

1. POWDER APPLICATION

1.1 Poor Fluidization

• **Scenario:** Powder is supposed to flow like water in the fluid container (boil). Poor fluidization is recognizable in a slow and non-continuous transportation of the powder coating from the fluid container to the guns. No homogenous powder cloud is achieved.

Possible causes	Corrections, testing, procedures
Fluidizing air too low or too high	Change pressure Use larger hose diameter
Fluidizing plate defective	Exchange plate
Fluidizing plate clogged	Clean plate
Oil remnants in compressed air	Check filter in front of coating booth
Powder too fine (reclaim), high overspray ratio	Add virgin powder, change powder
Powder moist	Dry powder and store at room temperature max. 25 °C, 77 °F)
Powder in carton very hard or lumpy	Strain Do not set fluidizing plate to continuous operation
Excessive temperatures in the coating system	Correct condition / Provide circulation / Cool, Reconstruct



Img. 1.1.1. Fluidization - the powder has to flow like water



Img. 1.1.2. Poor fluidization

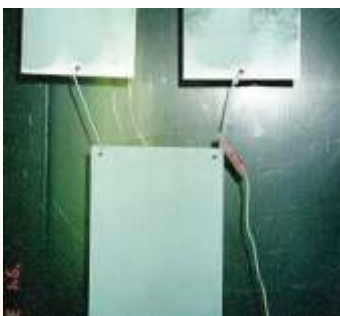


Img. 1.1.3. Poor fluidization - too much powder

1.2 Powder does not adhere to substrate

- **Scenario:** The powder coating, which should electrostatically adhere to the substrate, falls off – no relevant coating thickness can be achieved.

Possible causes	Corrections, testing, procedures
Insufficient grounding	Test contacts and transport mechanism (especially booth) and hooks (< 1 MW). Insulation from lubricants and residues in transport
Voltage too low or no voltage	Gun, test high voltage, cable and cable lead
Not enough charging	Increase voltage, reduce powder flow
Wrong particle size distribution	If reclaim is involved add virgin powder, Contact powder manufacturer
Wrong grading (too coarse)	Contact powder manufacturer
Chain does not run smooth, vibration too strong	Check conveyor system
Film build too high	Check geometry of part Reduce powder flow
Insufficient wetting	Check pretreatment
Airspeed blow of air too high	Optimize controls
Too much powder output	Reduce air flow and/or powder flow
Gun distance to part too close, blast off effect	Adjust distance
Unsuitable geometry of the part	If possible change geometry or hanging position



Img. 1.2.1. Check earthing



Img. 1.2.2. No earthing at multi coated hooks



Img. 1.2.3. Create an additional earthing

1.3 Poor Wrapping

- Scenario: With one sided gun positioning only minimal film thickness can be achieved on opposite side.

Possible causes	Corrections, testing, procedures
Powder flow too low or too high	Optimize system parameters, adjust air flow
Insufficient grounding	Use clean hooks, test transfer resistance (< 1 MW), check diameter of hooks
Temperature of the part too high after dry-off oven or pre-heating	Allow adequate time for cooling (less than 40 °C / 104 °F)
Supplemental air flow is too high or too low	Adjust air speed and powder cloud
Unsuitable particle size distribution	Consult powder manufacturer
Gun voltage too high	Adjust voltage to suit part geometry
Insufficient charging of the powder	Adjust high voltage
Poor or wrong positioning of the parts	Adjust hanging configuration
Gun defective	Consult equipment and powder manufacturer



Img. 1.3.1. Poor wrap-around



Img. 1.3.2. Powder lumping in the box

1.4 Powder lumping in the box

- Scenario: Lumping in the powder coating in powder box.

Possible causes	Corrections, testing, procedures
Inappropriate storage (temperature too low/too high, in excess of shelf life)	Strain before use, use fresh powder
Box feeding	Avoid continuous vibratory operation
Transport too slow or too warm	Strain powder before use, consult powder manufacturer

1.5 Poor penetration into recesses

• **Scenario:** Despite the physical conditions (faraday cage), it is possible to achieve a minimum coating thickness in the corners. With poor penetration procedures penetration depth is very limited. Extreme film thickness variations are noticeable.

Possible causes	Corrections, testing, procedures
Feed supplemental or tribo air too high	Change of lower pressure
Air speed too high	Adjust equipment controls
Powder flow too high	Adjust equipment controls to suit part
Not enough powder flow	Adjust/optimize equipment parameters
Inappropriate application, unsuitable nozzle	Utilize flat spray nozzle or deflector; Adjust nozzle
Insufficient charging of powder, defective gun	Adjust voltage (increase, test) Contact equipment manufacturer
Voltage too high	Adjust/reduce voltage
Faraday cage effect due to electric field	Use tribo equipment and powder; Reduce voltage
Insufficient grounding	Use clean hooks, test transfer resistance
Powder spray too wide	Use different gun nozzle or deflector
Unsuitable particle size distribution	Optimize through testing; Contact powder manufacturer
Distance from gun to part is too big or too small	Increase or decrease distance



Img. 1.5.1. Additional earthing for hollows



Img. 1.5.2. Rip up caused by poor metal-production

1.6 Film Thickness too high

- **Scenario:** Powder coat layer shows uneven surface prior to curing, after curing shows orange peel, wavy flow, or pinholes.

