TIGER Drylac® Powder Coatings

Troubleshooting Guide

TROUBLE SHOOTING

Tips & Tricks for Powder Coating

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Tips & Tricks for Powder Coating

Dear valued clients,

Powder coating technology has seen rapid advancement. This development requires experience and knowledge to keep pace. This knowledge has become an essential "commodity" within the company. In the future, "knowledge" as a coefficient of productivity inherent in every product, service and processes of the company will surpass the significance of "work" and "capital" (the traditional factors in productivity).

Applying knowledge accumulated throughout the years has become a new and sophisticated challenge for business. Against the backdrop of intensive regional and global competition in the field of industrial surface finishing, employees expertise and broad knowledge of different paint systems represent a crucial competitive edge.

This manual entitled "Tips & Tricks for Powder Coating" represents our efforts to catalog the experiences gathered throughout the years and make it available to you in condensed form.

It includes many of the potential causes for errors, as well as a multitude of detailed questions - from A like Application to Z like Zinc.

We believe this manual provides valuable support for your production process and project planning. We look forward to continuing our cooperation as partners.

Your TIGER Team

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1. Pretreatment as a cause of errors

TIGER Coatings does not produce pretreatment chemicals The following explanations for pretreatment of the most common substrates are intended to provide a brief overview. It goes without saying that this topic has to be addressed in a more thorough and differentiated way. However, the principle below applies every time: The best and most expensive powder coating cannot make up for poor pretreatment!

1.1 Chromating of aluminum, zinc and magnesium

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Rinse water beading** • **Substrate not completely wet**	• Inadequate degreasing effect *Fig. 1.1.1*	• Increase temperature of degreasing bath • Increase concentration of degreasing agent • Increase process times • Increase spraying action or circulation speed in immersion bath • Wetting check with distilled water
• **Conversion film (chromating) uneven or spotty** *Fig. 1.1.2*	• Degreasing effect not adequate	• Increase temperature in degreasing zone • Increase chemical concentrations • Extend exposure times • Increase spray action • Increase bath time
	• Oxide films not removed completely	• Check pickling solution • Increase concentration of acid or alkali, if applicable • Increase temperatures of baths • Increase exposure time
	• Drying between individual baths, tank level possibly to low	• Reduce transfer time between the individual baths • Spray nozzles may be blocked
	• Delay of pretreatment *Fig. 1.1.3*	• Change method of suspending components • Avoid stopping the conveyor
• **Conversion film (chromating) not firmly adhering and/or cannot be wiped off**	• Incorrect composition of bath	• Correct composition of bath • Possibly a new batch
	• Exposure time too long	• Reduce treatment time
	• Rinsing baths excessively contaminated from previous bath	• Increase drain off time between baths • Increase rinse water volume
	• Spray not adequate	• Increase pressure • Increased circulation in immersion baths • Increase rinse times

Fig. 1.1.1 Poor (no) chromating

Fig. 1.1.2 Spotty chromating

Fig. 1.1.3 Potential transfer of pretreatment media

1.2 Chromium-free pretreatment for aluminum and magnesium

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Rinse water beading – (poor water break)** • **Substrate not completely wet**	• Inadequate degreasing effect	• Increase temperature of degreasing bath • Increase concentration of degreasing agent • Extend process times • Increase spraying action or time in bath/tank or increasing the pressure
• **Powder-coating film detaches during boiling water test.** • **Powder-coating film detaches from substrate when exposed to humidity.** • **Generally poor mechanical adhesion of the paint film**	• Degreasing effect not adequate	• Improve degreasing process
	• Pickle rate not adequate	• Ensure higher pickle rate

	• Conversion film not adequate
	Fig. 1.1.4
		• Check the entire pretreatment
		  • Degreasing
		  • Pickling
		  • Processing times

	• Conversion film too thick and therefore brittle *Fig. 1.1.5*	• Determine thickness of conversion film as exactly as possible (photometric methods / x-ray fluorescence analysis)

Fig. 1.1.4 Conversion film too thin.

Fig. 1.1.5 Conversion too thick

1.3 Phosphate-coating steel and galvanized steel

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• Conversion film (phosphate-coating) not continuous **• Uneven or spotty** **• Rinse water is beading and not completely wetting the surface**	• Temperature of degreasing bath too low	• Increase temperature
	• Retention time in degreasing system too short *Fig. 1.3.1*	• Increase retention time
	• Degreasing effect not strong enough *Fig. 1.3.2*	• Addition of degreasing boosters
	• Floating grease	• Remove grease, if necessary
	• Degreasing bath depleted	• Prepare a new bath
	• Degreasing chemicals not suitable *Fig. 1.3.3*	• Use of a more suitable degreasing system, if necessary
	• Plant-related errors	• Check nozzle alignment and correct, if necessary • Clean blocked nozzles • Optimize part orientations • Improve position of components • Ensure downtimes between baths are reduced • Inadequate drying *Fig. 1.3.4*
• Conversion film (phosphate-coating) too thick **• Dusty film**	• Treatment times too long	• Adjust treatment times
	• Accelerator volume too high	• Comply with specified bath composition
• Corrosion on substrate *Fig. 1.3.5; 1.3.6; 1.3.7*	• Conveyor stopped • Chemicals become tacky	

Fig. 1.3.1 Grease residues after pretreatment

Fig. 1.3.2 Deep-drawing lubricants resistant to pretreatment

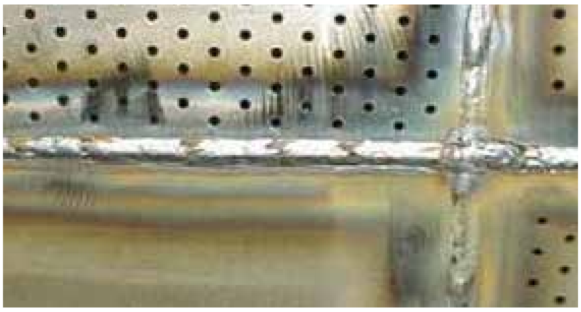


Fig. 1.3.3 Carbon due to welding work

Fig. 1.3.4 Poor rinsing, material stored wet

Fig. 1.3.5 Corrosion due to Fe-phosphate coating on sandblasted workpieces

Fig. 1.3.6 Corrosion of sandblasted workpieces after pretreatment

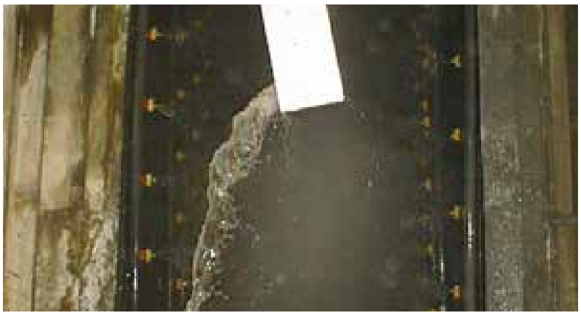


Fig. 1.3.7 Potential transfer of pretreatment media

2. Application process

2.1 Inadequate fluidization

Powder in fluidization hopper - Insufficient fluidization can be recognized by a sluggish and discontinuous transfer of the powder coating from the reservoir to the spray guns; there is no formation of an even powder cloud. Surging & spitting of powder

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating is not “flowing” in the reservoir** *Fig. 2.1.1* • **Formation of small craters in the reservoir** *Fig. 2.1.2* • **Uneven powder cloud** *Fig. 2.1.3*	• Not enough fluidization air	• Air volume increase
	• Fluidized bed defective	• Replace fluidized bed
	• Fluidized bed clogged	• Clean fluidized bed
	• Powder too fine (reclaiming) • High overspray ratio	• Add fresh powder • Replace powder coating, if necessary
	• Moisture in powder	• Store powder dry and at room temperature
	• Powder coating heavily compacted in box	• Screen the powder coating • Do not keep box vibrators working in continuous operation
	• Ambient temperatures in coating plant too high	• Cool down • Structural measures, if necessary
	• Powder coating ground too finely	• Contact TIGER Coatings
	• No or not enough fluidization additive in powder coating	• Contact TIGER Coatings

