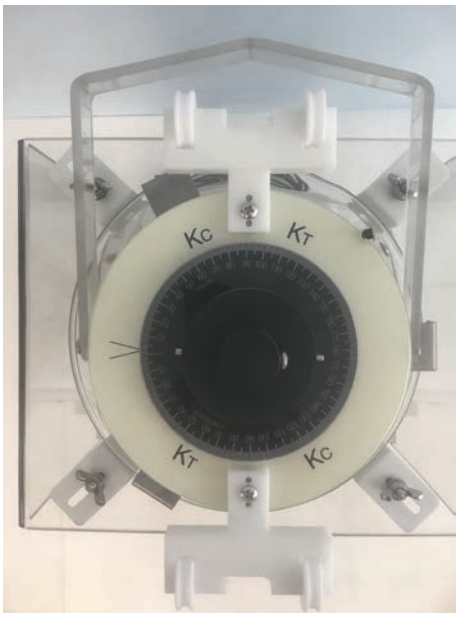
SPIRAL CONTRACTOMETERS

Know The Stress in Your Applied Metallic Coatings

ASTM B636 Standard Test Method for Measurement of Internal Stress of Plated Metallic Coatings with the Spiral Contractomenter.



ADVANTAGES

Accurate repeatable results
Simple and rapid calculations
No need to figure out the pitch

IMPROVEMENTS

Thread stripping is prevented
Reduced calibration wheel friction
Fluoropolymer construction
Inside of the spiral (helix) surface is shielded
Screws help prevent spiral (helix) slippage
Precise scale to arrow view

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SPECIALTY TESTING AND DEVELOPMENT COMPANY

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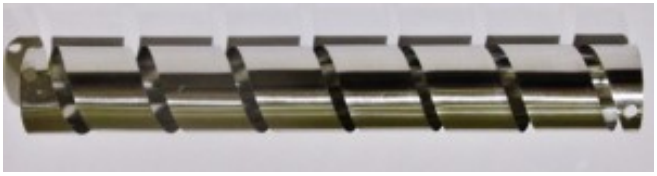
SPIRAL CONTRACTOMETER MEASUREMENT METHOD

Internal stress exists as an inherent force within electroplated and chemically applied metallic deposits. This induced stress can be tensile or compressive in nature, causing the deposit to contract or expand in relation to the base material. High levels of stress in deposits produce micro-cracking and macro-cracking, and in severe cases produce a lack of deposit adhesion in the form of blistering, peeling, and flaking. Two ways to evaluate the internal deposit stress in metallic coatings are the bent strip Deposit Stress Analyzer and the Spiral Contractometer methods. These represent two stress test procedures that have approval status by the American Society for Testing Metals Standards (ASTM).

SPECIALTY TESTING AND DEVELOPMENT COMPANY Spirals (Helices) are constructed from 0.010 inch thick stainless steel and each has a precise surface area of 13.57 square inches, thus, there is no need to estimate the surface area that has been plated. The spiral (helix) mounts on to the contractometer in a manner that permits plating on the entire outside surface of the spiral (helix).



SPIRAL (Helix) FOR THE SPIRAL CONTRACTOMETER DESIGN AND PLATING TEST CONDITIONS:

Surface Area, in² 13.57
Square Feet 0.0942
Stock Thickness, inches 0.010

Equipment:

Spiral Contractometer Kit with calibration weights (PN:KSC114)

Adjustable Support Stand (PN: SAS141)

Anode Buttons 4 pounds*

Titanium anode basket 5″OD for plating bath (PN:ABL14)

4,000 ml Pyrex beaker for plating bath (other source)

Direct Current Power Supply 0-5 Amp output constant amp constant voltage (PN: HY3005)

Magnetic Stirrer Hot Plate (PN:MSH4000)

Digital Temperature Controller (other source)

Equipment *continued:*

Spirals (Helix) (PN: CTS214)

GrabLab Timer*

** Can be purchased from Kocour Company, 4800 South St. Lewis Avenue, Chicago, IL 60632, 1-773-847-1111).*

Spiral (Helix) preparation and use video:

https://specialtytest.com/contractometer-system/video-how-to-use-the-spiral-contractometer/

NOTE: If the Spiral Contractometer is not free moving take apart and clean the center connector rod and make sure the rod is straight.