Possible causes	Corrections, testing, procedures
Parts are too hot coming from dry-off oven	Allow longer cooling time (less than 40 [°C] / 104 [°F]) for parts
Preheat temperature too high	Lower preheat temperature or allow for cooling (less than 40 [°C] / 104 [°F])
Powder flow too high	Lower powder feed
Coating time too long	Lower coating time
Unfavorable geometry of parts	Change hanging or gun configuration
Gun-to-part distance too close	Increase gun-to-part distance



Img. 1.6.1. Film thickness too high (ornateness)



Img. 1.6.2. Too thick powder cloud



1.7 Film thickness too low

- Scenario: Substrate shows through and powder coat has grainy flow.

Possible causes	Corrections, testing, procedures
Insufficient charging of powder	Test and adjust voltage
Inappropriate particle size distribution/percentage of overspray too high	Continuous and even introduction of virgin powder to reclaim powder; Ratio adjusted to actual consumption Optimize particle size distribution through testing
Powder flow too low	Increase powder flow
Powder delivery hose too long	Shorten hose; Change hose diameter; Change injector
Fluid characteristics of powder not optimal	Check fluidization (see 2.1 poor fluidization)
Residence time of parts in front of gun too short	Slow down line speed of conveyor; Increase number of passes of gun in front of part; Add more guns
Suction of reclaim system too high	Lower suction capacity
Booth draft too strong to allow powder cloud to deposit on its own	Change system configuration; Consult with booth supplier Slow down line speed
Changed powder supply due to powder deposits in the transport system, injectors, hose and nozzle	Cleaning of the transport system components, coordinate feed and atomized air, check fluidization
Plugged transport system due to foreign materials (e.g. fibers, cleaning residues)	Commit to cleaning cycles and regular maintenance
Inappropriate hanging of parts	Check and adjust hanging configuration
Insufficient grounding	Use clean hooks; Avoid thin hooks (note voltage loss) Check transfer resistance if system
Processing of non Tribo powders in Tribo systems	Use Tribo powder
Low level of powder in fluid hopper	Replenish powder; Check minimum indicator
Particle size too fine due to circulation in system	Increase virgin to reclaim ratio
Too much overspray in booth due to cleaning cycles	Regular transport of overspray from booth to reclaim system
Intermittent back pulse of filter too long, sudden shift of powder particle size (too fine)	Keep back pulse of compressed air short (e.g. 20 seconds)
Insulation of base coat too strong	Reduce voltage for second coat and lower powder flow Use tribo powder coatings
Gun-to-part distance too high	Reduce distance
Powder hose causes friction charge of opposite polarity to charge generated in gun	Change hose material or ground hose

2. SURFACE DEFECTS

2.1 Powder puffs on the work piece

• **Scenario:** Powder puffs are powder clusters that in an improperly fused condition are visible as powder hills in the powder film. After curing these powder puffs appear as disturbing elevations on the surface.

Possible causes	Corrections, testing, procedures
Poor fluidization	See section 2.1 (poor fluidization)
Powder hose too long or diameter too large	Change hose diameter, Shorten hose, Change configuration
Powder too fine (reclaim)	Add virgin powder
Uneven transport	Test air pressure, Check for pressure variations
Clogging of the feed hoses	Note hose path, see section 2.2. (clogging of the powder feed hoses)
Powder falls off booth ceiling	Adjust/increase frequency of booth cleaning intervals
Powder falls off hanging devices	Remove/ reduce powder coat layer, check grounding
Powder build-up on deflector plate	Check atomized air
Powder falls off work piece	Test grounding, Check diameter of hoses
Catch nozzle worn	Change nozzle
Air pressure variations in powder supply system	Adjust air pressure
Level in powder supply container varies greatly	Reduce distance between minimum and minimum level
Gun nozzle defective	Check nozzle, replace
Powder moist	Use dry powder; Check for condensation (temperature difference from powder storage area to coating area), Check air filter and moisture traps in compressed air system



Img. 2.1.1. Film thickness too high (ornateness)



Img. 2.1.2. Too thick powder cloud

2.2 Craters

- **Scenario:** Defect – blank area in the powder coat, which extends all the way to the substrate (diameter up to 2 mm).

Possible causes	Corrections, testing, procedures
Insufficient pretreatment (e.g. oil and grease residues)	Test pretreatment if necessary, contact pretreatment supplier
Chemical residue, faulty pretreatment	Test pretreatment, if necessary contact pretreatment supplier
Rust, white rust on parts	Assure clean surface, apply recommended pretreatment, possibly buff or sandblast (sweep) surface
Oil in feed and/or atomizing air	Check in-line filters and moisture traps in air system
Silicones from chain lubricants or welding sprays	Use product without silicon content, educate line operators
Incompatibility with powder coatings from other manufacturers	Cleaning of coating and application equipment, contact powder coating supplier
Outgassing from substrate	Pre-heat work pieces, use OGF additive
Surrounding air contaminated	Balance air flows in plant, avoid cross drafts
Spin-off-products at the cross-linkage of the powder coating in the curing oven	Adjust the powder coating, Consult powder manufacturer, Provide enough air circulation
Work piece moist/wet	Increase drying time/temperature Note material thickness especially with anodized parts
Liquid and powder paint in same plant	Definitely avoid - reconfigure plant
Body filler or other compounds not compatible	Forced drying, test suitability
Base coat was cleaned with solvents	Preheat work piece or avoid solvents
Blasting media decontaminates surface	Do not reclaim blasting media
Back ionization effect	Adjust application, use tribo if possible
Instead of rough texture effect only penetration-to-metal and craters visible	Insufficient coating thickness



Img. 2.2.1. Crater caused by oil in the compressed air



Img. 2.2.2. Crater caused by oil residue

2.3 Pin Holes

- **Scenario:** Surface defects – development of fine pores on the surface, also leads to change in gloss level.