Fig. 2.1.1 Fluidization - powder must flow like water

Fig. 2.1.2 Poor fluidization

Fig. 2.1.3 Poor fluidization; powder volume too large

2.2 Sintering in injectors, hoses and spray guns

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating sintering in injectors, hoses and spray guns** • **Sintering dislodge results in contamination of the powder coating**	• Conveying air too high *Fig. 2.2.1*	• Reduce pressure
	• Moisture or oil present in air supply	• Check cryogenic dryer and air filter
	• Inefficient routing of hose, tight radii	• Optimize routing of hose
	• Ratio of fine powder particles too high *Fig. 2.2.2*	• Reclaim ratio suggested – 70% virgin 30% reclaim • Contact TIGER Coatings if necessary • Check screen analysis
	• Material not suitable for venturis (glass, polyamide)	• Use venturis made of Teflon, if possible
	• Injektor nozzles (venturi) worn out, therefore increased air pressure required	• Replace injektor nozzles (venturi)
	• Unsuitable hose material *Fig. 2.2.3* • Unsuitable hose diameter	• Contact plant manufacturer • Adjust material and diameter of hose
	• Room temperatures and humidity in coating area too high	• Cool, dehumidify • Reduce temperature and humidity in spray area
	• Powder coating does not fluidize adequately	• Contact TIGER Coatings • Add suitable fluidizing additive

Fig. 2.2.1 Conveying air too high, replace with "Sintering on flat spray nozzle"

Fig. 2.2.2 Fine particle ratio of powder too high, replace with "Sintering on impact mill"

Fig. 2.2.5 Unsuitable hose material

2.3 Powder coating falling off the part

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating fails to adhere to the component** • **Powder coating falling off the part** • **Complete powder film or a part thereof slides off the part** *Fig. 2.3.1, 2.3.2*	• No or insufficient grounding *Fig. 2.3.3, 2.3.4*	• Measure electrical resistance between part and ground/mass • Improve grounding, if necessary
	• Voltage too low or interrupted	• Spray gun (cascade), high voltage, check cable
	• Particle size distribution, powder coating too fine	• Regular addition of fresh powder coating, if necessary contact powder manufacturer regarding powder particle size
	• Particle size distribution, powder coating too coarse	• Contact powder manufacturer regarding particle size
	• Severe vibrations during transport of powder-coated parts	• Make sure that there is as little vibration as possible during transportation
	• Film thickness too high *Fig. 2.3.5*	• Reduce film thickness
	• Conveying and secondary air resulting in blow-off effects	• Reduce air volumes
	• Powder output per spray gun too high	• Reduce powder volume
	• Not enough distance between spray gun and workpiece • Blow-off effects	• Increase distance
	• Faraday areas	• Optimize suspension and positioning, if possible • Change design

Fig. 2.3.1 Parts of the powder film slip off

Fig. 2.3.2 Powder film slips off entirely

Fig. 2.3.3 No grounding or inefficient grounding

Fig. 2.3.4 Experiment with additional grounding

Fig. 2.3.5 Powder film too thick

2.4 Insufficient wrap-around

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **No powder application on the rear of part or panel in case of onesided spray gun arrangement**	• Powder output too low or too high	• Optimize powder output
	• Insufficient grounding of workpiece	• Check grounding and optimize, if necessary
	• Spray gun air too high or too low	• Select air setting as per spray gun manufacturer's specifications
	• Particle size of powder coating not suitable	• Contact TIGER Coatings
	• Spray gun voltage too low	• Increase voltage
	• Insufficient charging of powder coating	• Optimize current and voltage settings
	• Incorrect positioning of workpieces *Fig. 2.4.1*	• Optimize positioning of workpieces, if possible
	• Spray gun defective	• Repair or contact spray gun manufacturer

Fig. 2.4.1 Incorrect positioning of workpieces

Fig. 2.4.2 Incorrect positioning of workpieces

2.5 Clumping in carton

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Clumping of powder coating in box** *Fig. 2.5.1*	• Improper storage • Ambient temperatures in storage area too high • Product stored too long	• Ensure that storage conditions are suitable • Screen powder coating prior to processing • Perform requalification checks on a panel (check powder coating for flow and mechanical properties)
	• Moisture in powder coating	• Ensure dry transport and storage conditions
	• Extended transport • Temperatures during transport too high	• Screen prior to use • Perform requalification checks on a panel (check powder coating for flow and mechanical properties) • If necessary, contact TIGER Coatings
	• Powder coating ground too finely	• Contact TIGER Coatings
	• No (or not enough) fluidizing additive in powder coating	• Contact TIGER Coatings

Fig. 2.5.1 Clumping in box

2.6 Powder cloud pulsing, stops intermittently

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder cloud pulsing, stops intermittently**	• Inadequate fluidization	• See 2.1
	• Hose too long • Hose tangled up • Hose angles too narrow	• Hose lengths as short as possible • Untangle hoses • Adjust hose diameter, reduce angles
	• Venturi injector worn	• Renew venturi
	• Powder pumps / Dense-phase conveying technology	• Perform service, contact application equipment manufacturer

2.7 Insufficient ability to penetrate faraday areas

Despite the physical conditions (Faraday cage, ionized air), a particular minimum thickness must be achieved in corners and cavities for the most part. Poor penetration indicated by falling far short of possible powder penetration depths.

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating is poorly penetrating corners and cavities** *Fig. 2.7.1*	• Conveying air pressure too high resulting in blow-off effects	• Reduce air pressure
	• Excessively high powder output per spray gun	• Reduce powder output
	• Powder output per spray gun too low	• Increase gun output
	• Spray gun nozzles not suitable	• Improved results mostly with flat spray nozzles
	• Insufficient charging of powder coating	• Increase current and voltage setting • Check the gun
	• Voltage and current too high	• Reduce current and voltage settings
	• Faraday cage effect *Fig. 2.7.2*	• Use of triboelectric spray gun eliminates Faraday cage effect; insert corona spray gun deeper into the cavity

	• Grounding of workpieces not adequate	• Check grounding, optimize if necessary
	• Particle size of powder coating not suitable	• Conduct experiments with more coarse or fine grind specification • Contact TIGER Coatings
	• Space between spray gun and workpiece too small or too large	• Optimize spacing
	• Ionized (charged) air in cavities	• Use of ion conductors • Test Supercorona, Coronastar

Fig. 2.7.1 Powder coating is poorly penetrating corners and cavities

Fig 2.7.2 Faraday cage effect

3. Surface imperfections

3.1 Powder accumulates uneven on workpiece (spittings, splotches)

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder spittings/ splotches are small powder accumulations on workpiece which appear uneven when cured**	• Poor fluidization	• See 2.1
	• Powder hose too long • Diameter too large • Possibly Powder compacted in tight hose radii – (impact fusion)	• Optimize hose diameter • Shorten hose • Structural measures
	• Powder coating too fine due to reclaim operation	• Add fresh powder coating
	• Uneven powder delivery	• Check compressed air for fluctuations
	• Sintering in hose, spray gun, nozzles *Fig. 3.1.2*	• See 2.2
	• Powder falling off the goods carrier and/or conveyor line	• Strip the paint off goods carriers (hooks) and/or clean them • Check grounding

	• Powder dropping off the spray gun nozzles *Fig. 3.1.3*	• Increase air pressure on nozzle • Clean nozzles regularly
	• Powder dropping off other workpieces	• Check grounding
	• Venturi worn	• Check venturis • Replace venturis if necessary
	• Spray gun nozzle defective	• Check nozzle • Renew, if necessary
	• Damp powder coating	• Ensure that powder is dry, store in dry location
	• Metallic pigment accumulations *Fig. 3.1.1*	• Contact TIGER Coatings
	• Airborne particulates, dust in the coating hall	• Ensure cleanliness • Turbulence caused by draft, fork lifts, etc.

Fig. 3.1.1 Metallic pigment splotches

Fig. 3.1.2 Sintering in the spray gun

Fig. 3.1.3 Powder splotches due to deposits on spray guns

3.2 Craters

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Crater-shaped depressions in the coating (fish eye)** • **Some may extend down to the substrate** *Fig. 3.2.1*	• Insufficient pretreatment, e.g. grease and oil residues	• Check pretreatment • Contact chemical supplier, if necessary
	• Chemical residues • Pretreatment not OK	• Check pretreatment • Contact chemical supplier, if necessary
	• Corrosion residues • Rust, white rust on workpieces *Fig. 3.2.2, 3.2.3, 3.2.4*	• Ensure that surfaces are free of corrosion • Grind or blast, if necessary
	• Oil in compressed air	• Check compressed air filter and cryogenic dryer
	• Silicone, welding sprays • Greasy hand cream *Fig. 3.2.5, 3.2.6*	• Avoid using such substances in the entire coating area
	• Incompatibility with other powder coatings, such as acrylate powder coating	• Clean coating plant thoroughly • Check compatibility with other powder coatings in advance by adding small volumes
	• Outgassing from workpiece (casting materials, zinc films)	• Use of powder coatings optimized for outgassing • Addition of outgassing additives • Tempering workpieces • Hot coating, if necessary
	• Air in plant may be contaminated, e.g. from welding sprays	• Check plant for contaminated materials and remove them
	• Workpiece still damp	• Optimize the time and temperature for drying
	• Wet paint and powder coatings in the same plant	• Check compatibility of individual paints • Process them at different times, if necessary • Structural changes in the plant
	• Use of powder coat putty	• Thoroughly dry putty • Preheat, if necessary • Check that putty is suitable
	• Applying powder coating to surfaces painted with wet paints	• Check that wet paint is suitable for over coating with powder.
	• Substrate was cleaned with slow-acting volatile solvents	• Allow to dry • Preheat, if necessary

