Electrodeposition of Coatings, Part VI: Additional Surface Defects

As I pointed out in last month’s article [CoatingsTech, 10 (8) 44 (August 2013)], electrodeposition (ED) coatings suffer less from surface defects than do most coatings, but they do have some. In addition to the cratering and gassing problems that were covered, I have run into additional defects, including horizontal settling, mapping, hash marking, frosting, run-out, and difficult-to-rinse drag-out in ED coatings.

**Horizontal Settling:** In this defect, pigment settles on horizontal surfaces in the form of small clumps or granules, giving a gritty surface like sandpaper that often is easier to identify by touch than by eye. The surface must then be sanded before it can be topcoated. The settling is due to insufficient agitation and/or pigment flocculation, the latter of which can be a result of high bath temperature or aging of an unstable bath. It may be possible to control the settling by increasing agitation, but often that is not sufficient. Pigment flocculation is the likely culprit. The degree of flocculation can be evaluated via optical microscopy of bath specimens. Ideally that evaluation should be done periodically, starting when the tank is first filled. If flocculation is the problem, a solution may be filtration and feeding in new paste. Unless the flocculation was caused by a temperature spike, however, changes in the dispersion process or reformulation of the paste probably will be required to stop the settling.

**Mapping:** ED coatings normally are smooth and homogeneous, but sometimes there are peculiar streaks, drip lines, and/or patterns that may be in or under the coating. Examination of the substrate before it is e-coated usually will show that these same elements appear on the surface of the pretreatment. Pretreatment defects are telegraphing through to the e-coat. So, now a pretreatment problem needs to be solved. The defect could be caused by poor rinsing (clogged nozzles?) or even by a metal cleaning process that is leaving detergent residues. Faint mapping often is topcoated without problems, but I have seen very obvious mapping that had to be sanded before being topcoated. Better control of the cleaning and pretreatment process was needed in the latter case.

**Hash Marks:** This defect consists of stripes that form on ware as it is lowered into the ED bath. The defects form parallel to the surface of the bath. Entry into a bath never is completely smooth, and sometimes is even quite jerky. The current density at the leading edge of the paint film is very high, and this produces a band of relatively heavy deposition with each hesitation. There is less deposition during subsequent movement. The final effect is one of clearly noticeable alternating bands or stripes. Coatings that wet and flow well are less apt to suffer from hash marking. Raising the solvent level in the bath or prewetting the substrate with ultrafiltrate has been known to help as they tend to improve substrate wetting. Operating at a lower voltage in the first zone has helped in several cases in which I have been involved. Hash marks also have been associated with foam wetting at entry.

**Frosting:** This is a defect in which water and/or solvent are trapped in the e-coat, resulting in bubbles and pops. This can occur where the coating is overly thick or when the ware heats up rapidly due to an especially hot oven or a hot spot in the oven. Often, the coating just looks rough or bumpy, but sanding or a cross-section will reveal the bubbles. After topcoating, the defects may show up as pops, bumps, or roughness. Sometimes they look like solvent pops or galvanized gassing. This defect is rare and can be prevented by using a staged bake, lowering film thickness, and avoiding excessive overbakes.

**Run-out (or boil-out, as it is sometimes called):** Paint that is trapped in seams, flanges, and inner areas may boil and run out on baking and produce drips or thick spots. The latter may contain bubbles and pops and resemble frosting on a small scale. The defects must be sanded out before topcoating. Run-out can be reduced by better rinsing and/or a staged or ramped bake that allows flow before cure occurs.

**Drag-out:** The portion of the paint that comes along with the coated part as it exits the bath is called drag-out. Usually, it easily is rinsed back into the tank. However, under certain circumstances, drag-out includes gummy, elastic material that is difficult or impossible to rinse off and results in defects on baking. In my experience, such material has turned out to be resin that has had its molecular weight (MW) increased due to high bath temperatures, resin instability, or both. A simple way of identifying whether there is high MW material present is to compare the melt viscosities of an air-dried deposition of the problem coating and a similar specimen of a control. High MW gives high melt viscosity. Foam at the bath exit also can be picked up and dragged out. It may be difficult to remove by rinsing, leaving residues that harm appearance when they are baked in.