Possible causes	Corrections, testing, procedures
Moisture content of powder too high	Testing through drying of powder/test storage conditions In cold climates, watch for condensation in powder (cold storage area to warm coating area)
Pre-reaction of powder coat	Check storage parameters, storage time exceeded Consult powder manufacturer
Trapped air	Check heat up curve Possible slow heat up curve Modify powder coating
Film build too high	Note recommendations of powder manufacturer Minimize film thickness
Incompatible with other powder coatings	Clean equipment/booth Consult powder manufacturer (if necessary change)
With rough textures, instead of effect development only pinholes develop	Film thickness too low (see 2.8 film thickness too low)
Very porous work pieces	Check for satisfactory work pieces, possible surface is too rough from sand blasting
Out-gassing from porous work pieces (cast parts, zinc galvanized material, magnesium castings, anodized materials)	Preheat parts Modify powder coating Cast anodized materials not scaled and dried



Img. 2.3.1. Pinholes caused by too coarse steel resources

2.4 Blistering

- **Scenario:** Elevations of differing size in the powder coat, no adhesion due to enclosures at the part surface.

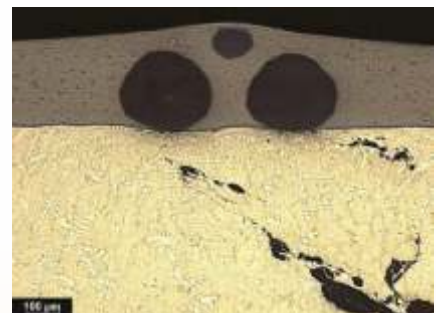
Possible causes	Corrections, testing, procedures
Water on work piece	Check dryer and hanging configuration
Water in scooping type of work pieces	Note geometry, drying time and temperature or change hanging configuration; Air blast work pieces
Corrosion, oil and grease residues	Optimize pretreatment
Over coating	Assure flawless first coat
Over coating of liquid paint	Check suitability of base coat
Over coating of filler areas	Dry or cure filler; Check suitability
Salt residues or chemical remnants on the work piece surface, insufficient wetting	Check pretreatment, final rinse stage, and drying of media/ chemicals during transport inaction
Film thickness too high, powder accumulations, powder drizzles off work piece on edges and corners	Check system parameters; Reduce film thickness
Break in zinc layer, double zinc layer, corrosion under the zinc layer	Avoid double zinc layers; Ensure flawless zinc layer



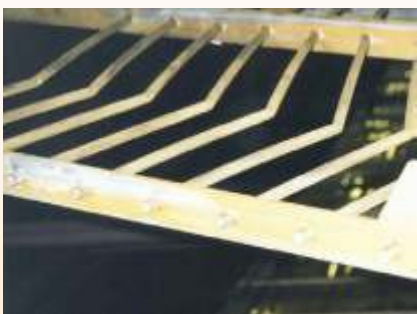
Img. 2.4.1. Corrosion as bubble causale



Img. 2.4.2. Bubbles caused by corrosion after pretreatment



Img. 2.4.3. Bubbles caused by outgassing at the die-cast aluminium



Img. 2.4.4. Bubbles caused by corrosion after pretreatment



Img. 2.4.5. Bubbles caused by tassels in the galvanized plate

2.5 Drip Developments

- **Scenario:** Running or dripping of the gelling powder coat off the work piece.

Possible causes	Corrections, testing, procedures
Film thickness too high (with wire or sheet metal parts)	Reduce film thickness
Powder slides to the edge	Increase voltage; Check grounding
Substrate temperature is too high (from preheating or dryer), therefore film build too high	Increase cooling time (max. 40 [°C] / 104 [°F]) between dry-off oven and booth; Optimize film thickness
Heat up rate too high or inappropriate	Reduce heat up speed; Control oven temperature
Powder accumulation on inside corners from drizzled off powder coating	Optimize system parameters and blast off effect



Img. 2.5.1. Drop formation caused by a too high film thickness



Img. 2.5.2. Drop formation

2.6 Orange peel

- **Scenario:** Poor flow (orange peel look), short or long waviness of powder coat layer, noticeable only after curing.

Possible causes	Corrections, testing, procedures
Heat up cycle of parts too slow	Determine heat up curve and increase (especially with parts of high wall thickness)
Substrate temperature exceeds the melt temperature of the powder, causing excessive film build	Check substrate temperature (max. 40 [°C] / 104 [°F]) Increase cool down phase
Powder coating material too reactive	Consult powder manufacturer
Shift in particle size distribution, portion of reclaimed powder too high	Optimize deposit results of powder guns Increase lift intervals
Unsuitable particle size distribution	Optimize particle size distribution; Consult powder manufacturer
Film thickness too high or too low	Check system parameters
Incompatibility with other powder coatings	Clean booth, check compatibility Consult powder manufacturer
Powder stored too long/pre-reacted	Check storage. If powder is too old, exchange
Voltage too high	Optimize voltage; Change to low ionizing application or tribo guns
Uneven wall thickness (thick to thin)	Optimize oven temperature
Back ionization effect	Reduce voltage; Increase distance from work piece to gun
Textured work piece surface	Optimize texture, check work piece surface
Air speed too high at oven entrance	Reduce air speed (max. 0.5 [m/sec] / 1 1/2 [ft./sec]), change air flow guides



Img. 2.6.1. Smashing through of the scarred surface



Img. 2.6.2. Orange peel effect

3. SURFACE VARIATIONS IN THE POWDER COAT

3.1 Color Deviations

- **Scenario:** Continuous or suddenly appearing changes in color or effect compared to original sample part or compared to first parts coated.