	• Substrates sandblasted too coarsely *Fig. 3.2.7*	• Use finer blasting material • Measure peak-to-valley surface roughness profile
	• Spray-back effects, dielectric breakdowns	• Reduce current and voltage settings • Check grounding • Use ion conductor systems (Supercorona, Coronastar), if necessary • Check use of triboelectric spray guns
	• Craters in case of rough-texture powder coatings	• Increase film thickness • Contact TIGER Coatings
	• Craters on hot-dipped galvanized parts	• Use AGF powder coatings • Tempering • Zinc film too thick
	• Defect in substrate *Fig. 3.2.8, 3.2.9*	• Fill with putty

Fig. 3.2.1

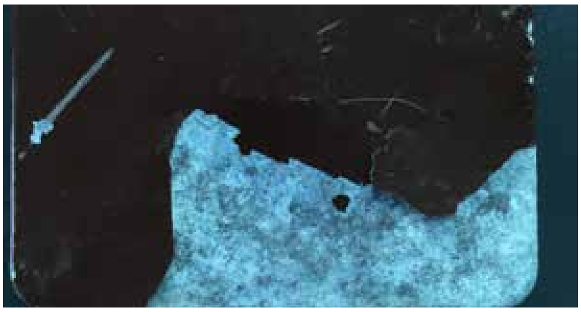


Fig. 3.2.2 White rust on workpieces

Fig. 3.2.3 Rust on workpieces

Fig. 3.2.4 Craters in powder coating film due to corrosion

Fig. 3.2.5 Fingerprints beneath clear coat

Fig. 3.2.6 Fingerprints from hand cream

Fig. 3.2.7 Poor rinsing sandblasted, e-coat as base

Fig. 3.2.8 Defect in substrate

Fig. 3.2.9

3.3 Pinholes

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Pinhole-shaped pores, up to 1 mm in diameter**	• Excessively high powder coating films, especially with primid-curing polyester powder coatings due to water vapor being expelled during curing	• Reduce film thickness
	• Object temperatures too high when curing	• Avoid object temperatures >200°C
	• Highly porous workpieces	• Ensure workpieces are non porous (particularly castings) • Avoid excessive peak-to-valley surface roughness (pretreatment of surface with sandblasting)
	• Outgassing from porous substrates (cast components)	• Use powder coatings optimized for outgassing • Add outgassing additive • Preheat part befor coating
	• With rough-texture powder coatings only. Pinholes and craters instead of formation of texture	• Increase film thickness
	• Lack of compatibility between powder coatings	• Clean plant thoroughly • Contact powder coating supplier, if necessary

	• Pre-reacted powder coatings	• Observe the recommendations regarding duration and temperature of storage • Perform requalification check, if necessary
	• Moisture content of powder too high	• Store in dry conditions • Avoid switching between extremely cold and warm temperatures

3.4 Picture Frame Effect

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Greater powder-coating film thickness at the edge, resulting in uneven flow and visible differences between surface and edge area** *Fig. 3.4.1, 3.4.2, 3.4.3*	• Powder is wrapping around the edges	• Reduce film thickness
	• Voltage setting too high	• Try reducing to 30-50 kV
	• Current setting too high	• Try reducing to 5-10 µA • Use ion conductor systems (Coronastar, Supercorona), if necessary
	• Distance between spray gun and workpiece too large or too small	• Reduce, optimize distance of spray gun
	• Particle size of powder coating too large and/or not ideal for application	• Contact powder coating manufacturer
	• Occurs only with the use of ion conductors (Supercorona, Coronastar)	• Try removing ion conductors

Fig. 3.4.1

Fig. 3.4.2

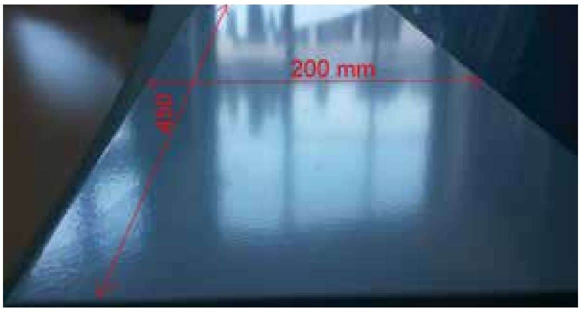


Fig. 3.4.3

3.5 Bumps, inclusions (other colors), contamination

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Contamination embedded in the powder-coating film**	• Contamination from conveyor, transport chain, etc.	• Thorough cleaning of plant, possibly “roofing” individual goods carriers
	• Contamination of paint surface from sources outside the coating booth (room air, floor, grinding jobs, blasting plant, etc.) *Fig. 3.5.1*	• Shield/encase coating booth • Avoid high air speeds in hall • Avoid tasks that generate dirt (grinding, blasting) in coating hall
	• Fibers, lint from cleaning rags and work clothing *Fig. 3.5.2*	• Use cleaning rags and work clothing that are lint-free
	• Pre-reacted non melting powder particles *Fig. 3.5.3*	• Screen, if necessary • Use new carton • Contact TIGER Coatings
	• Inadequately finished weld seams • Metal shavings, beads of weld metal, aluminum die pick-ups, rolling defects *Fig. 3.5.4*	• Check production process • Improve grinding or cleaning process, if necessary
	• Input of dirt when cleaning the plant	• When cleaning the booth with compressed air, powder coating should not be dispersed in the hall
	• Blow-off effects from workpiece at oven opening resulting in contamination of differently colored workpieces	• Reduction of air speeds in the area of the oven entry • Separate the area of the oven entry, if necessary • Pre-gelling zone
	• Sintering of powder particles and dust when removing the workpieces from the oven while they are still hot	• Create dust-free environment in the unloading area
	• Transfer of powder dust when coating booths are situated in close proximity *Fig. 3.5.5*	• Check suction capacity of booths, clean carefully • Increase distance between coating booths, if necessary
	• Contaminations when storing the powder coating *Fig. 3.5.6*	• Ensure proper storage • Always close powder bags • Close cartons, store by type

	• Inadequately cleaned spray guns and hoses (especially problematic with rough-texture powder coatings)	• Thorough cleaning • Use different hoses for different shades, if necessary
	• Dirt particles from curing oven	• Clean oven regularly • Check use of dirt absorption films
	• Pretreatment residues	• Ensure perfect pretreatment
	• Gelled particles in powder coating *Fig. 3.5.7*	• Contact TIGER Coatings
	• Rust particles in powder coating	• Lack of pretreatment
	• Deficient hot-dip galvanizing *Fig. 3.5.8*	• Ensure improved quality, clean zinc-coating

Fig. 3.5.1 Contamination of paint surface from grinding jobs

Fig. 3.5.2 Fibers, lint from cleaning rags and work clothing

Fig. 3.5.3 Pre-reacted non melting powder particles

Fig. 3.5.4 Shavings in coat

Fig. 3.5.5 Transfer of powder dust - situated too closely together

Fig. 3.5.6 Contamination when storing powder coating

Fig. 3.5.7 Gel particles in powder coating

Fig. 3.5.8. Deficient hot-dip galvanizing

3.6 Blisters

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Blisters of varying sizes on the painted surface**	• Remnants of water on the workpiece	• Optimize the time and temperature for drying • Modify suspension of parts, if necessary
	• Water from cleaning process remaining in workpieces prior to coating	• Change hanging position • Drill holes for drainage • Optimize drying
	• Corrosion, grease and oil residues	• Optimize pretreatment
	• Top-coating	• Ensure perfect substrate
	• Applying a top-coat on wet paint films	• Check suitability of wet paint film for applying powder coating
	• Applying a coat on putty	• Drying or pre-heating of putty • Check that putty is suitable for powder coating
	• Salt residues or remnants of chemicals • Malfunction in wetting	• Check pretreatment • Avoid stoppages in pretreatment • Ensure adequate rinsing
	• Very high film thickness, e.g. due to powder having trickled off in corners of workpiece	• Check application settings • Carefully blow any powder coating that trickled off out of the corners
	• Outgassing from substrate material (casting materials, zinc films)	• Pre-heating • Addition of outgassing additives (AGA)

