QUALITY CONTROL
PROCEDURES
Rev. 2010
Tests done for coatings that have been sprayed on cookware:

1) **INSPECTION**
   - Spray coating, and inspect at 30X magnification for surface flaws.

2) **BOILING WATER CROSS-HATCH ADHESION TEST**
   **Purpose:** Check adhesion properties of the non-stick system to a specific type of pretreatment and substrates.
   - Submerge coated pan in boiling water for 15 minutes.
   - Scribe a 10mm X 10mm cross-hatch on the coating surface with a blade, ensuring that the cross-hatch fully penetrates to substrate.
   - Using Glass-Reinforced pressure-sensitive tape, press tape firmly on to the cross-hatched area, Forcefully rip off in one motion.
   - Repeat 5 times in various directions (horizontally, vertically, diagonally)

   No coating should be removed with the tape in order for the coating to be considered satisfactory.

3) **DRY EGG RELEASE TEST**
   **Purpose:** To check initial non-stick properties of the coating system. Egg should show absolutely no sticking.
   - Heat the pan to 400°F;
   - Break a standard egg in the center of the pan;
   - Allow the egg to cook thoroughly (usually 90-120 seconds);
   - Attempt to remove the egg with a spatula;
   - Check the pan for any sticking or residue remaining on the coated surface.
4) **STAINLESS STEEL SPATULA TEST**

**Purpose:** Check adhesion, scratch resistance, and hot hardness of the coating system under cooking conditions.

- Install coated pan and stainless steel spatula on fixture of abrasion test machine;
- Apply 5 pound weight static vertical pressure;
- Heat substrate to 204°C on machine’s hot plate;
- Stroke substrate with stainless steel spatula at a 45° angle to surface;
- Run 30,000 cycles for standard 2-coat systems.
- Run 50,000 cycles for standard 3-coat systems.

Check for topcoat scratching, basecoat and/or substrate penetration.

5) **SCOTCH BRITE ABRASION / EXTENDED DRY EGG RELEASE TEST**

**Purpose:** Check the abrasion resistance and extended release properties of a non-stick coating system.

- Install coated pan on abrasion test machine and new 3M Scotch-Brite 7447 pad to fixture.
- Apply 10 pound weight static vertical pressure.
- Run 30,000 cycles for 2-coat systems.
- Run 50,000 cycles for 3-coat systems.
- For high performance systems, run until failure (maximum 250K cycles).
- Every 10,000 cycles, change Scotch-Brite pad.
- Every 10,000 cycles, check dry egg release on unabraded and abraded surface.
- **NOTE:** As of 2010, this test is being modified by adding 5% soapy water to the substrate during the test to simulate kitchen use and to accelerate coating failure.
Check for superficial scratches and/or intercept/substrate penetration. Egg should be easily removable from wear track. If egg sticks, coating system must be modified.

6) **PENCIL HARDNESS**

**Purpose:** To check the room-temperature hardness of the new coating system

- Hold pencil at an angle approximately 45° to coating surface.
- Use pressure, short of breaking lead, to push the pencil forward.
- Any marring of the surface, visible at an oblique angle in strong light indicates that the specific pencil lead is harder than the film.
- The “pencil hardness” rating is expressed as the grade of the next softer pencil.

7) **TIGER PAW TEST**

**Purpose:** Measure hot hardness, scratch resistance and overall durability off a non-stick coating system at cooking temperatures and conditions.

- Use the hand-held “TIGER PAW” testing device;
- Cover bottom of pan with vegetable oil;
- Heat pan to 400°F;
- Rotate “TIGER PAW” device on surface of pan, changing directions every 100 cycles (clockwise & counter-clockwise)
- Repeat for 2000 cycles, 3000 cycles for high performance systems.

Check for superficial scratches, intercoat/substrate penetration.

8) **CORROSION TEST**

**Purpose:** Check the corrosion resistance of a non-stick system on a specific type of pretreatment and substrate.

- Prepare a solution of 5% Sodium Chloride solution.
• Fill pan being tested to the rim.
• Bring the water to a 170°F and cover.
• Run for 48 hours covered at a constant temperature of 170°F.
• Empty the pan and wash with mild soap and water.

No surface defects (i.e. blistering or corrosion) should appear on surface of coating.

STANDARD TESTS FOR “WET” BATCHES IN PROCESS

1. FINENESS OF GRIND

Purpose: To ensure that pigment dispersion is adequate to obtain desired appearance of final coating.

• Use of Hegman grind gauge (as specified in ASTM D1210)
• Put a small amount of paint at the deep end of the groove and draw down towards and of gauge with device.
• The dispersion rating of the product is the point on the scale at which pigment particles first begin to appear above the surface.
• Reading should be taken within 10 seconds after completion of drawdown especially for grinds of 7 or better.
• Make two or three more drawdowns using fresh material each time.
• Grind should be at the rating specified on QC card in Laboratory.

2. WEIGHT PER GALLON

Purpose: To ensure that the density of the batch is in accordance with specifications.

• Weigh empty “weight per gallon” cup and cover.
• Fill cup almost to the rim with the material being tested.
• Carefully place cover on the cup and wipe off excess material that exudes through hole in cover and along the rim. Record weight measured.
• (Grams of Paint in cup/10) = weight per gallon

3. VISCOSITY

There are various devices which can be used to measure viscosity of a coating. GMM uses Iwata#2 standard viscosity cup unless otherwise specified by customer.