Possible causes	Corrections, testing, procedures
Film thickness varies greatly	Assure constant film thickness
Differing substrates and substrate colors (steel, aluminum, brass, glass)	Use substrates of same type for comparisons
Differing surfaces and reflections (polished, blasted, chromated)	For comparison use surfaces of same type
Film thickness too thin (not covering)	Apply higher film thickness (same as samples)
Not sufficient or wrong pigmentation in the formulation	Consult powder coating manufacturer
Color deviations due to curing technique or oven atmosphere (example: direct fired gas oven, IR oven), use of room air for burner!	Use suitable powder coatings Control oven Use outside air supply for burner
Over curing of powder coating (especially with organic pigments)	Observe curing parameters of powder manufacturer
Differing curing parameters with same parts	Observe powder manufacturers curing parameters
Differing curing parameters with greatly varying parts (different wall thickness)	Observe curing parameters of powder manufacturers and adjust to wall thickness
Several powder manufacturers/suppliers	Use powder coatings from the same manufacturer or check the compatibility
Varying film thickness with over coating	Assure even film thickness
Bleeding of first coat with over coating	Check suitability of first coat when over coating
During over coating extensive color deviations from first coat	Avoid over coating of strongly deviating colors
Uneven pretreatment of parts	Assure more even pretreatment of parts
Metamerism, color deviations with differing light sources	Judge work pieces in daylight (not direct sunlight) Use day light cabinet
Rough texture too pronounced	Use suitable powder coat
Powder transport directly from the powder box	Use fluid container



Img. 3.1.1. Color shift between RAL-cards HR and GL



Img. 3.1.2. Color shift caused by a communication mistake

3.2 Gloss Level Variations, Yellowing, Discolorations

- **Scenario:** Difference between suggested gloss level and color and the gloss level and color of the original sample or parts coated at the beginning of the job.

Possible causes	Corrections, testing, procedures
Cure parameters of manufacturer were not observed	Optimize curing parameters Adhere to powder manufacturers suggestions
Oil, soluble materials in oven	Do not use oil or soluble materials in oven area
Incompatibility with other powders, poor flow	Clean system, Distribute incompatible powders to other booths
Film thickness too high or too low	Optimize job parameters
Powder coating is not temperature stable	Use temperature stable powder coatings Consult powder manufacturer
Over curing in oven	Adjust oven temperature and speed to parts being coated Lower temperature during conveyor halts
Incompatibility of powder coating in the oven	Do not use powder coatings from different manufacturers at the same time in one oven
Direct fired ovens and IR ovens	Adjust powder coating to oven parameters Adjust oven temperature to powder coating
Powder coating pre-cured or too old	Check warehouse parameters, use fresh powder coatings
Unsuitable cleaning agents for example prior to silk screening	Check suitability of cleaning agents for powder coat, pre-testing necessary
Separation of 2 component matte powders	Check reclaim system for uneven suctioning of over spray
Uneven gloss level due to different wall thickness of work piece	Lower oven temperature, Increase duration time, Re-construct system
Components of the powder formula migrate to the surface causing haze and lower gloss	Discuss possible changes with powder supplier and consider trade-off between performance parameters and better stability, Optimize oven parameters
Binder in powder coating poorly dispersed	Consult powder manufacturer
Diffused liquid paints, felt pens, stamping inks, markers	Remove the residues before coating with suitable solvents



Img. 3.2.1. Stamping ink (untreated)



Img. 3.2.2. Blood supply of felt pen or stamping ink



Img. 3.2.3. Yellowing in the interior caused by UV-light



Img. 3.2.4. Color hue change caused by insufficient adhesion

4. LACK OF TECHNICAL PROPERTIES (MECHANICAL AND CHEMICAL)

4.1 Poor mechanical properties and chemical resistance

- Scenario: Insufficient compliance with the necessary technical properties of the powder coating (mechanical and chemical).

Possible causes	Corrections, testing, procedures
Too high/too low heat up temperature or time	Observed curing parameters of powder coating manufacturer
Oil, grease, extrusion oils, dust on the surface	Optimize pretreatment
Insufficient pretreatment	Optimize pretreatment
Incompatible pretreatment and powder coating	Adjust pretreatment method Consult chemical and powder supplier
Inappropriate powder coating	Use appropriate powder coating Consult powder manufacturer
With transparent top coats slow deterioration of the powder coating (chalking)	Over coating of interior grade powder coatings with exterior grade transparent powder coatings does not result in a UV resistant coating system, therefore adhesion problems of the top coat



Img. 4.1.1. Chalking caused by faulty powder coating selection



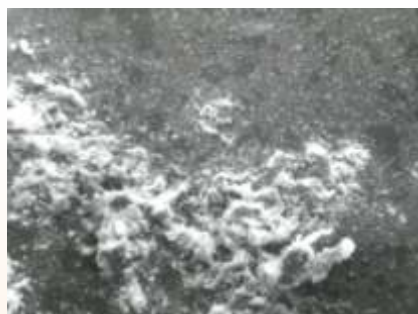
Img. 4.1.2. Infiltration caused by chemical exposure



Img. 4.1.3. Metal particles oxidize at the cleaning



Img. 4.1.4. Mortar residues on the powder coat layer



Img. 4.1.5. Mortar residues on the powder coat layer (microscope view)

4.2 Lifting of the powder coat layer

- **Scenario:** Cured powder coat backs out of the work piece under mechanical encumbrance, no adhesion to the surface of the work piece.