3.7 Formation of drops and beads

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Heavy formation of beads or even drops on the workpiece**	• Film thickness too high *Fig. 3.7.1*	• Reduce film thickness
	• Heat-up rate of workpieces extremely fast or very slow (effect depends on reactivity and viscosity of powder coating)	• Optimize oven settings • Contact powder coating supplier, if necessary
	• Unsuitable powder coating (viscosity and/or reactivity too low)	• Contact TIGER Coatings
	• Powder coating accumulations in corners due to powder that trickled off *Fig. 3.7.2*	• Optimize application (grounding, charge, spray-gun air)
	• Workpiece temperatures too high during coating film thickness too high	• Allow workpieces to cool off below 40°C • When using hot-coating, apply powder coating sparingly
	• Powder coating accumulations at the border and edges	• See 3.4 Picture-frame effect

Fig. 3.7.1 Film thickness too high

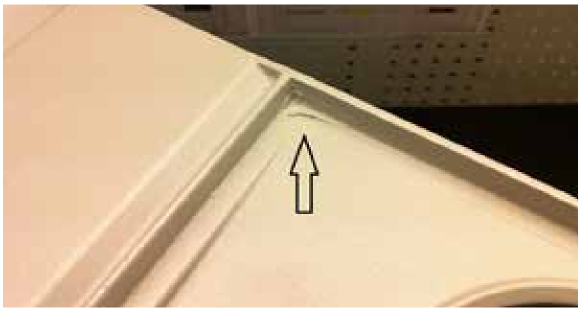


Fig. 3.7.2 Powder-coating accumulation in corners due to powder that trickled off

3.8 Orange peel, poor flow

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Poor flow** • **Uneven surface** • **Orange peel-like surface**	• Work pieces heating up too slow	• Determine heat-up rate of workpieces by means of measuring object temperature • Adjust oven temperatures
	• Highly reactive powder coatings - powder coating in liquid phase very briefly	• Lower curing temperatures • If necessary, contact TIGER Coatings
	• Back-ionization effects / dielectric breakdowns (charging the powder coating too much will result in dielectric breakdowns)	• Reduce voltage and/or electric charge (μA) • Increase distance between workpiece and spray gun • Check use of ion conductors (Supercorona/ Coronastar)
	• Film thickness too high or too low	• Keep film thickness within the range of 60-120μm, if possible
	• Powder coating reacted in the box, shelf life exceeded	• Check film thickness, curing conditions, shelf life and storage conditions • Reject, if necessary
	• Particle size not suitable	• Contact TIGER Coatings
	• Textured surfaces of workpieces; the flow is predetermined by the substrate	• Texture will be determined by surface of the workpiece

3.9 Insufficiant powder on workpiece /component

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder not covering the full workpiece** *Fig. 3.8.1*	• Oil, grease or release agent • Insoluble lubricants	• Check pretreatment • Optimize pretreatment, if necessary • Use other lubricants
	• Pretreatment residues	• Ensure adequate rinsing
	• Oil/grease in pretreatment	• Check and/or optimize pretreatment and oil removal
	• Poor charging • Charging problems or powder coating discharged too quickly • If the powder coating is not charged enough, it will not adhere sufficiently to the work pieces	• Check grounding, increase current and voltage settings • Contact TIGER Coatings, if necessary

	• Contamination of workpieces due to sweat, contaminated gloves, hand cream, etc. *Fig. 3.8.2*	• Do not touch pretreated workpieces with your bare hands or contaminated gloves
	• Poor pretreatment due to line stopping	• Avoid line standstill

Fig. 3.8.1 Large areas of discontinuity that fail to exhibit a paint film

Fig. 3.8.2 Contamination due to hand sweat, hand cream, ...

3.10 Formation of bubbles

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• bubbling or foaming **• In practice, mainly with primid-curing polyester powder coatings**	• Film thickness too high, >120µm	• Reduce film thickness
	• Accumulation of excess powder coating, possibly falling of workpieces	• Ensure proper charging • Parts should be transported with as little vibration as possible • Careful removal of excess powder coating
	• Excessively high object temperatures during the curing process	• Avoid object temperatures >200°C when bubbling/foaming occurs
	• Parts to be coated heat up extremely quickly	• Adjust curing conditions

4. Deviations in the surface of the powder-coating film

4.1 Deviations in shade or color

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Continuous or sudden changes in shade or color compared to the master samples during the coating process**	• Considerable fluctuation in film thickness *Fig. 4.1.1*	• Ensure that film thickness is as consistent as possible
	• Overcuring of powder coating, especially of paints with organic pigments (bright red, orange, yellow and violet shades)	• Avoid object curing temperatures >200°C and retention times in the oven • Comply with the recommendations of TIGER Coatings
	• Different curing conditions with identical workpieces	• Ensure that the curing conditions are the same • Avoid conveyor standstill
	• Fluctuations in shades due to oven technology (gas oven with direct/ indirect heat, infrared ovens, recirculating air ovens)	• Use suitable powder coatings for oven type • Determine deviations from shade in advance with testing
	• Paint films that are too thin and do not cover *Fig. 4.1.2*	• Comply with manufacturer data for minimum film thickness
	• Variation of different curing conditions on a workpiece, depending on thickness of materials to be coated	• Avoid excessive air temperatures within oven • Ensure full curing by extending or lowering the time in the oven
	• Different suppliers and/ or powder coating manufacturers	• Always use paint from one manufacturer for one project
	• Incorrect pigmentation of powder coatings	• Contact TIGER Coatings
	• Different substrates (black steel, aluminum, brass)	• For color comparison, always use the same substrates
	• Poor coverage with rough texture powder coatings (inadequate coverage)	• Increase film thickness • Select a different type of powder coating, if necessary
	• Metamerism, deviations in shade due to different light sources (sunlight, light bulbs, fluorescent strip lights)	• Evaluate coated parts with a defined light source (preferably daylight); otherwise it will be necessary to define the subsequent location where the parts are used and that location's light source.

	• Different surfaces and reflectivity of the substrates (sandblasted, polished or chromated)	• For comparison, always use the same substrates
	• Powder delivery directly from the box (applies only to metallic powder coatings)	• Use fluidized container

Fig. 4.1.1 Different color due to varying film thickness

Fig. 4.1.2 Paint films that are too thin and do not cover

4.2 Clouding/Inconsistant appearence

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Variations in shade and/or gloss levels on the workpiece**	• Not enough distance between spray gun and workpiece	• Increase distance
	• Sine curves of the individual spray guns fail to pass over the workpieces evenly	• Synchronize gun reciprocation and track speed (special calculation programs are available) • contact application equipment manufacturer
	• Uneven powder delivery	• Check fluidization, lengths and routing of hoses • Check injector, compressed air and fluidized container
	• Manual coating after automatic coating	• Manual pre coating prior to automatic coating
	• Uneven powder charge	• Check voltage and electric charge of spray guns
	• Film thickness fluctuates significantly (especially with matte powder coatings)	• Ensure film thickness is as consistant as possible
	• Reclaim system ineffective	• Ensure consistent ratio of fresh and reclaimed powder

4.3 Poor coverage

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Insufficient coverage of substrate by powder coating**	• Film thickness too low	• Increase film thickness
	• Film thickness fluctuates significantly	• Ensure that film thickness is as even as possible
	• Different substrates, colors (steel, aluminum, brass)	• Increase film thickness until it reaches its full coverage
	• Pigmentation of powder coating not adequate or incorrect	• Contact TIGER Coatings
	• Incorrect ratio of reciprocation to chain speed (uneven distances of sine curves in automatic booths)	• Synchronize speed of reciprocation and conveyor
	• Different surfaces and reflectivity of the substrate	• Perform comparisons on identical substrates only • Increase film thickness until it reaches its full coverage

4.4 Deviations in gloss level

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Deviations and/or fluctuations from specified gloss level**	• Curing conditions that are too high or too low	• Observe the manufacturer's specifications
	• Pinholes (especially with primid-curing polyester paints)	• Observe recommendations for maximum film thickness and maximum curing temperatures
	• Film thickness too high or too low	• Pay attention to recommendations
	• Incompatibility with other powder coatings	• Clean coating plant thoroughly
	• Gas ovens with direct heat, infrared ovens	• Adjust oven conditions to powder coatings • Use better suited powder coatings for oven type
	• Exceeded shelve life • Poor storage conditions • Powder coating pre-reacted in the box	• Check if the powder coating still meets all technical requirements. • Reject, if necessary
	• Unsuitable cleaning agents on paint surface	• Follow the powder coating manufacturer's recommendations for cleaning

	• Separation of 2 component matte powders due to reclaiming operation	• Stop reclaiming, if necessary
	• Migration of paint additives to surface of coating (waxes, outgassing additives, etc.) *Fig. 4.4.1*	• Pay attention to oven parameters • If necessary, contact TIGER Coatings
	• Powder coating insufficiently dispersed • Lack of paint consistency	• Contact TIGER Coatings

Fig. 4.4.1 Blooming effect - sweating of paint additives

4.5 Yellowing, discoloration

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Yellowing, discoloration** *Fig. 4.5.1*	• Incorrect curing condition, mostly too high temperature	• Comply with the recommendations of TIGER Coatings
	• Powder coating not heat stabilized	• Use stabilized powder coatings • Contact TIGER Coatings
	• Gas ovens with direct heat • IR curing ovens	• Use powder coatings that are formulated for these curing conditions
	• Liquid paint components, felt-tip pen, stamp colors, markers diffused into paint film *Fig. 4.5.1*	• Thoroughly remove residues prior to coating
	• Oil, solvents in oven	• Ensure that the curing oven is clean!

