrinkle free).

5.1.2 Use the JDC #50 to cut five tensile specimens.

5.1.3 Cut the five 10 inches long specimens to 6 inches long.

Note: Accuracy is important in the ½ inch x 6 inches dimensions because it is used to determine foil thickness and cross-sectional area.

5.2 Weighing Samples

5.2.1 Weigh tensile sample to at least three places beyond the decimal point, in grams.

5.2.2 Record the weight and calculate the mean average cross-sectional area.

Note: The density of electrodeposited copper is 8.909 gm/cc (16.389 cc/in^3 x 8.909 gm/cc = 146 gm/in^3).

The density of rolled copper is 8.93 gm/cc (16.389 cc/in^3 x 8.93 gm/cc = 146.35 gm/in^3).

$$\text{Mean average thickness} = \frac{\text{Weight of tensile sample in grams}}{\text{Area of Tensile sample in sq. inches} \times \text{The density of copper in gm/in}^3}$$

$$\text{Mean avg. cross-sectional area} = \frac{\text{Weight of tensile sample in grams}}{\text{Area of Tensile sample in sq. inches} \times \text{The density of copper in gm/in}^3}$$

5.3 General Test Information

5.3.1 If the tensile tester is equipped with an area compensator, dial the mean average cross-sectional area into it. If not then the cross-sectional area has to be used to compute the tensile strength.

Note:

$$\frac{\text{Tensile Strength}}{\text{in lbs/in}^2} = \frac{\text{Load used to break sample in lbs.}}{\text{Mean average cross–sectional area}}$$

If Tensile Tester is equipped with area compensator after the test is complete, the Tensile Strength can be read directly from the chart.

5.3.2 Ambient Temperature Testing

5.3.2.1 Select load range.

5.3.2.2 Place the sample in the jaws of the Tensile Tester being careful that it is properly centered and the axis aligned with the jaws.

5.3.2.3 Test Conditions

(1) Gage length 2.0 inches
(2) Crosshead speed 2.0 inches/min.
(3) Chart speed 20 inches/min.

Note: At a chart speed of 20 inches/min., a gage length of 2.0 inches and a crosshead speed of 2.0 inches/min. each one inch of chart paper equals 5.0% linear elongation.

5.3.3 Elevated Temperature Testing

5.3.3.1 Select load range.

5.3.3.2 Bring temperature chamber or fixture up to 180°C ±10°C.

5.3.3.3 Open temperature chamber and clamp foil sample between tensile jaws. (*Note:* Caution must be exercised to avoid excessive clamping pressures and to provide good sample alignment for testing.)

5.3.3.4 Close temperature chamber and monitor sample temperature with a thermocouple. Permit foil sample to dwell at 180°C temperature for 5 minutes prior to tensile test. Maximum time at temperature should not exceed 10 minutes.

5.3.3.5 Test Conditions

(1) Gage length 2.0 inches
(2) Crosshead speed 0.050 inches/min.
(3) Chart speed 20 inches/min.

Note: At a chart speed of 20 inches/min., a gage length of 2.0 inches and a crosshead speed of 0.050 inches/min., each one inch of chart paper equals 0.125% linear elongation.

Note: Temperature chamber contains normal ambient air. Inert gas atmosphere is not necessary, but may be used.

5.4 Evaluation

5.4.1 Activate crosshead to break sample and make calculations of tensile strength in pounds/in^2 and elongation in %.

5.4.2 Percent elongation may be determined by fitting the ends of the fractured specimen together carefully and measuring the distance between the original gage marks to the nearest 0.01 inch. Elongation is the increase in length of the gage length, expressed as a percentage of the original gage length.

$$\text{Percent elongation} = \frac{\text{length at break} - \text{original gage length X 100}}{\text{original gage length}}$$

5.4.3 Average all five elongation readings.

6.0 *Notes*

6.1 For guidance, typical values for tensile strength and elongation are:

TENSILE STRENGTH

Oz/ft²	*Electrodeposited Standard or high ductility*	*As rolled*	*Light cold rolled*	*Annealed*
	lb/in²	*lb/in²*	*lb/in²*	*lb/in²*
1/2	15,000	50,000	—	15,000
1	30,000	50,000	—	25,000
2 & over	30,000	50,000	25,000	25,000

ELONGATION

	Electrodeposited				
Oz/ft²	*Standard*	*High ductility*	*As rolled*	*Light cold rolled*	*Annealed*
	percent	*percent*	*min. percent*	*min. percent*	*min. percent*
1/2	2	5	1/2	—	5
1	3	10	1/2	—	10
2	3	15	1	5	20