Possible causes	Corrections, testing, procedures
Under or over curing of the powder coating film (for example in IR oven)	Observe curing parameters
Insufficient/inappropriate pretreatment	Adjust pretreatment to job at hand
Basic material too thick or unevenly thick	Observe curing parameters, use slower or faster curing powder coatings
Scale, surface rust on the work pieces	Use "fresh" work pieces or store in dry environment; mechanical pretreatment
Oxide layer on the work pieces, white rust on zinc plating	Store work pieces in dry environment or use "fresh" work pieces; Use suitable pretreatment materials Use mechanical pretreatment (sweeping) if necessary
No adhesion on laser cut edges	Treat edges mechanically (brush, polish, sweep)
Purpose and powder coating properties are not suited for each other	Use suitable powder coatings
Film thickness too high	Reduce film thickness or use more flexible powder coatings
No adhesion to base coat	If possible lightly polish base coat or partially edge with suitable solvent
No adhesion to liquid base coat, electro coat or coil coating	Test suitability, lightly abrade base coat
Break in zinc, conversion or primer layer	Adjust pretreatment to work piece and powder coating
Double zinc layers, corrosion under zinc layer	Consult with H.D.G. supplier
Transport residues on work pieces (salt, dust etc), which have not been removed by pretreatment	Assure flawless surfaces and protected transportation, suitable pretreatment



Img. 5.3.1. Poor adhesion caused by direct heated gas oven



Img. 5.3.2. No adhesion of the top coat caused by directed heated gas oven



Img. 5.3.3. Blistering caused by cross-linkage



Img. 5.3.4. Blistering caused by an inappropriate pretreatment



Img. 5.3.5. Infiltration caused by an insufficient pretreatment

5. SPECIAL CHARACTERISTICS OF APPLICATION WITH RECLAIM

5.1 Contamination of the Powder Coating (additional to section 3.5)

- **Scenario:** Foreign or powder particles of a different color are enclosed in powder film.

Possible causes	Corrections, testing, procedures
Powder remnants or dirt in coating booth, cyclone or filter	Clean system Constantly clean screen
Powder remnants in application, powder accumulation from injector, hose or gun	Clean application Check screen
Contamination of reclaim	No sieve or insufficient screen; Use proper screen size (mesh size approx. 200 [μm] / 8 [mils]); Check screen for tears or dirt
Final filter defect, powder is blown into coating area	Check and repair final filter
Chafing of carpet material in carpet systems	Use suitable carpet or replace carpet



Img. 5.1.1. CO² Beads of sweat in the filter residue



Img. 5.1.2. Contamination from poor equipment cleaning



Img. 5.1.3. Fibers at the reclaim



Img. 5.1.4. Dust in the filter residue



Img. 5.1.5. Dust in the reclaim powder (enlarged)

5.2 Continuous Shade Variations

- **Scenario:** Continuous or sudden changes in color/shade or effect compared to sample or originally coated parts.

Possible causes	Corrections, testing, procedures
Separation or particle size distribution changes through reclaim	Add virgin powder
Powder remnants in reclaim system	Clean reclaim system
Detraction due to several booths being located next to each other	Reconstruct coating area layout; Cover booth during downtime, since powder or dirt may transfer and contaminate area
Powder transfer due to uneven air flow or performance of booths	Reconstruct/reconfigure area
With powder extraction from box feeder no even ratio of reclaim and virgin powder is achieved	Use fluid container Ensure even ratio of virgin to reclaim powder
Addition of reclaim powder is inconsistent, virgin powder ratio is too high or too low	Add sufficient virgin powder Ensure consistent ratio



Img. 5.2.1. Continuously test of the reclaim



Img. 5.2.2. Color hue change during the production

6. SPECIAL CHARACTERISTICS OF APPLICATION OF METALLIC POWDERS

6.1 Color shift from color chart or original sample

- **Scenario:** Result of the coating process not equivalent to the original color sample/template.

Possible causes	Corrections, testing, procedures
Inconsistent batches	Coat each job with powder from a single batch Consult powder manufacturer
Varying application (Corona, Tribo, Corona modified with ion catch)	Use only one type of application equipment Consult with powder manufacturer
Defective application, gun short circuits	Check application Use proper application
Object related coating jobs	With several applicators for one coating job, colors and systems have to be checked against each other. Use original samples, and warn customers of risks involved
Differing work pieces	For comparison always use a single work piece with its particular substrate color (aluminum, steel, zinc plated steel, glass, wood)
Poor grounding	Check ground and contacts
Wrong RAL chart used or effect difference between RAL chart and powder coating	Use proper RAL chart (GL or HR), inform customer



Img. 6.1.1 Color shift at coatings\ of different manufacturers



Img. 6.1.2. Effect difference at different applications



Img. 6.1.3. Color compare with the original color sample during the production

For the processing of metallic powder coatings also observe identification sheet 36 - processing guidelines for powder coatings with metallic-effect of the Austrian coating institution (see addendum).

6.2 "Greying" of the Surface

- **Scenario:** Disappearance of the metallic or non-metallic effect components (drowning).

Possible causes	Corrections, testing, procedures
Powder coating is tribo suitable, or metallic effect appears different	Use Corona gun, always conduct pretests
Varying application methods (Corona, Corona modified with ion catcher or Tribo) and inappropriate gun settings	Adjust KV setting and gun-to-part distance: the higher the KV setting, the lesser the metallic appearance; the lower the KV setting, the more metallic effect will appear
Varying deposition of effect pigments gives rise to color/effect changes	Use one suitable application method
Different powder coating equipment	If possible fill all orders in only one coating system



Img. 6.2.1. Greying caused by cleaning compounds

6.3 Cloud Formation

- **Scenario:** Uneven light to dark effect of the coating on the work piece.