Fig. 4.5.1 Yellowing, discoloration

4.6 Film thickness too high

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Film thickness is far too high**	• Powder output too high	• Reduce powder output
	• Coating time in booth too long	• Reduce coating time
	• Workpieces too hot during coating, powder melts on the substrate immediately	• Avoid workpiece temperatures >40°C in booth
	• Complex shape of workpieces	• Optimize application • Change position of workpiece
	• Tribo application allows for significantly higher film thickness than Corona application	• Be mindful of the peculiarities of the tribo application

4.7 Film thickness too low

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Low film thickness** • **Uneven flow** • **Poor covering power**	• Coating time in booth too short	• Increase coating time
	• Powder output too low	• Increase powder output
	• Distance between spray gun and workpiece too high	• Reduce distance
	• Grounding not adequate	• Optimize grounding
	• Powder coating charge too low	• Increase current and voltage settings • Check spray guns
	• Particle size too fine (overspray ratio too high or/and ratio of reclaimed powder too high)	• If the ratio of fine particles in powder continues to increase, consistantly add virgin powder • Empty reservoir
	• Extraction of air in booth too high	• Reduce air extraction (via filters) • Contact spray booth supplier
	• Complex shape of workpieces	• Optimize/change position of workpiece
	• Fluidization of powder coating not optimal	• Improve fluidization
	• Powder hose too long, diameter too large	• Optimize length and diameter

	• Blockage in nozzle due to sintering in spray gun, hoses, venturis • Injector venturis worn out	• Remove sintering • Check venturis and renew, if necessary
	• Lack of powder in hopper	• Refill powder coating • Check minimum level probe
	• With multiple coats and/or double coating, the first film acts as insulation. Result: charge on surface too high	• Reduce current and high voltage settings • Increase distances from spray guns to parts • Check on use of an ion conductor system (Coronastar, Supercorona)

4.8 Uneven film thickness

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Uneven film thickness distribution on workpiece**	• Not optimized spray gun arrangement in automatic booth or incorrect ratio of conveyor and reciprocation speed	• Determine the correct spray gun distances and also the ratio of reciprocation and conveyor speeds using calculation programs (e.g. Gema, Wagner, Nordson)
	• Insulating effect from initial coating	• Reduction of current and voltage settings • Increase distance between spray gun and workpiece • Use of ion conductor (Coronastar, Supercorona), if necessary
	• Heavily fluctuating ratio of fresh and reclaimed powder in hopper	• Continuous and/or regular addition of virgin powder adjusted to the optimum powder output needed
	• Uneven powder delivery	• Checking fluidization (see 2.1), injectors (or powder pumps), as well as routing, lengths and diameters of hoses
	• Complex shape of workpieces (crevices cavities, Faraday cage)	• See 2.7 (Insufficient ability to penetrate cavities)
	• Geometry of workpieces varies greatly	• Optimize spray gun and plant settings for the workpiece

4.9 Waxy appearance on coating surface - blooming

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Waxy appearance on coating surface that can be wiped off**	• Additives migrating to surface of coating	• Replace powder coating • Use suitable powder coating • Optimize curing conditions
	• Powder coating not cured	• Pay attention to curing conditions
	• Blooming effect, whitish residue on the coating surface that can be wiped off • Mostly caused by too low curing temperatures below < 140°C seemed primarily in dark polyester powder coatings *Fig. 4.9.1*	• Increase curing temperature
	• Insufficient air exchange in curing curing oven	• Improve air exchange

Fig. 4.9.1 Blooming effect

5. Deficiencies in mechanical properties and chemical resistance

5.1 Inadequate mechanical properties and chemical resistance

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Mechanical properties and chemical resistance do not meet specification**	• Powder coating not sufficiently cured *Fig. 5.1.1*	• Comply with the curing conditions of TIGER Coatings • Determine temperature curves on the individual work pieces, if necessary • Comply with data sheets
	• Unsuitable powder coating	• Request information about suitability of powder coating with respect to specific technical properties from TIGER Coatings or verify suitability yourself
	• Faulty pretreatment, unsuitable pretreatment	• Check suitability of pretreatment

Fig. 5.1.1 Not sufficiently resistant to cleaning agents

5.2 Powder chipping off substrate

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating film chipping off substrate when part is subjected to mechanical impact (blow, deformation)**	• Under-curing or gross over-curing will degrade mechanical properties *Fig. 5.2.1*	• Comply with specified curing conditions
	• Pretreatment unsuitable or insufficient *Fig. 5.2.2*	• Check pretreatment • Optimize, if necessary (see 1.1 and 1.2)
	• Scale, flash rust, white rust, dust on the workpiece *Fig. 5.2.3*	• Remove any contamination or corrosion using mechanical means prior to coating

	• No adhesion on laser-cut edges due to oxide film (applies only to oxygen laser, not to nitrogen laser)	• Remove oxide films by mechanical means, if necessary • Use nitrogen laser
	• Powder coating properties are not tailored to the application	• Use suitable powder coatings • If necessary, contact TIGER Coatings
	• High film thickness dramatically degrade mechanical properties	• Keep film thickness at <100µm, if possible except textured powder coatings
	• Poor intercoat adhesion (i.e. primer and top coat) *Fig. 5.2.4*	• Check intercoat adhesion between the two powders in advance (test panel) • If necessary abrade off first coat • Directly fired gas ovens may add to the problem
	• No adhesion of powder coating to wet paint films (e-coat, wet paint primer)	• Check suitability in advance • Abrade, if necessary
	• Inadequate pretreatment or priming of zinc substrates	• Prepare substrate correctly for powder coating
	• Contaminated workpieces	• Ensure that workpieces are clean

Fig. 5.2.1 Poor mechanical properties

Fig. 5.2.2 Pretreatment unsuitable or insufficient

Fig. 5.2.3 Scale, flash rust, white rust

Fig. 5.2.4 No or poor inter-coat adhesion

5.3 Poor scratch resistance

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Poor resistance of paint film to scratching**	• Powder coating not adequately cured	• Comply with specified curing conditions
	• Powder coating too soft and/or sensitive to scratching	• Use suitable powder coating • Contact TIGER Coatings
	• Inadequate packaging materials and/or shipping containers not suitable (marring) *Fig. 5.3.1*	• Use suitable packaging material or shipping containers *Fig. 5.3.2*
	• Incorrect and/or abrasive cleaning agents	• Use suitable cleaning agents

Fig. 5.3.1 Packaging material not suitable

Fig. 5.3.2 Use suitable packaging material

6. Issues with reclaiming of powder

6.1 Contaminations on paint surface (addition to section 3.5)

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Reclaiming causes contamination on the paint surface**	• Powder from previous production runs, dirt in coating booth, filters or cyclone *Fig. 6.1.1*	• Clean entire coating booth thoroughly
	• Powder from previous production runs in application equipment • Powder sintering in injector, hose or spray gun	• Clean application equipment thoroughly • Use individual hoses for different powder coatings, if necessary
	• After filter defective, powder is blown into the coating area	• Check after filter
	• Potential transfer of powder from one booth to another *Fig. 6.1.2*	• Clean booths carefully and without excessively high air pressure • If necessary, separate booths by using structural barriers

Fig. 6.1.1 Powder remnant or dirt in coating booth contamination

Fig. 6.1.2 Potential transfer of powder from one booth to another – cross

6.2 Poor processing properties

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Powder coating process slowed down or interrupted**	• Changes in particle size due to reclaiming	• Optimize cyclone settings • Ensure that the ratio of fresh and reclaimed powder remains consistent • Avoid excessive overspray and minimise gaps between components • Ensure consistant removal of overspray from booth

