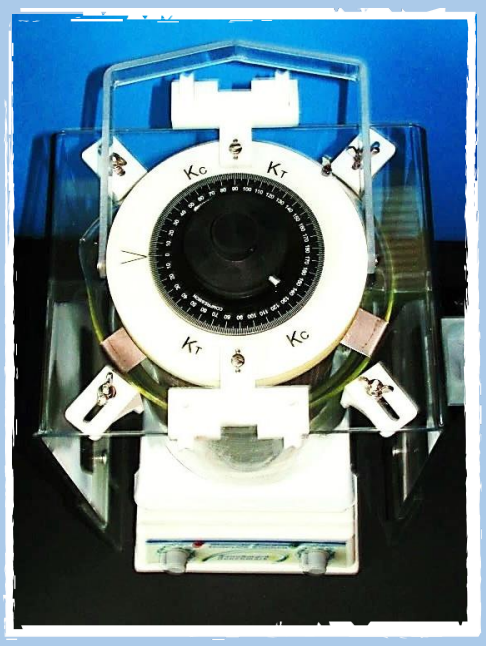
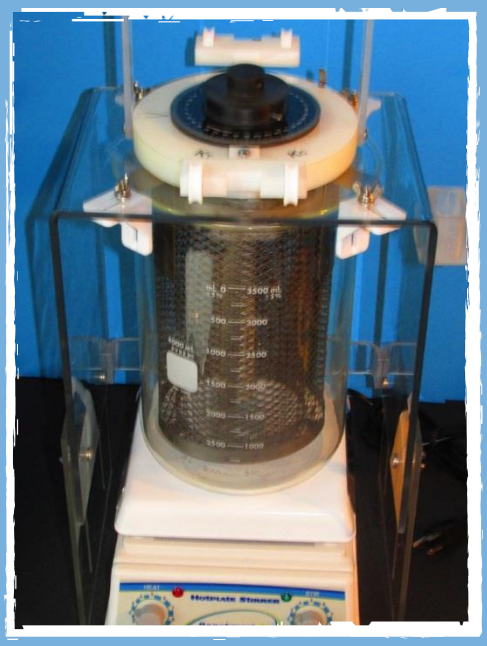
A NEW DESIGN FOR SPIRAL CONTRACTOMETERS

Know The Stress In Your Applied Metallic Coatings

Specialty Testing Calculating App link:

https://play.google.com/store/apps/details?id=com.wordpress.zackleaman.specialtytestinganddevelopmentco





ADVANTAGES

- Accurate repeatable results
- Easy centering of the helix
- Easy centering of the anode basket
- Holes at helix ends - no slippage
- Simple and rapid calculations
- Guess steps are eliminated

IMPROVEMENTS

- Thread stripping is prevented
- Reduced calibration wheel friction
- 25% glass filled Teflon construction
- Inside spiral surface is shielded
- Minimal deposit on helix interior
- Precise scale to arrow view

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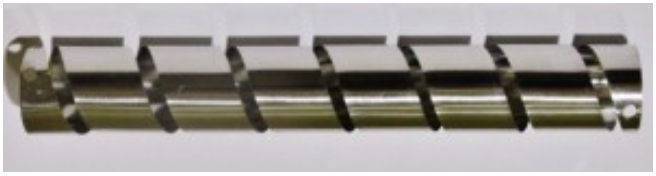
SPIRAL CONTRACTOMETER MEASUREMENT METHOD

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.

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. The spiral (helix) mounts on the contractometer in a manner that permits plating on the entire outside surface of the spiral (helix) and discourages deposition on the inside of the spiral (helix). Thus, there is no need to estimate the surface area that has been plated.



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

For plating Amps, times etc. visit our web site:

https://specialtytest.com/deposit-stress-analyzer-test-procedures-to-determine-internal-deposit-stress-values/

Equipment:

Spiral Contractometer Kit with calibration weights (PN:KSC114)

Adjustable Support Stand (PN: SAS141)

Titanium anode basket 3.5”OD for Wood’s nickel strike (PN:ABS14)

Anode Buttons 4 pounds (AB-NI)

Beaker approx. 4" wide x 9.5” tall for striking (other source)

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-PS)

Magnetic Stirrer Hot Plate (PN:MSH4000)

Digital Temperature Controller prewired with probe (PN:TC590)

Equipment *continued*:

Spirals (Helix) reusable (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:

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

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 and 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 #2, if not go to #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 #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 polycarbonate screws through the holes provided sufficiently to secure the spiral (helix) so as to prevent 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 adjustable support stand center in the holes in the top surface of the stand. Then allow two minutes for the spiral (helix) to reach the plating bath temperature.

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

For photo instructions visit our web site at:
https://specialtytest.com/calibration-of-the-helix/

1. Loosen the pulley calibration wheel screw that holds the pulley calibration wheel tight against the top of the center rod and position the dial by rotating it 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 knob to which the spiral (helix) is attached.

2. Attach the eye loop thread of one of the calibration weights over the pulley calibration pin at the zero and wrap the thread *clockwise* part way around the pulley calibration wheel and suspend the weight over the grooved Teflon guided wheel near the Kc marker.

3. Attach the eye loop thread of second of the calibration weights over the remaining pulley calibration pin at the 180 degrees and 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 Teflon guided 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 identified with a minus sign.

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 Teflon guided 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.
   (Visit: http://specialtytest.com/deposit-stress-values-for-various-metal-deposits/)

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)

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

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:

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

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 1/4" to 3/8" 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.

$$\text{Stress} = \frac{13.02\,(d)}{(K)\,(T)} \times 1 + \frac{\text{EDeposit}\,(T)}{\text{ESubstrate}\,(t)} = \_\_\_\_\_\ \text{PSI}$$

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

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

T = deposit thickness in inches,

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)

Link to Specialty Testing calculating app:
https://play.google.com/store/apps/details?id=com.wordpress.zackleaman.specialtytestinganddevelopmentco

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 helix shows visible etching, the helix should be discarded.

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