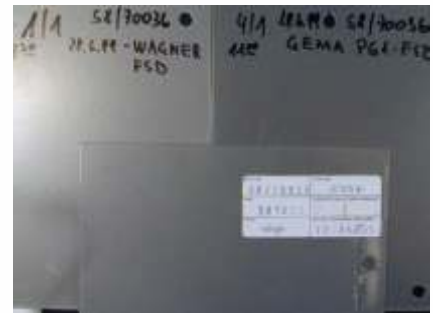
Possible causes	Corrections, testing, procedures
Powder extraction from box feeder	Use fluid container
Powder separation	Check reclaim; Spray to waste Read metallic application guidelines datasheet
Separation of powder in cyclone or in reclaim system	Check Cyclone; Check reclaim
Batch change during coating job	Use only one batch for each coating job
Color change between manual and automatic application	Touch-up difficult to spray areas before automatic application



Img. 6.3.1. False position caused by incompatibility of the flux



Img. 6.3.2. Color variations caused by reclaim



Img. 6.3.3. Color variations caused by different application manu-facturers



Img. 6.3.4. Effect-deviations caused by reclaim



Img. 6.3.5. Color-deviation at dormant caused by two different shades in the oven

6.4 Cloud Formation

- Scenario: Uneven light to dark effect of the coating on the work piece.

Possible causes	Corrections, testing, procedures
Gun distance to work piece too big or too small	Check distance
Reciprocator operation parameters inappropriate	Check lift and chain speed
Uneven powder transport	Add sufficient virgin powder Check compressed air for variation
Manual touch-up	Position manual touch-up before automatic booth
Uneven charging (defective gun)	Check application
Uneven grounding of work pieces	Check grounding
Extremely varying film thickness (especially with matte coatings)	Optimize film thickness
Powder extraction from box feeder	Use fluidizing hopper



Img. 6.4.1. Cloud formation at metallic



Img. 6.4.2. Cloud formation caused by different film thickness



Img. 6.4.3. Sweat-cinder not removed



7. TERMINOLOGY

The following is a brief overview of the most commonly used terminology in the powder coating industry. It should be noted that the explanations were not intended to be scientifically and linguistically correct terminology, but rather a collection of commonly used terms for the purpose of creating a general understanding.

A	B	
<p><u>Additive</u> Materials added in powder production to optimize powder film for certain applications</p>	<p><u>Base Material</u> Substrate</p>	<p><u>Cleaning</u> Cleaning of powder application unit during color change. A necessary evil of powder coating</p>
<p><u>Adhesion</u> Sticking of the powder coating to the work piece; Mechanical anchoring and/or chemical connection between powder coating and substrate surface. Prerequisite is proper pretreatment</p>	<p><u>Bonding Agents</u> Main components of powder coatings, resins like epoxy, polyester, polyurethane or acrylic</p>	<p><u>Coating System Maintenance</u> Necessary regular servicing of the coating system by the system manufacturer</p>
<p><u>Adhesive Remnants</u> Remnants that are not removable by pretreatment cause these surface defects and adhesion problems</p>	<p><u>Booths</u> Cabinet for coating (steel, stainless, glass, plastics)</p>	<p><u>Color</u> Perception transmitted by the eye, caused by light sources and light reflexes</p>
<p><u>Agglomeration</u> Powder which does not adhere to the work piece or does not get recycled, but rather piles in the booth</p>	<p><u>Bubbles</u> Elevations in the powder film caused by water, salt and oil remnants etc</p>	<p><u>Color Deviation</u> Difference in color from original sample to test part (color chart to work piece or work piece I to work piece II)</p>
<p><u>Anodizing</u> Surface treatment for aluminum, establishment of a (colored) aluminum oxide layer and its subsequent solidification</p>	<p><u>Bubbling</u> Gassing of the powder itself at high mil thickness (starting at 150 [μm] / 6 [mils]), especially with TIC-free powders and IR ovens)</p>	<p><u>Color Standard</u> Official color charts, which represent industry standards (RAL, Pantone)</p>
<p><u>Application Equipment</u> Equipment necessary for powder application, i.e. guns, charging equipment, nozzles, hoses etc.</p>	<p><u>Buchholz Hardness</u> Test procedure to measure the resistance of powder coating surfaces against pointed pressure demands; DIN 53 153/ISO 2815</p>	<p><u>Contamination</u> Dirt</p>
<p><u>Atomized Air</u> To support spray cloud, also to help avoid sintering at the corona needle and deflector</p>	<p><u>Carbon</u> Burnt oil or grease on the work piece, burnt in through welding</p>	<p><u>Conveyor Halt</u> Materials added in powder production to optimize powder film for certain applications</p>
<p><u>Atomizing Air</u> Supplemental air to regulate amount of powder in the gun, higher supplemental air – less powder coating, smaller powder cloud</p>	<p><u>Chalking</u> Decomposition of the resin and bleaching of the pigments through UV light or chemical influence</p>	<p><u>Corona Charging</u> See e-static '</p>
<p><u>Automation</u> Powder application in connection with automatic guns (permanently mounted on reciprocator or robotics)</p>	<p><u>Charging</u> Electrostatic charging of the powder through corona or tribo method</p>	<p><u>Corrosion</u> The reaction of a metallic work piece with its surrounding environment, which causes measurable changes affecting the function</p>
	<p><u>Chemical Resistance</u> Resistance of the powder coat surface against various chemicals</p>	<p><u>Crater</u> Surface defects, which reach through the powder film to the surface</p>
		<p><u>Cratering of Hammertone Effects</u> Through insufficient grounding, development of star shaped voltage craters that expose the underlying surface</p>



Crosslinking

The setting up of chemical links between the molecular chains of a resin to form a three-dimensional network polymer system