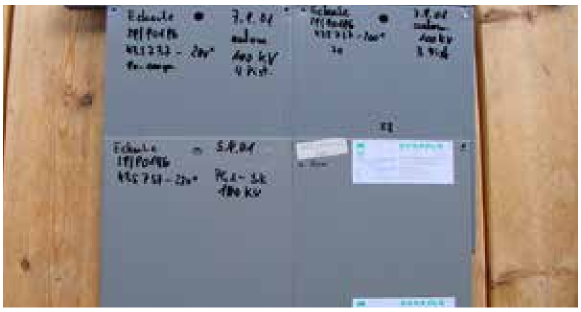
6.3 Continuous changes in shade

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Continuous or sudden changes in shade compared to master samples or the start of the coating process**	• Separation and/or changes in particle size due to reclaim operation	• Ensure that the ratio of fresh and reclaimed powder remains consistent
	• Powder contamination from previous production run in the plant	• Clean entire spray booth area thoroughly before start-up of new production
	• When delivering powder directly from the box, proper ratio of fresh and reclaimed powder is not maintained	• Use fluidized container
	• Reclaimed powder is not added consistently	• Ensure consistent ratio of virgin and reclaimed powder

7. Issues with applications of metallic powder coatings

7.1 Deviations in shade from color chart or master sample

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Result of coating not identical to original or to sample of color/effect**	• Some of the different application techniques (tribo, corona application or use of ion conductor systems greatly impact the shade/effect	• Always use the same application technology and gun settings for long-term projects • Always compare to the original (regularly)
	• Different current, voltage, air settings and distances between spray gun and work piece that vary greatly	• Always use the identical application parameters for long-term projects
	• Variations in different powder coating batches (poor batch consistancy) *Fig. 7.1.1*	• If possible, use only one batch for any specific component or object/order • Contact TIGER Coatings
	• Defective spray guns	• Check the spray guns for current and voltage
	• Inadequate grounding	• Ensure consistent grounding
	• Used powder coating does not match with color sample or color chart *Fig. 7.1.1*	• Verify that color charts or sample panel are still current • Coat a test panel prior to the powder coating job • Approve the color from a current powder coating batch
	• Film thickness too low	• Comply with the minimum film thickness specified by TIGER Coatings



7.1.1 Sample fails to match the powder coating from the outset

7.2 Variations in shade during the coating process

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Gradual or sudden changes in shade or effect**	• Powder delivery direct from the box	• Use fluidized container
	• Separation of powder coating and metallic pigments during application (poor bonding)	• Use the same application equipment • Avoid excessive high air speeds in hoses, and excessive fluidization
	• Separation of base powder coating and metallic pigments due to reclaiming *Fig. 7.2.1*	• Ensure that there is a consistent ratio of fresh and reclaimed powder • If necessary, stop reclaiming in case of very stringent requirements for consistency of shade • Use only very well bonded powder coatings
	• Change of batches during the coating process *Fig. 7.2.2*	• Only use one batch for project/order
	• Insufficient bonding of powder coating	• Contact TIGER Coatings

Fig. 7.2.1 Separation due to reclaiming

Fig. 7.2.2 Switching batches during coating process

7.3 Clouding and striping

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• **Light-dark deviations on work pieces** *Fig. 7.3.1*	• Spray gun distances to workpieces too close	• Increase distances approx. >40cm
	• Distances of individual spray guns unbalanced	• Determining the correct spray gun distances and also the ratio of lift and chain speeds using calculation programs (e.g. Gema, Wagner, Nordson)
	• Uneven powder delivery	• Check fluidization, injectors as well as lengths, routing and diameter of hose

	• Subsequent manual coating	• With metallic powder coatings, if possible, apply first coat manually
	• Charge on individual spray guns are not consistant • Spray guns may be defective	• Verification of actual settings of current and of voltage
	• Insufficient grounding of workpieces	• Ensure consistent grounding of all work pieces
	• Film thickness varies highly	• Ensure compliance with minimum film thicknesses specified
	• Powder delivery direct from box	• Use fluidized container
	• Spray gun nozzles not suitable	• Best results achieved with flat-spray nozzles for difficult metallic powder coatings try different spray nozzles
	• Air speeds from spray gun too high	• Ensure that the powder cloud is balanced • High air speeds are to be avoided

Fig. 7.3.1 Light-dark deviations on workpieces

7.4 Charging problems

Fault Profile	Potential Causes	Elimination | Experiments | Measures
• Powder is falling/sliding from the workpiece **• Charged powder not adhering to the workpiece**	• Grounding not adequate, especially with dry air in winter	• Ensure consistent grounding
	• Powder coating is not adequately charged by the spray guns	• Check spray guns, experiment with high current and voltage settings, remove ion conductor systems (Coronastar, Supercorona), contact powder manufacturer, if necessary
	• Powder coating "discharges" much too quickly on the workpiece and loses adhesion	• Contact TIGER Coatings

7.5 Processing guidelines for powder coatings with metallic effect

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ENGLISH

Metallic Powder Coatings

Application Guidelines for Powder Coatings with Metallic Effects
Data sheet 36

This data sheet is intended as a guide for the applicator, informing the user on parameters that have considerable influence on the quality of the finish. Caution must be exercised when working with metallic effect powder coatings. Prior to application, the suitability of the entire coating system must be established by comparison with the powder manufacturer's reference samples. Otherwise no assurances can be given with regard to the color or metallic effect. The following recommendations are necessary for satisfactory results:

COLOR DEVIATIONS

Powder coatings are formulated and manufactured to meet color standards: i.e. the RAL standard. Despite the stringent quality control measures exercised during production, a complete **batch-to-batch consistency** cannot be guaranteed. For exact evaluation of color/effect, upon request, the manufacturer therefore supplies production panels of individual batches. **Batch-to-batch consistency** of products supplied is comparable to that of non-metallic powder coatings. Color deviations between two batches – depending on color – may with lighter shades be at approximately 1–2 Delta E, with darker shades possibly significantly more. However, application process and equipment are also factors in the final color/effect of the coating and have not yet been included in the above values. Evaluations according to car industry standards are not admissible. An acceptance test must be performed on the actual application equipment before processing. Those color/effect variables, particularly with regard to share of **recycled powder**, must first be established via an upper and lower tolerance sample. To largely eliminate color/effect differences caused by the coating system, an entire coating job must be processed on the same coating line, without parameter fluctuations, preferably without interruptions and with consistent recycling percentages (guideline: 30%). **Manual coating** is likely to produce variations of color and/or effect due to inconsistent film thickness. Manual coating must therefore be adjusted to automatic processing with respect to color and effect. **Coating thickness** is of importance as variations will cause color/effect and gloss differences. The application of sparkling metallic effects based on bigger effect particle pigments at a too-thin film thickness may result in surface defects (e.g. specks). Therefore, **a minimum film thickness of 70 – 90 µm is recommended**. Please **contact the sales department of the powder coating producer** if in doubt.
Color/effect variations inherent to metallic coatings are primarily linked to content of metallic pigments. Generally fine flakes of metallic pigment are used. Positioning of those flakes within the applied coat determines the metallic effect and color. Experience has shown that any **parameter of application** may influence the position of the flakes and thus also color/effect. It is therefore important that throughout an entire coating job all equipment is left at precisely the same settings. Coating one entire job with a variety of equipment should be avoided, or else considered only after exact adjustments and comparisons produce identical test results with different equipment. Separate tests shall be carried out in order to determine to which extent color changes are to be expected as a result of specific component geometries.

RECLAIM

To achieve a consistent color/effect it is important for the coater to establish **a ratio of virgin and reclaim powder** and adhere to this ratio during the entire coating process. The ratio of virgin powder should not fall short of 70%. Repeated or exclusive use of reclaimed powder is not advisable. Since not all metallic effect powders are reclaim-consistent, the virgin powder percentage must be established via **upper and lower tolerance samples**. A final quality inspection for color is still highly advisable.