TEST PROCEDURES:

1. Place the anode basket containing buttons or anodes in a 4,000 ml Pyrex beaker, then place the beaker on a magnetic stirrer hot plate. Add the desired plating solution to the beaker, then place the spiral contractometer adjustable support stand over the beaker. Warm the plating solution to the desired temperature.
   Note: Use gloves to prevent contamination of the spiral (helix).
   Note: If a nickel Strike is necessary go to Step #2, if not go to Step #5.

2. If a nickel strike is necessary for adhesion of the applied coating, pour the nickel strike solution into a beaker use a circular titanium anode basket containing Nickel anodes or buttons.

3. Clean a spiral (helix) as the cathode (positive lead) in an alkaline steel electrocleaner at 3 amps for 30 seconds and warm water rinse.

4. Nickel strike the spiral (helix) at 3 amps for 1 minute. Remove the spiral (helix) from the Spiral Contractometer and water rinse, isopropyl alcohol rinse and dry completely. Go to Step #6.

5. Clean the spiral (helix) in a soak clean solution, water rinse and alcohol rinse, then dry completely.

6. Weigh the spiral (helix) to the nearest milligram, record the starting weight in grams. (example 19.1649)
   SW=_____

7. Mount the spiral (helix) onto the Spiral Contractometer and tighten the screws through the holes provided to secure the spiral (helix) preventing slippage during the plating process.
   Note: That the wire contact end must be positioned over the top of the spiral (helix) with a screw.

8. Place the Spiral Contractometer assembly and the attached spiral (helix) into the center of the adjustable Support Stand center through the hole in the top of the stand. Then wait two minutes for the spiral (helix) to reach the plating bath temperature.

Spiral Contractometer Kit

PN: KSC114

The Spiral Contractometer Kit includes, calibration weights, a spiral (helix), and a wire repair kit. For a video on how to use the Spiral Contractometer visit:

https://specialtytest.com/contractometer-system/video-how-to-use-the-spiral-contractometer/

This Spiral Contractometer design enables spiral (helices) to be plated tip to tip so the plated surface area is the same for every spiral (helix). Stainless steel inserts prevents thread damage.

Spiral Contractometer Repair Kit

PN: SCWRK

The Kit includes, 1 wrapped wire and 4 screws that are to be attached to the Spiral Contractometer when the wire needs to be replaced.

Coated and Non Coated Spiral

PN: CTS214 Fluoropolymer Coated Spiral

PN: NCS314 Non Coated Spiral

This Spiral is constructed of high grade stainless steel 0.010 inch thick. It has an exact surface area of 13.57 square inches and is designed to allow plating of the entire outside surface of the spiral so the plated surface area is known. Holes are provided at each end of the spiral to hold it in place and prevent slippage. The spirals can be used up to 400 degrees F.

Most plated deposits can be chemically stripped without causing damage to the Fluoropolymer coating, so the helix can be used in a repeatable manner. For directions on how to strip helices visit:

https://specialtytest.com/contractometer-system/stripping-deposits-from-spiral-helices/

Adjustable Support Stand

PN: SAS141

The stand is Lexan construction. It's designed to support the Spiral Contractometer PN:KSC114 for calibrating and plating the spiral. The Adjustable Support Stand adjusts for height and diameter differences and centers the spiral over the beaker so as to remain on center in the anode basket or and the beaker throughout the test. The Adjustable Support Stand is designed for a 4,000ml beaker with a diameter of 6 1/2 to 7 1/2 inches.

