INTERNATIONAL

Designation: B975 – 22

Standard Test Method for Measurement of Internal Stress of Metallic Coatings by Split Strip Evaluation (Deposit Stress Analyzer Method)[1]

This standard is issued under the fixed designation B975; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The split strip method provides a determination of the internal tensile and compressive stress in metallic and nonmetallic coatings. Internal stress is expressed in pounds per square inch or megapascals.

1. Scope*

1.1 This test method for determining the internal tensile or compressive stress in applied coatings is quantitative. It is applicable to metallic layers that are applied by the processes of electroplating or chemical deposition that exhibit internal tensile or compressive stress values from 200 psi to 145 000 psi (1.38 MPa to 1000 MPa).

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other. Conversion between unit systems may result in errors that can cause confusion and should be avoided.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B636 Test Method for Measurement of Internal Stress of Plated Metallic Coatings with the Spiral Contractometer

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *average deposit thickness, n*—the deposit weight in grams divided by the specific gravity of the deposit in grams per cubic centimetre multiplied by the plated deposit surface area per test strip (see Eq 2).

3.1.2 *constant K, n*—this certifiable calibrated number is determined experimentally for each material lot of test strips manufactured to enable simple mathematical calculation of the internal deposit stress while factoring the influence of the percent elongation difference between the deposit and the substrate without the use of complicated bent strip formulas. See Section 10.

3.1.3 *internal stress, n*—stress in a given layer of coating can result from foreign atoms or materials in the layer that stress the natural structure of the deposit as the coating is being formed from sources independent of foreign atoms such as misfit dislocations and the result of additional processing.

3.1.3.1 *compressive stress (-), n*—stress that tends to cause a deposit to expand.

[1] This test method is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.10 on Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

3.1.3.2 *tensile stress (+), n*—stress that tends to cause a deposit to contract.

3.1.3.3 *Discussion*—Stress that develops in a given layer of material is measured as pounds per square inch or megapascals where 1 MPa = 145 psi.

3.1.4 *modulus of elasticity, n*—stress required to produce unit strain, which may be a change in length (Young's modulus), a twist of shear (modulus of rigidity or modulus of torsion), or a change in volume (bulk modulus).

3.1.5 *sample test strip, n*—test strip that is used to set the desired amperage on the power supply. This can be a previously used test strip.

3.1.6 *units spread, n*—the amount of deflection between test strip legs is the value of U. Plating test should be continued until the test strip legs deflect from 2-20 total units spread for the most accurate results. The U is measured on the measuring stand.

4. Summary of Test Method

4.1 The first attempt to measure stress values in applied coatings was the bent strip method, wherein a coating of known thickness was applied to a strip of flat stock material having a known modulus of elasticity, length, width, and thickness. In the test, one end of the strip was held in a fixed position and one end could bend. The degree of bend experienced by the test strip was then measured. Equations were proposed by Stoney, Barklie, and Davies[3]; Heussner, Balden, and Morse[4]; and Brenner and Senderoff[5] for this method of measurement to calculate the internal deposit stress that was sufficient to cause deflection of the flat stock material.

4.2 Later methods include the use of flat stock material formed into a helix that contracts or expands as a stressed coating is applied to the base material (spiral contractometer as described in United States Patent 4,086,154) and a disk formed from flat stock material that bows outward or inward as a stressed coating is applied to the base material (stress meter).

4.3 The deposit stress analyzer method for determining the internal stress value of a given plating uses bent strip technology and the formulas devised for calculation of results applicable to this approach. A specific test piece comprises a selected metallic material that exhibits spring-like properties with specified dimensions that define an end area split to give two legs (see Fig. 1). These test strips are coated with a resist, to prevent deposition on the front of one leg and the back side of the other leg and on both sides above where the legs divide, leaving a space uncoated at the top for the purpose of making electrical contact to the test piece during the plating process. See Fig. 2. Each test is performed at specific operating conditions that are usually selected to approximate the conditions for parts being processed in production mode.

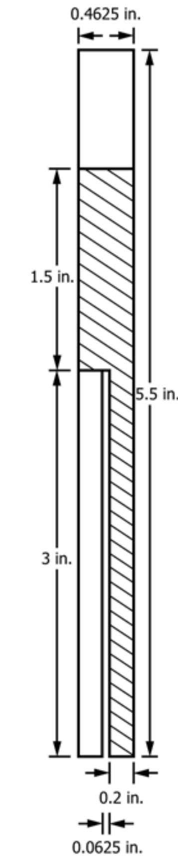

FIG. 1 Test Strip Parameters
1 in. = 2.54 cm

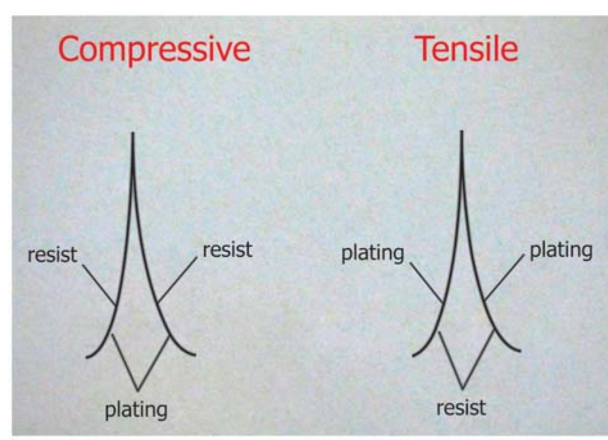

FIG. 2 Compressive and Tensile Stressed Test Strips (provided by the Specialty Testing and Development Company, PO Box 296, Seven Valleys, PA 17360)

4.3.1 The internal deposit stress is calculated based on the total number of increments deflection observed from tip to tip after plating. This value is determined as the test strip is suspended above a measuring stand. See Fig. 3. Results are calculated by use of split strip formulas expressed in pounds per square inch. (See Eq 1 and Eq 3.)

5. Significance and Use

5.1 Internal stress in applied coatings exhibits potential to cause a breakdown of resistance to corrosion and erosion as a

[3] Stoney, G. G., *Proceedings of the Royal Society A*, Vol 82, No. 172, 1909, p. 553.

[4] Heussner, Balden, and Morse. "Some Metallurgical Aspects of Electrodeposits," *Plating*, Vol 35.

[5] Brenner, A., and Senderoff, S. *Journal of Research of the National Bureau of Standards*, Vol 42, No. 89, 1949.