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APPLICATION EQUIPMENT	Different **powder coating guns, systems and spray parameters** are often the cause for varying results. It is very important to only work with nozzles suitable for metallic powder application. Depending on the type of object to be coated, powder should be applied with a flat-spray type nozzle or with an aerated impact disk, in an even cloud pattern. **Grounding** and **charging** of the powder cloud must be constantly monitored. **Interim cleaning** of the powder hoses and removal of deposits from powder guns and booths is also part of a regular process control. Metallic powder coating should exclusively be done from **fluidized powder containers**. Since metallic powder coatings react more sensitively to differing reclaim ratios, the coating should from the very beginning be at approximately 30% reclaim (initial coating without parts).
CHARGING	Generally very few metallic powder coatings are suitable for tribo application. Suitability must be established prior to a coating job. Due to the differing changing characteristics of powder coating and metallic particles not all metallic particles are transported to the part to be coated. This too can cause a variation in color/ effect. Changing from electrostatic to tribostatic charging is not permissible. With metallic powder coatings a particularly clean coating system is very important in order to avoid short-circuiting in the gun area from powder deposits. Once again the importance of constant control over the charging of the powder cloud is stressed.
GROUNDING	When working with metallic powder coatings proper grounding of equipment as well as work piece is very important. This contributes to a high degree of **color/effect consistency**.
COATING DURABILITY	Generally the durability is determined by the processing system – one or two coat. The durability of a metallic powder coating is **product-specific** and therefore we recommend consulting the powder manufacturer prior to application, with particular reference to special requirements, such as wear and scratch resistance, cleaning recommendations, colorfastness and chemical resistance. The manufacturer needs complete **information about all of the requirements** that the powder coating is subjected to in a project / application in order to give appropriate advice. This includes all materials that the coated part may come in contact with during final installation, i.e. glazing aids. In the case of materials of unknown chemical influence, tests must be performed after consultation with the coating manufacturer. This might necessitate a clear top coating to establish a barrier that prevents color/effect changes caused by those materials, to the metallic coating. Please note established 2-coat curing parameters.
CLEANING	Cleaning of metallic powder coated materials must be performed at regular intervals and as quickly as possible after they get soiled. Dried and old dirt can only be removed by scouring, which means scratching of the powder-coated surface. It is highly advisable to follow the cleaning recommendations of the manufacturer.
GENERAL RECOMMEN-DATIONS	A primer should be applied on parts that are difficult to coat, since a subsequent touch-up job may produce clouding. When both sides of a finished part must be coated, the side most visual in its final use should be coated last. The **final orientation** of curtain wall panels on a building must be established prior to coating and all panels must either be coated horizontally or vertically to achieve the same color/effect throughout a coating project. Variations in the heat-up period are to be avoided: parts of **varying wall thicknesses** cannot be coated at the same time. Please observe and consult the powder coating-instruction sheet.

Working with metallic powder coatings requires precision. All stipulations of these guidelines shall be observed. What is most important is proper communication between coater and the customer, but also between coater and coating manufacturer, to assure that all provisions are given for a quality finish.

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8. Glossary

Below is a brief explanation of the most important and common key words in the powder coating sector. Please note that these explanations are not scientific nor do they comply with the standards. Instead, they reflect the language commonly used in practice, with the focus on general understanding.

Ability to Penetrate	Ability of coating to get into corners, recesses and cavities
Abrasion resistance	Resistance of powder film to abrasive media, e.g. sand, liquid scouring cleaner, cardboard, wood, paper etc.
Absolute Filter (superfine filter)	Also final filters of coating plant for superfine particles not separated by the recycling process
Accumulations	Powder overspray that does not adhere to the workpiece and/or is left behind in the booth
Additives	Additives used by powder coating manufacturers aimed at optimizing the application or the powder coating film
Adhesion	Strength (quality) of bond (mechanical anchoring and/ or chemical compound) at the interface of powder coating film and workpiece surface
Adhesive Remnants	Residues that cannot be removed by pretreatment; resulting in surface imperfections and problems with adhesion
AGA additive	(AGA = Outgassing additive) Additive to reduce the occurrence of outgassing in the powder coating film
Agglomerations	Sintering of powder in the delivery system, application equipment or in recycling system
Anodic Oxidation	Surface finish for aluminum, creating a (colored) aluminum oxide film and its (see anodizing)
Anodizing	Anodic oxidation of aluminum, also referred to as anodizing; can be used as a pretreatment of aluminum without sealing the oxide film
Application	Technology, spray guns, charging device, injectors, hoses, etc. directly needed for powder coating
Atomizer Air	To support the spray cloud, also to prevent sintering at Corona needle and impact disc
Automatic System	Application in conjunction with automatic spray guns (arranged in fixed positions or on reciprocators or robot)
Binder	Primary component of powder coating, resins like epoxy, polyester, PUR or acrylic
Blisters	Imperfections in powder coating film caused by drops of water, salt and/or oil residues, etc.
Blooming Effect	Formation of a white, waxy film on the powder-coated surface that can be wiped off; occurs during cross-linking at the lower temperature range
Booths	Cabinets fitted with equipment for coating (usually made from steel, stainless steel, plastic)
Bubbling	Outgassing hrough the powder coating especially with very high film thicknesses (starting at 150 µm; particularly TGIC-Free and in IR ovens)
Buchholz Hardness	Test procedure to determine the resistance of powder-coated surfaces to pointed loads; DIN 53 153

Bulk powder Conveying	Method for transporting powder to the coating plant
Cavities	Interior spaces that cannot be reached with powder coating (see Faraday cage), such as profile pipes, welded structures
Chalking	Degradation of resin and pigments being bleached by UV light or chemicals
Charge	Electrostatic charge of powder by means of Corona or Triboelectric charge
Chipping	Powder flakes off the workpiece under mechanical loads (e.g. When creased, cut or milled)
Cleaning	Cleaning the plant when switching colors: a necessary evil of powder coating
Clot	See powder splotches
Clumping	Agglomeration of powder coating in carton due to vibration, inflow of water, Corona charge or heat
Color	Sensation transmitted through the eye which is triggered by light sources and light reflexes
Color Deviation	Difference of the shade between original and sample (color chart to workpiece or workpiece A to workpiece B)
Color Standard	Official color charts representing industry norms (RAL, NCS, Pantone, RAL-Design, Sikkens, HKS, British Standard, etc.)
Contamination	See Dirt
Conveying Air	Required air for transporting powder coating to the spray gun, increase conveying air = increased powder volume
Conveying Hose	For transporting the powder-air-mixture from powder container to the spray gun
Conveyor	Delivery method for transporting workpieces through the coating plant, see also Conveyor
Conveyor	Transport rail for transporting workpieces (powered or manual operation)
Conveyor standstill	Very costly stoppage of conveyor due to potential faulty coating (plant failure)
Corona Charge	See Corona Charge
Corona charge	See E-Static
Corrosion	Reactions of a metallic material to its environment resulting in a measurable change to the material and functional impairment
Cracks	Surface imperfection of coating; cracking as a result of insufficient cross-linking after mechanical stress
Craters	Surface imperfection extending through the powder coating film down to the workpiece surface
Cross-linking	Irreversible chemical reaction of thermoset plastics
Curing	Complete cross-linking of the powder coating; process requires conforming to the recommended curing schedule
Cyclone	Facility to return overspray in the powder cycle; always needs a final filter (See Filter)
Deionized Rinse	Final pretreatment rinse with fully desalinated water (max. 30 µs)
Dirt	Primarily contributes to a lower coating quality (dust, fibers, shavings)
Dissolving partially	Softening the powder coating film with solvent

Distance I	Distance of spray gun to work piece
Distance II	Distance between workpieces
Dosing Air	Supply air for controlling the powder volume in the spray gun; increase in dosing air will result in less powder coating and a less dense powder cloud
Drawing Agent	Oils and grease used as lubricants when shaping (extruding, stretching) profiles
Drop Formation	Sagging of powder coating at the bottom edges in the liquid stage
Dry -Off Oven	Equipment for drying the workpieces coming from wet chemical pretreatment at 70 - 130 °C
Edge Coverage	Powder accumulation at workpiece border
Edge Deposit	Accumulation of powder coating at edge of the workpiece (see Edge deposits)
Electro Galvanizing	Electrodeposition of corrosion protection film (zinc) of approx. 5-15 µm from aqueous, acidic or alkaline zinc electrolytes
Environmental Influences	Climate and environmental parameters existing in the coating room

E-Static	Electro-static charging of powder particles in the area of a Corona discharge; its high voltage is generated with a cascade in the spray gun or supplied to it via cable
Falling off	Powder fails to adhere to the workpiece: it falls off; see also snowboard effect
Faraday Cage	Physical phenomenon, screening of electric fields in case of closed designs
Filiform Corrosion	Thread-like formation of metal oxides (no Al2O3) on aluminum that appear as thin, clearly defined threads under the powder coating film
Film	Undesirable, effect on surface of coating
Film Thickness	Thickness of powder-coated film
Filter	Used to separate the powder-air mixture (overspray) (plate, bag or cartridge filter)
Final Filter	See Absolute Filter
Fines	Powder coating particles (<10 microns)
Fish Eyes	See cratering

Flow	Smoothness of powder coating film
Fluid Bed	Air-permeable sintered material in powder reservoir; the powder turns into fluid (fluidized) as a result of inflowing air (0.3 - 0.5 bar)
Fluidization	Fluidizing powder coating in the fluid hopper or powder container using compressed air
Freshwater Rinse	Rinse step within pretreatment for removing cleaning chemicals with tap water
Friction Charge	See Tribo
Galvanizing	Application of a corrosion protection film (Zn) on steel (hot-dip galvanizing, galvanizing or Sendzimir galvanizing)
Gelled Particles	Resin particles in powder coating
Glass-transition temperature	Transition of powder coating into liquid phase
Gloss	Reflectivity of a surface, in case of powder coating glossy to flat matte
Grain size and/ or spectrum	Distribution of powder particles by size and proportion