Anode Baskets

PN: ABL14 Anode Basket

The Anode Basket, (inside diameter 4 in x outside diameter 5 in x height 8¼ in), is constructed of titanium mesh to hold nickel anode buttons. It is designed to fit into a 4,000ml Pyrex beaker and centers itself by engaging the top of the beaker with the side tabs to permit space at the bottom of the beaker for a Magnet Stir Bar to provide uniform bath temperature during the test period.

Visit the web site for more information ***https://specialtytest.com***

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Magnetic Stirrer/Hot Plate

PN: MSH4000

This Magnetic Stirrer/Hot Plate is made with a heat-resistant anticorrosive aluminum casting body with a high quality powder coating. A 1.5 inch long Magnetic Stir bar is included with purchase. Heats to Temperatures up to 248 degrees F.

- *High precision Speed control /range is 60rpm to 1500rpm.*
- *Temperature range is 80 degrees C to 380 degrees C.*
- *Plate dimensions: 180mm x 180mm (7.1in x 7.1in)*
- *Overall dimensions:*

  (W) 205mm x (D) 250mm x (H) 110mm

  (W) 8.5in x (D) 10in x (H) 4.5in
- *Power consumption Mat. 500 Watt, 3D amp*

DC Power Supply *(Product may differ from photo)*

PN: HY3005

This DC power supply is recommended for plating spirals/helices at the desired amperage. It is equipped with coarse and fine controls for adjusting the voltage and current outputs, making it easy to set the output to the desired level. The unit comes with a positive and negative lead, and power cord.

Technical parameters: Adjustable outputs: 0-30V and 0-6A, Input voltage: 110V/220V switchable, LCD reading accuracy: +/-1% for voltage and +/-2% for current.

Visit the web site for more information ***https://specialtytest.com***

Prices are in U.S. funds payable by US drawn check, American Express, Master Card, or Visa, or by Bank Wire Transfer.

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Calibration of the Spiral (Helix) To Find Your K.

For photo instructions visit our web site at:
https://specialtytest.com/contractometer-system/callibration-of-the-spiral-contactometer-helix/

1. Loosen the screw on the pulley calibration wheel that holds it tight against the center connector rod and position the dial to match the zero with the arrow, and then tighten the screw to secure the rod so slippage cannot occur.

   Note: It is important that when the spiral (helix) is attached to the contractometer, a space of about 3/16 inch should be allowed between the bottom of the contractometer spiral shaft and the top of the spiral (helix) holder to which the spiral (helix) is attached.

2. Attach the eye loop of the thread on one of the calibration weights over the zero pulley calibration pin then wrap the thread *clockwise* ¾ way around the pulley calibration wheel and suspend the weight over the grooved guide wheel near the Kc marker.

3. Attach the eye loop of the thread on the second calibration weight over the 180 pulley calibration pin then wrap the thread *clockwise* ¾ way (making sure to put the thread under the previous one) around the pulley calibration wheel and suspend the weight over the grooved guide wheel near the Kc marker.

4. Tap the pulley calibration wheel at the top of the contractometer lightly and read the degrees compressive stress. Record this degree reading as Kc.
   Kc=___-_____.

   Note: The compressive stress values are Negative.

5. Remove the weights from the pins making sure the dial is at zero. Repeat step 2-4 procedure except wrap the strings *counterclockwise* ¾ of the way and suspend the thread over the grooved guide wheel near the Kt marker. Again, tap the pulley calibration wheel at the top of the contractometer lightly and read the degrees tensile stress. Record this reading as Kt. Finally, remove the calibration weights. Kt=_____.

   Note: The tensile stress values are positive.

Plating the Spiral (Helix) To Find Your d.

1. Make sure the solution temperature is at the desired temperature.

2. Set the timer for the desired time.

3. Connect the positive lead (red) of the power supply to the anode basket and the negative (black) lead to the wire contact at the top of the spiral contractometer.

4. With the rectifier plugged into the timer, turn on the timer and begin the plating process. For critical work, maintain the bath temperature ± 3°F. It is helpful to tap the top of the pulley calibration wheel every 3 minutes or so with a blunt instrument to assist in stabilizing the degree reading.