Curing

Complete fusing of the powder coat. Minimum time and temperature are required

Cyclone

Device to return and circulate oversprayed powder. Always requires a final filter

D

De-ionized Water Rinse

Final stage of pretreatment with salt free water (0 – 15 tds)

Development of Stripes

Uneven film thickness caused by uneven sinus curve

Dip Pretreatment

Pretreatment for parts, not suitable for scoop shaped parts

Dirt

Mainly contributes to reduce quality of coating (dust, fibers, shavings etc)

Distance I

Distance from gun to work piece

Distance II

Distance between work pieces

Dry-off oven

Oven (chamber) for drying parts after liquid chemical pretreatment

Duration Time

Time a coated part remains in the curing oven

E

Edge Deposits

Powder accumulation at the work piece edge

Environmental Conditions

Existing climate and environmental conditions in the coating area

E-Static

Electrostatic charging of the powder particles in the area of corona discharge, whose voltage is produced by the electrode inside the gun or conveyed by cable

F

Faraday Cage

A physical phenomenon – the area of a part where the electric field does not penetrate

Filiform corrosion

Thread like development of metal hydroxides (not Al₂O₃) on aluminum surface, shows as thin threads with sharp edges under the powder coating

Film (Float)

Surfacing of additives in the powder coating, example OGF additive

Film (Haze)

Undesirable haze on powder coat surface

Film Thickness

Thickness of the powder coat

Filter

Used to separate the powder-air-mixture (overspray) in reclaim system (plate, pocket or cartridge filters)

Final Filter (Purification Filter)

Final filter in the coating system for micro particles, which are not eliminated by the reclaim system

Fish eyes

Same as craters

Flow

Smoothness of the powder coat film

Fluidizing

Stirring of powder coating in the fluid container or powder storage box via pressurized air

Fluidizing base

Air permeable sinter material in the powder storage container. Powder is fluidized through incoming air (0.3 – 0.5 bar).

Fresh Water Rinse

Rinse stage in the pretreatment system to rinse cleaning chemicals with fresh water

Friction Charging

See Tribo Charging

G

Galvanized Zinc Plating

Application of an approximately 5 – 15 [μ m] / 0.2 – 0.6 [mils] layer of corrosion protection (zinc) via electrolytical separation of watery, acidic or alkaline zinc electrodes

Gas Quality

Gas used to heat the dry-off oven and powder curing (natural gas, city gas, butane, propane). Heating value and blend are of essence

Gassing

Ingredients in the substrate, which through melting of the powder on the surface escape (evaporation, air, gases etc.) can cause irregularities in the powder film

Gel Particles

Unopened resin particles in the powder coating

Glass Point

Transition phase of the powder – gelling



Gloss

Reflection capacity of a surface, with powder coatings ranging from glossy to flat mat.

Graininess

Ingredients in the substrate, which Surface defects, elevations in powder film

Grounding

Contact by work piece and coating system component with earth/ground

Gun

Necessary for charging and application of powder coat (Corona charging and Tribo)

H

Hanging Devices

For suspension of work pieces during the coating process

Heat Up Speed

Time required to heat an object to required temperature

Heater

For pretreatment and powder drying; gas and oil, direct/indirect, electric, IR

Hiding Power

Ability of the powder, given appropriate film thickness, to sufficiently hide the color of the substrate

Hose

Comp. Transport hose

Hot Dip Galvanizing (H.D.G.)

Corrosion protection- application of an approx. 30 – 80 [μm] / 1 – 3.2 [mils] thick zinc layer by dipping at high temperatures (approx. 400 [$^{\circ}\text{C}$] / 752 [$^{\circ}\text{F}$])

I

Incompatibility

Condition of the surface through uncontrollable chemical reactions

Infiltration

Development of corrosion through moisture and salts (osmosis) between powder coating and part

Injector

Venturi pump for powder transportation

Insulation of work pieces

Insufficient grounding, caused by excessive film thickness on parts and hanging devices

Intercoat Adhesion

Adhesion between first and second powder coat layer

Ionization

Comp. e-static

L

Lifting

Cured powder coating lifts from substrate under various types of mechanical stain (i.e. during deburring, cutting, milling)

Lubricants

Oils and greases used to help in gliding during forming of profiles in the manufacturing process

Lumps

Clustering of powder coating in the box due to transportation, moisture influence, Corona charging or heat

M

Material Selection (Powder Coating)

Suitable powder coating (exterior vs. interior coating, special effects etc) for an application

Material Selection (Substrate)

Suitable, coatable materials (steel, aluminum, glass) for the application

Matting

Reduction of the gloss level, powder coating surface appears lower in gloss level

Mechanical Properties

Necessary properties of the powder coating (test according to ASTM, example: Conical bending or impact test, Erichsen cupping etc)

Metal Shavings

Machining residues on parts (cutting, polishing, drilling etc)

Metallic Pigments

Conductive or non-conductive effect producers in powder coatings

Metallic Powder Coatings

Effect powder coatings with metallic appearing surface (pearl, glitter, Glimmer etc)

Metamerism

Color difference at varying light conditions

Moisture

Absolute moisture content in a powder coating

Movement of Reciprocator

Spray pattern with reciprocating guns, influenced by conveyor speed and lift

N

Nozzles

Various end pieces on the gun (powder bells, finger nozzles, round and flat type nozzles)

O

OGF-Additive

(OGF = Out-gassing Forgiving) Additive to help reduce out-gassing of the substrate in the powder film

Oil Remnants

Remnants of oil on parts, which were not removed by pretreatment (Lanolin, extrusion oil etc.)

