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AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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Standard Test Method for Measurement of Internal Stress of Plated Metallic Coatings with the Spiral Contractometer¹

This standard is issued under the fixed designation B 636; 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.

^{€1} NOTE—Section 12 was added, the title changed to “Test Method,” and other editorial changes made in January 1992.

1. Scope

1.1 This test method covers the use of the spiral contractometer for measuring the internal stress of metallic coatings as produced from plating solutions on a helical cathode. The test method can be used with electrolytic and autocatalytic deposits.

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

2. Terminology

2.1 Definitions:

2.1.1 *compressive stress* (–)—stress that tends to cause a deposit to expand.

2.1.2 *internal stress*—the net stress that remains in a deposit when it is free from external forces. The internal stress tends to compress or stretch the deposits.

2.1.3 *tensile stress* (+)—stress that tends to cause a deposit to contract.

3. Summary of Test Method

3.1 The test method of measuring stress with the spiral contractometer is based on plating on the outside of a helix. The helix is formed by winding a strip around a cylinder, followed by annealing. In operation, one end of the helix is fixed and the other is allowed to move as stresses develop. The free end is attached to an indicating needle through gears that magnify the movement of the helix. As the helix is plated, the stress in the deposit causes the helix to wind more tightly or to unwind, depending on whether the stress is compressive (–) or tensile (+). From the amount of needle deflection and other data, the internal stress is calculated.

3.2 With instrument modifications, the movement of the helix can be measured electronically instead of mechanically as described in 3.1.

4. Significance and Use

4.1 The spiral contractometer, properly used, will give reproducible results (see 8.5) over a wide range of stress values. Internal stress limits with this method can be specified for use by both the purchaser and the producer of plated or electroformed parts.

4.2 Plating with large tensile stresses will reduce the fatigue strength of a product made from high-strength steel. Maximum stress limits can be specified to minimize this. Other properties affected by stress include corrosion resistance, dimensional stability, cracking, and peeling.

4.3 In control of electroforming solutions, the effects of stress are more widely recognized, and the control of stress is usually necessary to obtain a usable electroform. Internal stress limits can be determined and specified for production control.

4.4 Internal stress values obtained by the spiral contractometer do not necessarily reflect the internal stress values found on a part plated in the same solution. Internal stress varies with many factors, such as coating thickness, preparation of substrate, current density, and temperature, as well as the solution composition. Closer correlation is achieved when the test conditions match those used to coat the part.

5. Apparatus

5.1 The spiral contractometer is described by A. Brenner and S. Senderoff.²

NOTE 1—Spiral contractometers are available from many of the suppliers of nickel sulfamate.

5.2 Helices shall be stopped-off on the inside to prevent plating. Helices are available with or without a permanent inert coating on the insides (see Appendix X1).

5.3 The clamps holding the helix to the contractometer shall be coated with an inert nonconductive coating to prevent their plating and acting as thieves.

5.4 For testing electroplating solutions, anodes are placed equidistant from the helix and symmetrically positioned to produce even plate distribution. A minimum of four anodes is required. A concentric anode arrangement is preferred.

¹ This test method is under the jurisdiction of ASTM Committee B-8 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.10 on General Test Methods.

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² Brenner, A., and Senderoff, S., *Proceedings of the American Electroplaters Society*, Vol 35, 1948, p. 53.