5. When the plating time expires, tap lightly on the top of the pulley calibration wheel, to stabilize the degree value, then read the degrees value and note if the stress is compressive (negative) or tensile (positive). Record the degree value as Kc- or Kt+ accordingly (d = _____).

6. Remove the spiral contractometer from the adjustable support stand, rinse the spiral (helix) in water, and rinse it in isopropyl alcohol. Remove the spiral (helix) from the contractometer using gloves. Dry completely.

   Note: It is helpful to twist part of a rolled sheet of paper towel gently through the interior of the spiral (helix) to assist in drying.

7. When the spiral (helix) is completely dry, weigh the spiral (helix) and record the finished weight in grams. FW=_____.

Calculations for the Deposit Thickness.

1. Subtract the start weight from the finished weight to obtain the weight of metal deposited. FW - SW = W

2. Calculate the average deposit thickness in inches.
   (for D density, see chart 1)

$$T = \frac{W}{D\ (13.57 in^2)(6.45 cm^2/in^2)(\ 2.54\ cm\ /\ inch)} = Inch$$

W = Grams of deposit

D = Density of plated material, g/cm³

T = Deposit thickness in inches

Note: For the Specialty Testing spirals (helices) plated on our spiral contractometer, the constant spiral (helix) plated surface area is 13.57 in² since the entire spiral (helix) receives plating on the outside diameter, and the following shortened formula applies:

$$T = \frac{W}{D(222.32\ cm^3/\ inch)} = Inch$$

Note: For the spirals (helices) others than "Specialty Testing and Development Company's", the surface area plated must be determined by wrapping the spiral (helix) tightly around a 3/4 inch diameter rod. Then the diameter and estimated plated length in inch values are used to calculate the plated surface area as follows: Surface Area = πdh = cm²

3. Record the average deposit thickness of the spiral (helix) in microinches: T = _____inches

Suggested Tip Distance ¼" to ⅜" at the bottom of the Spiral Contractometer

Chart 1. Density and Modulus of Elasticity

Deposited Metal	(D) Density	(Edeposit)Modulus of Elasticity
Cadmium	8.64	8,010,000
Chromium	7.19	36,000,000
Cobalt	8.80	30,600,000
Copper	8.93	16,000,000
Gold (Soft)	19.30	11,200,000
Gold (Hard)	19.32	
Nickel	8.88	30,000,500
Palladium	12.02	17,000,000
Platinum	21.45	24,800,000
Rhodium	12.45	52,100,000
Sliver	10.50	11,000,000
Tin	7.26	5,900,000
Zinc	7.10	14,000,000

Calculate the Deposit Stress in PSI.

$$\text{Stress} = \frac{13.02\,(d)}{(K)\,(T)} \times \left[1 + \frac{E\text{Deposit}\,(T)}{E\text{Substrate}\,(t)}\right] = \_\_\_\_\_\ \text{PSI}$$

d = deflection of the spiral (helix) caused by the deposit in degrees, after plating.
See Plating the Spiral To Find Your d on page #5.

K = deflection of spiral (helix) in calibration in degrees, before plating.
See Calibration of the Spiral To Find Your K on page #5.

T = deposit thickness in inches
See Calculations for deposit thickness on page #5.

t = substrate thickness in inches, for Specialty Testing Spiral (helix) 0.010 inch

EDeposit = Modulus of elasticity of the plated material _____ PSI, (see Chart 1)

ESubstrate = Modulus of elasticity of the Spiral (helix) substrate= 28,600,000 PSI
for Specialty Testing and Development Spiral (helix)

STRIPPING SPIRALS (HELICES) FOR REUSE.

1. Plated spirals (helices) can be stripped of deposits repeatedly in a 50% by volume nitric acid solution for reuse. Do not heat the solution above 90°F.

2. When the exterior surface of a spiral (helix) shows visible etching, the spiral (helix) should be discarded.

Note: If stripping Silver, Gold, or Copper see our website under Spiral Contractometer/Stripping Deposits from Spirals (Helices).