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Troubleshooting in Spray Applied Coatings

When coatings are spray applied, defects may be present. Understanding what the defects are and how to correct the formulation is important for any coating but critical for automotive coatings. Some appearance issues, what causes them, and how to formulate a more robust system are discussed in this article.

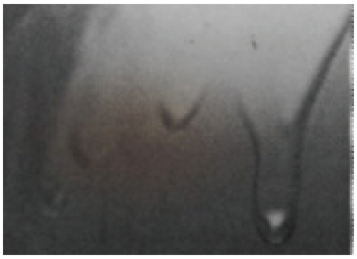

Figure 1—Sag.

SAG

Sags (*Figure* 1) are caused when the force of gravity on the coating is higher than its resistance to flow (viscosity). This can be caused during application if the spray gun is too close to the substrate, too much paint is being applied (too thick), there is poor atomization, fan width is too narrow, or the fluid delivery is too high. In water-based formulations, this can be caused by improper viscosity build (too slow a recovery from high shear application to low shear sag resistance) or the solvent mix is too hydrophobic and interferes with the thickener. Spraying under high humidity will result in too much water remaining in the film on the substrate, leading to sag.

In solvent-based systems, too low a viscosity is usually the reason for sag. This can be caused by the solvent mix being too slow. Ideally, it is desirable to have a solvent that allows a low viscosity for the best atomization, yet evaporates quickly, preventing low viscosity on the substrate. In baking systems, the viscosity of the coating on the substrate drops as the temperature increases. Adding a thermal slump modifier will prevent this.

FISHEYES/CRATERS

Localized areas of low surface tension will cause flow to the adjacent higher surface tension areas and result in film defects. These are caused by incompatible contaminants with a lower surface tension than the coating. If the contaminant is liquid, the results are craters; however, if it is a solid, a fisheye develops (*Figure* 2).

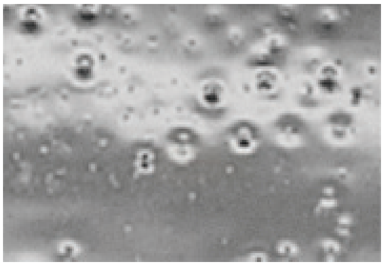

Figure 2—Fisheyes/craters.

The contamination can come from within the coating, from the substrate, or from the environment in the spray booth. Another cause can be overspray that does not reflow into the coating.

In water-based formulations, the high surface tension of water makes fisheyes or craters much more common. The most frequent cause of this defect can be attributed to the defoamers and de-aerators that are incompatible and have lower surface tension than the coating. This can be corrected by either increasing shear on the system—thereby making the particles small enough so they do not produce visible defects—or by adding a flow/leveling agent to reduce the surface tension of the system and allow reflow over the defect. A higher viscosity will also minimize flow from defects making them less noticeable. Overspray is usually not an issue as water evaporates too slowly.

In solvent-based systems, this is almost always caused by a silicone, oil, or grease contaminant, often originating in the air used for atomization. Eliminating the source of the contamination (filter for the air or determining the source) is the best method. However, the addition of flow/leveling agents can minimize or completely mask the issue. Adding an appropriate tail solvent will allow the system to reflow and absorb overspray.

ORANGE PEEL

Orange peel (*Figure* 3) is caused when the viscosity of the coating is too high and the coating does not properly flow. Causes can be too much air for atomization, the fan pattern is too wide, or the coating's surface tension is too high. In extreme conditions, this will lead to dry spray.

In water-based systems, the viscosity builds too quickly for flow on the substrate. Lowering the initial viscosity or using a less pseudo-plastic thickener will improve system flow. Addition of a flow/leveling agent also aids in reducing orange peel but may cause other coatings issues.

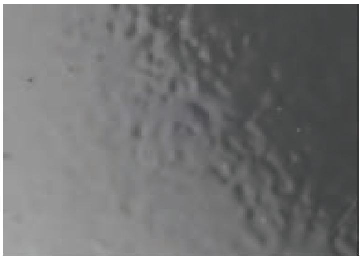

Figure 3—Orange peel.

In solvent-based systems, the solvent evaporation rate is too fast, but adding a low amount of a slow tail solvent (1–3%) will help. In newer low-VOC systems, this issue is more acute as most exempt solvents are extremely fast. In this case, flow agents, plasticizers, or low molecular weight resins are recommended.

SOLVENT POPPING/PINHOLES/HOLIDAYS

These defects (*Figure* 4) occur when air or solvent is trapped in the film and is then released, leaving a void in the film. They are usually caused by too high a wet film build combined with poor open time leading to a skinning of the surface. These holes can be invisible to the eye, yet severely diminish the corrosion resistance of the coating. A holiday detector will aid in determining the extent of holidays. Multiple thin coats of a coating instead of one thick coat will help prevent holidays. The rate of solvent diffusion to the surface is critical to preventing skinning. If the solvent diffuses to the surface at the same rate it evaporates, it will prevent skinning and lower the chance of defects.


Figure 4—Solvent popping/pinholes.

In water-based systems, high air flow over the surface will cause skinning. Air bubbles trapped due to poor defoaming/de-aeration will burst, creating the void. Another source can be water and co-solvents in the coating when the surface is skinned over, which will create holes in the film. Air bubbles will generally cause larger voids than solvent/water popping. These defects can be minimized by longer open times with hydrophilic co-solvents or glycols and thinner films.

In solvent-based systems, this is caused by too fast a solvent mix and too thick a film. Increasing the tail solvent will keep the film open longer and prevent solvent popping. Too slow a solvent mix will cause sagging so a balance is needed.

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