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the **Expert**

By Steve Ladatto, PCI technical director

You have questions, we have answers. In each issue of PCT, our powder coating expert provides information to help you with your powder coating challenges. Let us know what's keeping you awake at night, and we'll do our best to help you get a good night's sleep!

"Orange" You Glad It's Not the Powder

I manage a small custom powder coating shop specializing in primarily aftermarket automotive. We struggle to get smooth finishes on flat, high-visibility parts. Even with good powder, orange peel keeps showing up. What are we missing?

Orange peel is rarely caused by powder chemistry alone. In most cases, it results from an imbalance between film build, electrostatic application and cure dynamics. Excessive film thickness is the most common contributor. When too much powder is applied, the coating begins to gel before it has adequate time to flow and level. Once the melt phase is cut short, surface texture becomes locked in and cannot self-correct during cure.

Electrostatics play a major role in this outcome. High kilovolt settings increase deposition efficiency but often at the expense of uniformity, particularly on flat panels. Elevated voltage can cause uneven powder distribution, creating localized peaks and valleys that persist through cure. This issue is frequently compounded when operators chase coverage or color density rather than actively controlling film thickness and transfer efficiency.

Cure conditions are another critical factor. Powder coatings require sufficient time at temperature to fully melt, flow and then crosslink in sequence. If parts heat too quickly, too slowly or unevenly, the flow window may close prematurely. Air temperature alone is not a reliable indicator; profiling actual part metal temperature is essential. Without

this data, it is impossible to know whether the coating is being rushed through the gel phase or starved of proper flow time.

Corrective action typically starts with reducing overall film build and tightening application parameters. Lower gun voltage, slower gun movement, improved overlap consistency and disciplined trigger control all contribute to better leveling. Verifying oven performance through part profiling ensures that components reach target metal temperature smoothly and consistently, enabling the coating to flow before crosslinking initiates.

Ultimately, orange peel is a symptom of imbalance rather than a single-point failure. When application technique, film thickness, electrostatics and cure profile are properly aligned, smooth, automotive-grade finishes are achievable, even with standard, non-specialty powders.

Stretch Goals Not Met

We powder coat parts that look perfect coming off the line, but when they're bent, flanged or formed during downstream operations, the coating cracks or fractures along the bend. The powder passed adhesion and impact testing beforehand, so why is this happening?

Powder coatings have defined flexibility limits, and cracking after forming is almost always the result of exceeding those limits. Unlike liquid coatings, most thermoset powders cure into a tightly crosslinked film that resists deformation once set. This crosslinked structure provides excellent durability and chemical resistance, but it also limits post-cure stretch. If the coating is applied too thick, over-cured or formulated primarily for hardness and abrasion resistance rather than flexibility, it simply cannot elongate enough to survive mechanical forming without fracture.

Film thickness is the most common contributor to cracking. Excessive build increases internal stress within the coating and significantly reduces effective elongation. Even powders marketed as "flexible" can crack when applied beyond their recommended thickness range. Cure conditions further influence performance because over-curing increases crosslink density and brittleness. Parts that dwell too long in the oven, experience temperature overshoot or reach higher-than-required metal temperatures are especially susceptible to cracking during subsequent forming operations.

Part geometry plays an equally important role. Tight bend radii concentrate stress at the outer surface of the bend, precisely where the coating must stretch the most. Sharp edges, small inside radii and complex formed features amplify



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strain in localized areas. If the required bend radius exceeds the coating's tested elongation capability, cracking becomes inevitable regardless of powder quality or application technique.

Corrective action starts with reducing film build and validating cure profiles using actual part metal temperature rather than relying solely on oven air temperature. Selecting powders specifically designed for flexibility is important, but even these formulations must be applied within controlled thickness limits to perform as intended. From a process standpoint, forming parts prior to coating is always preferred when feasible, as it eliminates post-cure strain on the coating altogether.

Cracking after forming is not a coating failure—it is a mismatch between part design, process sequence and coating capability. Aligning these elements early in the design and finishing stages is the most reliable way to prevent cracking and ensure longevity.

Weld, Weld, Weld—What Do We Have Here?

We continue to see coating failures concentrated around weld seams, joints and heat-affected zones. Even when the rest of the part performs well in the field, weld areas seem to become the weak point. Why do failures keep starting at welds?

Welds create a perfect storm for powder coating failures because they introduce several challenges at the same time. Unlike flat, uniform base metal, weld areas combine surface contamination, complex geometry and thermal history, each of which works against coating durability.

From a surface standpoint, welds are rarely clean even when they look acceptable. Oils, flux residues, anti-spatter compounds and oxidation products can remain trapped in and around the weld bead. These contaminants are often invisible but interfere directly with powder adhesion and flow. During cure, trapped gases expand and escape through the molten coating, causing pinholes, craters and localized weak spots.

Geometry compounds the problem because weld beads introduce sharp transitions, undercuts and uneven surfaces that disrupt electrostatic fields during application. These disruptions cause powder to build thinner in those areas, reducing corrosion protection exactly where mechanical stress and environmental exposure are highest. Attempts to compensate by increasing overall film build often backfire, sealing in outgassing byproducts and increasing internal stress, which can accelerate cracking, porosity or premature coating failure.

The heat-affected zone (HAZ) introduces another variable. Changes in microstructure and surface chemistry around the weld can alter how pretreatment and powder interact with the metal. If pretreatment coverage is incomplete or inconsistent in the HAZ, adhesion suffers even when the rest of the part performs well.

Successful coating of welds requires intentional preparation. Welds should be thoroughly cleaned, degreased and where possible, ground smooth to reduce sharp transitions. Pre-baking is often necessary to drive off trapped volatiles before coating. Pretreatment processes must be verified to ensure full coverage at weld seams and joints.

Welds can be coated, but only when their unique challenges are acknowledged. Treating welded areas the same as flat base metal invites failure, while deliberate preparation and control produce reliable durability.

Letting Go Is Hard to Do

We often use textured powder coatings to hide minor substrate imperfections, weld marks or handling damage. Initially the parts look great, but customers later complain about dirt buildup and difficulty cleaning the surface. What's happening?

Textured powder coatings are doing exactly what they are designed to do, both the good and the bad. From an appearance standpoint, textures are excellent at masking surface defects. They visually break up light reflection, making small imperfections far less noticeable than they would be under smooth or high-gloss finishes.

The tradeoff lies in surface topography, with textures consisting of peaks, valleys and micro-voids that increase surface area. Those features trap dirt, oils, moisture and even cleaning residues. In environments where parts are touched frequently, exposed to airborne contaminants or cleaned regularly, these surfaces are simply harder to maintain. What looks uniform on day one can quickly begin to look dirty or uneven in service.

Wear further complicates the issue, with textured coatings burnishing over time in high-contact areas. The raised portions of the texture wear first, becoming smoother and shinier, while recessed areas retain their original appearance. This leads to uneven gloss and visible wear patterns that customers may interpret as coating failure, even though the coating itself is still intact.

The solution is not to avoid textures altogether, but to use them strategically. Textured finishes are best suited for areas where hiding substrate variation is more important than cleanability; structural components, low-touch surfaces or parts where cosmetic expectations are secondary. For high-touch, high-visibility or hygiene-sensitive applications, smoother finishes often perform better over the life of the product.

Clear communication is critical. Customers should understand the maintenance and appearance implications of textured finishes before approval. Textures aren't a problem; they're a tool. When used intentionally and in the right locations, they add real value. When used everywhere, they create new and avoidable complaints.

Have a question for our powder coating expert? Send it to techdir@powdercoating.org.