• Bring temperature of paint to 77°F/25°C.
• Dip specified Iwata#2 cup in to sample. When cup is filled, remove from sample. Starting stopwatch when rim of cup breaks through surface.
• Stop the watch when flow from cup breaks through surface.
• Take reading in seconds
• Viscosity of batch must match with standard viscosity of product within ± 3-5 seconds.

4. % NON-VOLATILE MATTER. (WEIGHT SOLIDS)

Purpose: To ensure weigh solids of coatings match product specification per ASTM.

• Weigh two samples of approximately 1-2 grams of coating in tared aluminum foil dishes.
• Spread coating to cover entire surface area of dish.
• For solvent based coating material add 1 ml of toluene and shake to mix.
• Bake for 1 hour at 220°F and then cool down at RT and weigh.

• Residue in dish is Non-volatile matter

\[
\text{\% NVM} = \frac{(\text{Wt. of Aluminum dish} + \text{residue}) - \text{Wt. of aluminum dish} \times 100}{\text{Wt. of aluminum dish} + \text{wet coating}}
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5. pH TEST - Checked for all Water based coatings

Purpose: To ensure that pH of batch matches QC standard of the particular product.

• Standardize pH meter with appropriate buffer solution
• Make sure electrode is cleaned properly
• Immerse electrode into sample (which has been stabilized at 77°F)
• Take pH reading

**STANDARD TESTS FOR “DRY FILM” OF BATCHES IN PROCESS.**

After checking wet coating properties, the batch is sprayed on customer specified substrates to ensure that appearance and physical properties of dry film are in accordance with standards.

1. DRY FILM THICKNESS

Purpose: To ensure that the appearance and properties of coating are achieved at the specific dry film thickness recommended by GMM

A. FERROUS SUBSTRATES

• Using Fischer Film thickness gauge, place the probe tip on the top of the coated panel
• The force required to detach the probe tip is inversely proportional to the thickness of the coating.
• The scale reading on the barrel calibration is taken as the coating thickness in microns.

B. NON-FERROUS SUBSTRATES.

• Use Fischer Film thickness gauge.
• Zero the gauge by pressing probe tip on the surface of the uncoated substrate.
• Take 2-3 readings and average. Reading are given in microns.

2. ADHESION TESTS

   Purpose: To ensure adhesion of coating system on specified pretreatment and substrates.

   *Zero coating should be removed by tape pull in any of the following adhesion tests.

A) CROSS-HATCH TEST
   • Using a razor blade, scribe a 10mm×10mm cross-hatch on the coating surface;
   • Insure that it penetrates the coating all the way to the substrate;
   • Using glass-reinforced pressure-sensitive tape, press tape firmly onto cross-hatched area;
   • Pull tape off in one abrupt motion and check for paint adhesion failure.

B) BOILING WATER TEST
   • Spray coating over appropriate substrate and cure per specification.
   • Immerse panel in boiling water for 15 minutes.
   • Check cross-hatch adhesion again.

C) RECOATABILITY (IF SPECIFIED)
   • Spray coating over appropriate substrate and cure per specification;
   • Cool panel to room temperature;
   • Spray material again over ½ of the coated panel and cure again;
   • Perform cross-hatch test again.
3. GLOSS
   **Purpose:** To ensure that the gloss of hatch matches product standard.
   - Use Byk-Chemie Glossmeter;
   - Standardize accordingly either at 20 degrees or 60 degrees (high or low gloss)
   - Take reading given by digital indicator and check QC specification.

4. COLOR
   **Purpose:** To ensure that the color of batch matches product standard
   - Use Hunter color machine;
   - Place the coated panel on the machine;
   - Based on the delta reading of the panel, add necessary shading pigments to coating.

5) **SOLVENT RESISTANCE (Double MEK Rub Test)**
   **Purpose:** To check that the new batch cures at the required temperature.
   QC card
   - Will indicate number of Double MEK rubs batch should pass.
   - Soak a clean rag or cheese cloth in MEK solvent;
   - Rub cloth on small surface of the film;
   - Rubbing the MEK-soaked rag up and down the film constitutes 1 “Double MEK”
   - For highly chemical resistant film, test only up to 100 Double rubs
   - Chemical resistance as >100 Double MEK rubs.

6) **PENCIL HARDNESS**
   **Purpose:** To ensure that the hardness of the cured film meets standard specification.
   - Hold pencil at an angle approximately 45° to coating surface;
   - Use pressure, short of breaking lead, to push the pencil forward;
   - Any marring of the surface visible at an oblique angle in strong light indicates that the specific pencil lead is harder than the film.
• The “Pencil hardness” rating is expressed as the grade of the next softer pencil.

7) **FLEXIBILITY. For coil-coated, roll-coated, or postformable products.**

**A) T-BEND TEST**
- Bend coated panels using a panel bending machine;
- Complete the bending using a Carver Laboratory Press;
- T-bend is expressed as the number of bends, with the first one being 0-1
- Check for adhesion failure, peeling or cracking of coating.

**B) IMPACT RESISTANCE (ASTM D2794-69)**
- Place coated panel face down over hole on base plate of Gardner Impact Tester;
- Lift the impact rod along the seale, Let rod fail;
- Mark the height at which it is lifted;
- Multiply height by the weight of the rod;
- This figure is the foot-lb of impact.