Oil Residues

Residues not removed by pretreatment

Orange Peel

Short or long ripple effect on the powder surface



Oven Types

Oven differences through construction and heating unit, i.e. chamber oven, conveyor oven, radiation oven, IR oven (comparable to heating, gas quality)

Over Coating

A second layer of powder is applied

Over Curing

Temperature in the curing unit is too high, or time in the oven is too long.

Oversize Particles

Powder particles that are larger than the screen size and are separated during straining

Overspray

Powder coat that does not adhere to the surface during application

Oxide Layer

Corrosion residues on the work piece surface

P

Particle Distribution

Distribution of powder coat particles according to size and percentage

Penetration

Ability to coat in to the corners, recesses and hollow areas

Pickling

Caustic, watery cleaning procedure, which removes oxide layers, rust, ground in dirt and foreign materials

Picture Framing Effect

Higher film thickness of the powder coating on the edges of the work piece, caused when current is too high at the edges, e.g. noticeable with fine textures and metallics

Pigments

Coloring agents in the powder coating

Pimple

Elevation in the powder surface

Pin Holes

Surface defect. Development of small pores in powder coating

Polishing Marks

Mechanical surface treatment. Can be visible through powder coats

Powder

Dry, dust like thermosetting coatings

Powder Adhesion

See adhesion

Powder Center

Compact device for powder transportation, made of thread with integrated cleaning unit

Powder Circulation

Transport of unapplied powder through reclaim for re-use (comp. to overspray)

Powder Clusters

I.e. powder puffs

Powder Dryer

Necessary device for gelling and drying of the powder coating film(see oven types)

Powder Film

Desired surface development of the gelled powder coating

Powder Hose

Comp. To transport hose

Powder Puffs

Agglomeration of powder coat on the coated surface

Powder Transport Device

For transport of powder coating from storage container to gun

Pressure Points

Visible notches in the powder coat surface, caused by too much pressure strain, especially at high film build

Pretreatment

Cleaning and conversion layer development with liquid chemicals (dipping, spraying)

R

Reclaim

Device to reclaim overspray

Release Agent 1

Sprays used in the metal fabrication industry, to reduce the adhesion of welding residues

Release Agent II

Liquid used for castings, to reduce the adhesion between cast part and casting mold

Remnant Powder 1

Contaminated powder from reclaim

Remnant Powder II

Economically not usable powder coating in carton or warehouse

Retracted Areas

Areas unreachable with powder (i.e. faraday cage), example: form tubing, welded parts

Return Point

Up and down end points in automatic reciprocating powder coating equipment

Rinse

Removal of pretreatment residues via fresh or de-ionized water

Run

Running of the powder coating film from the work piece (synonymous with liquid paint)

Rust

During corrosion of iron or steel

S

Salt Residues

Unremoved residues after pretreatment

Scratch Resistance

Durability of the powder coating surface (i.e. abrasion resistance)



Screen Tear

Defective screen used to qualify powder, oversize particles may cause flow problems

Screening Analysis

Determination of particle size

Screening Equipment

Integrated in reclaim system to strain powder. External straining possible (min. mesh size approx. 200 [μm] / 8 [mils])

Scuff Resistance

Powder film resistance against abrasive media, i.e. sand, scouring liquid, cardboard, wood, paper

Security Standards

Security standards published by equipment manufacturers and OSHA must be observed

Shavings

Fine manufacturing contaminations (metal, wood or plastic)

Short Circuit

Uncontrolled (electric) contact between high voltage and ground

Sintering

Depositing of powder in the powder feed system, application equipment or reclaim system

Snowboard Effect

Powder does not adhere to work piece, slides off in sheets, drizzles off

Softener

Additive used in plastics production

Softening

Softening of the powder coat film through use of solvents

Spikes

Elevations

Spray Wash System

Pretreatment of work piece via spray washer (approx. 1,5 bar) mechanical cleaning power

Spraying

Application of powder coat to part with spray equipment

Stability

Continuous resistance depending on requirement, for example against chemicals, weather or UV influence

Substrate

Work piece, to be coated material (steel, aluminum, stainless steel, glass, plastics, MDF)

Super Fines

Spectrum of particle size distribution of the powder coating ($< 10 \mu\text{m}$)

Surface Defects

Damages to the surface properties of the powder coating

Sweeping

Light blasting of parts. Mechanical removal of corrosion layer, especially for hot dipped galvanized parts

T

Tears

Surface defects, tearing/breaking during insufficient gelling, after mechanical strain

Temperature Curve

Elevating and dropping of substrate temperature during the curing process

Textures

Surface developments

TGIC

Triglycidylisocyanurate - Popular hardening system for polyester

TGIC-Free

Alternative hardener

Thermoplastics

Re-formable plastics that can be re-shaped with re-heating

Thermosetting Coatings

Irreversibly fused film, not changeable by re-heating

Transport Hose

Hose used to transport powder and air mixture from powder container to gun

Transportation Air

Necessary air to transport air to the powder gun. Increasing of air = increased powder consumption

Tribo Charging

Through charging separation (PTFE -rod) powder particles are positively charged and transported to the part

U

Use of Adhesives

Large selection, check suitability before use

V

Voltage

Necessary electrical voltage for charging

W

Wall Thickness

Material thickness of the work piece

Welding Points

Surface treatment. May be visible through powder coat. Problems with carbon

Work Piece

See substrate

Wrapping

Accumulation of powder on the backside and/or edge of a work piece



Y

Yellowing

Color change caused by excessive temperatures or time in direct fired gas ovens

Y

Zinc Coating

Application of a corrosion protection layer (Zn) on steel (galvanizing)