Grease Contamination	Residues on workpiece not removed by the pretreatment (grease, drawing lubricants, etc.)
Ground	See Substrate
Grounding	Contact of workpiece and system parts with electrical earth
Gum	Dried-up grease and oil residues
Hanger	For positioning workpieces during the coating process
Heating	Types of heating direct/indirect gas and oil, electric, IR
Heat-up Rate	Time needed to heat-up the object to the required temperature
High Voltage Discharges	Star-shaped surface tension craters caused by inadequate grounding
Hose	See Delivery Hose
Hot-Dip Galvanizing	Corrosion protection, application of zinc film >80µm, using the dipping method at about 400 °C
Immersion Pretreatment	Pretreatment of workpieces, not always suitable for hollow parts
Incompatibility	i.e. chemical reaction
Injector	Venturi pump for powder delivery
Insulation of workpieces	Inadequate grounding caused by excessively high films on workpiece or suspension gear
Intercoat Adhesion	Adhesion between first and second coat
Ionization charge	See E-Static
Maintenance	Required to keep optimum performance level of all equipments
Material Selection (powder coating)	Powder coating suitable for the intended application (exterior and/or interior grades, effects, etc.)
Material selection (substrate)	Materials suitable for the intended application (steel, aluminum, glass, MDF)
Mechanical Values	Required powder coating properties (test acc. to DIN, e.g. mandrel bending or impact test, Erichsen cupping, etc.)
Metal shavings	Processing residues on workpieces (cutting, grinding, milling, drilling, etc.)
Metallic Pigments	Effect particles in powder coating
Metallic powder coatings	Effect powder coatings with a surface that looks like shiny metal (pearl gloss, glitter, glimmer, etc.)
Metamerism	Effect of color science, difference in shade at various lighting scenarios
Moisture	Excess of humidity
Multiple Coats	Application of additional powder coating layers
Nozzles	Various attachments on the spray gun (impact discs, finger nozzles, round and flat spray nozzles)
OGF-Additive	Floating additives for powder reducing outgassing from substrate
Oil Carbon	Burnt oil or grease on the workpiece, with welding processes “burnt-in”
Oil Remnants	Residues on workpiece not removed by pretreatment
Opacity	Ability of the powder to completely cover the natural shade of a substrate with a reasonable minimum film thickness
Orange Peel	Waviness (short or long) on powder-coated surface

Outgassing	Volatiles in substrate escaping through the melting powder film (water vapor, air, gases, etc.) and causing surface imperfections in the powder coating film
Oven	See Powder Dryer
Oven Types	Differences in terms of design and heating, e.g. chamber oven, continuous oven, forced-air oven, IR oven (see also heating system, quality of gas)
Over-curing	Excessively high object temperatures or curing time in oven
Oversized Particles	Powder particles larger than the mesh size of the screen that are separated during the screening process
Overspray	Powder coating not taken up by the workpiece during application
Oxide Film	Corrosion residues on workpiece
Paint Adhesion	See Adhesion
Paint Film	Desired formation of the surface of the cross-linked powder coating
Pickling Solution	Water-based cleaning method for metal removal that takes off oxide films, rust, contamination and foreign particles
Picture Frame Effect	Higher powder-coating film thickness at the edges of the workpiece due to high field strength at edges, e.g. notable with fine-texture and metallic powder coatings
Pigments	Responsible for giving color
Pimples	Bumps in powder-coated surface
Pinholes	Surface imperfection, formation of fine pores in powder coating film
Pinholes	Surface imperfections, bumps in powder coating film (see pimple)
Plant Service	Necessary upkeep of the plant to be performed regularly by the manufacturer
Plasticizer	Additives used for production of plastics
Polishing Marks	Mechanical surface treatment; may be detected through powder coating film
Powder	Dry thermosetting plastics in powder form
Powder Center	Compact device for delivering powder from container with integrated cleaning system
Powder Circulation	Reuse of reclaimed powder coatings
Powder Delivery	Transport of powder coating from reservoir to the spray gun
Powder Curing Oven	Needed for cross-linking and curing the powder coting film (see oven types)
Powder Hose	See Delivery Hose
Powder Splotches	Agglomerates of powder coating on powder-coated surface
Pressure Points	Visible indentations in the powder coating film caused by excessive compressive loads, especially with high film thickness
Pretreatment	Cleaning and conversion film formation with wet chemical process (dipping, spraying) or with dry method, e.g. sandblasting
Quality of Gas	Gas used for heating (natural gas, city gas, butane, propane); the decisive factors are thermal value and composition
Reclaiming	Facilities for re-use of overspray

Release Agent	Sprays used in metal processing to remove residues, those containing Silicon not suitable
Release Agent II	Liquid used in casting to reduce adhesion between casting and mold
Resistance	Consistent resistance as required, e.g. to chemicals, weather or UV light
Resistance to Solvents	Powder coating resistance to various solvents
Retention time	Time of coated workpieces in powder dryer
Retraction Effect	See Wetting
Return Point	Top and bottom return point of spray guns with lift frames
Rinsing	Removal of pretreatment residues using fresh or deionized water with spraying or dipping
Running Away	Retraction of powder film from the edge of the workpiece, especially with workpieces having sharp edges (burr)
Runs	Powder-coated film dripping over the workpiece (i.e. not purely wet-paint-specific)

Rust	Corrosion products created as a result of corrosion of steel or other metals
Safety Regulations	The plant engineer and operator must comply with domestic safety standards
Salt Residues	From pretreatment not removed by rinsing
Screen Tear	Damage to the screen may result in oversized particles getting into the powder and cause disruptions in the flow
Screening Analysis	Determination of grain distribution (see Grain Size)
Screening Equipment	Screening the powder coating as part of reclaiming; can also be done separately (screen mesh at least 200 µm)
Sensitivity to scratching	Resistance of powder-coated surface (see abrasion resistance)
Shade	Designation of color, see color standard
Shavings	Fine, distracting particles from chipping and/or cutting production (metal, wood or plastic)

Short Circuit	Uncontrolled (current) contact between high voltage and ground
Sinusoidal Flow	Spray pattern with spray gun arrangement in lift frames influenced by conveyor and lift speed
Snowboard Effect	Powder fails to adhere to the workpiece: it slides off in sheets, see also trickle-off effect
Spikes	See Pinholes
Splotches	Agglomerations of powder coating in powder coating film (see also attachment)
Spray Gun	Charging and spraying device needed to apply the powder coating (Corona charge / Tribo)
Spray Scrubber System	Pretreatment of workpieces via spraying method (approx. 1.5 bar), mechanical cleaning effect
Spraying	Application of powder coating by means of spray guns onto workpiece
Static discharge	High-energy discharge off plastic surfaces which carry an electrical charge may ignite powder-air mixtures.

Striping	Uneven film thickness and appearance due to irregular sine curve
Substrate	Workpiece, material to be coated (steel, aluminum, stainless steel, glass, plastic, MDF)
Subsurface Corrosion	Formation of corrosion due to humidity and salts (osmosis) between powder coating and part
Surface imperfections	Impairment of visual properties of the powder-coated film
Sweep blasting	Sandblasting the work pieces, mechanical fine-grain removal of corrosion films, especially from hot-dip galvanized parts, max. 30 µm surface roughness
Temperature Curve	Increase and decrease of object temperature during the cross-linking process in the oven
Textures	Surface effect, in powder coatings can be rough or fine texture
TGIC (Triglycidyl isocyanurate)	Hardener system for polyester powder
TGIC-Free	Alternative hardeners to previously used TGIC
Thermoplastic	Plastics that can be melted and processed again when heated
Thermosetting Plastics	Irreversibly cross-linked plastics, cannot be re-melted by heating
Tribo charge	Powder particles are positively charged using friction (PTFE rod or pipe) and transported to the object
Ultrasound Screen	Used for sieving virgin and/or recycled powder coating
Use of Adhesives	Very broad spectrum, check for suitability prior to use
Voltage	In this case: High voltage electricity needed for charging
Wall Thickness	Thickness of workpiece material
Weld Points	Surface treatment, may be visible through powder coating film; problem with oil carbon, especially if processed with an angle grinder
Wetting	Adhesion of powder coating on workpiece, prerequisite for adequate adhesion; requires suitable pretreatment
Workpieces	See Substrate
Wrap-around	Powder coating build-up on the back of the workpiece
Yellowing	Change in shade due high temperatures or time in oven and/or due to gas oven using direct heat

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Proper use
This manual is intended to provide with the relevant reader and user with a tool to clarify major sources of errors in the individual application stages and to allow these error sources to be rectified as comprehensively as possible. Under these circumstances quoting from the relevant documents for your own needs is permitted. In these circumstances it is permissible to quote for one's own purposes from these documents.

Despite utmost diligence in creating this manual, we cannot assume liability for correctness of the information and potential errors.

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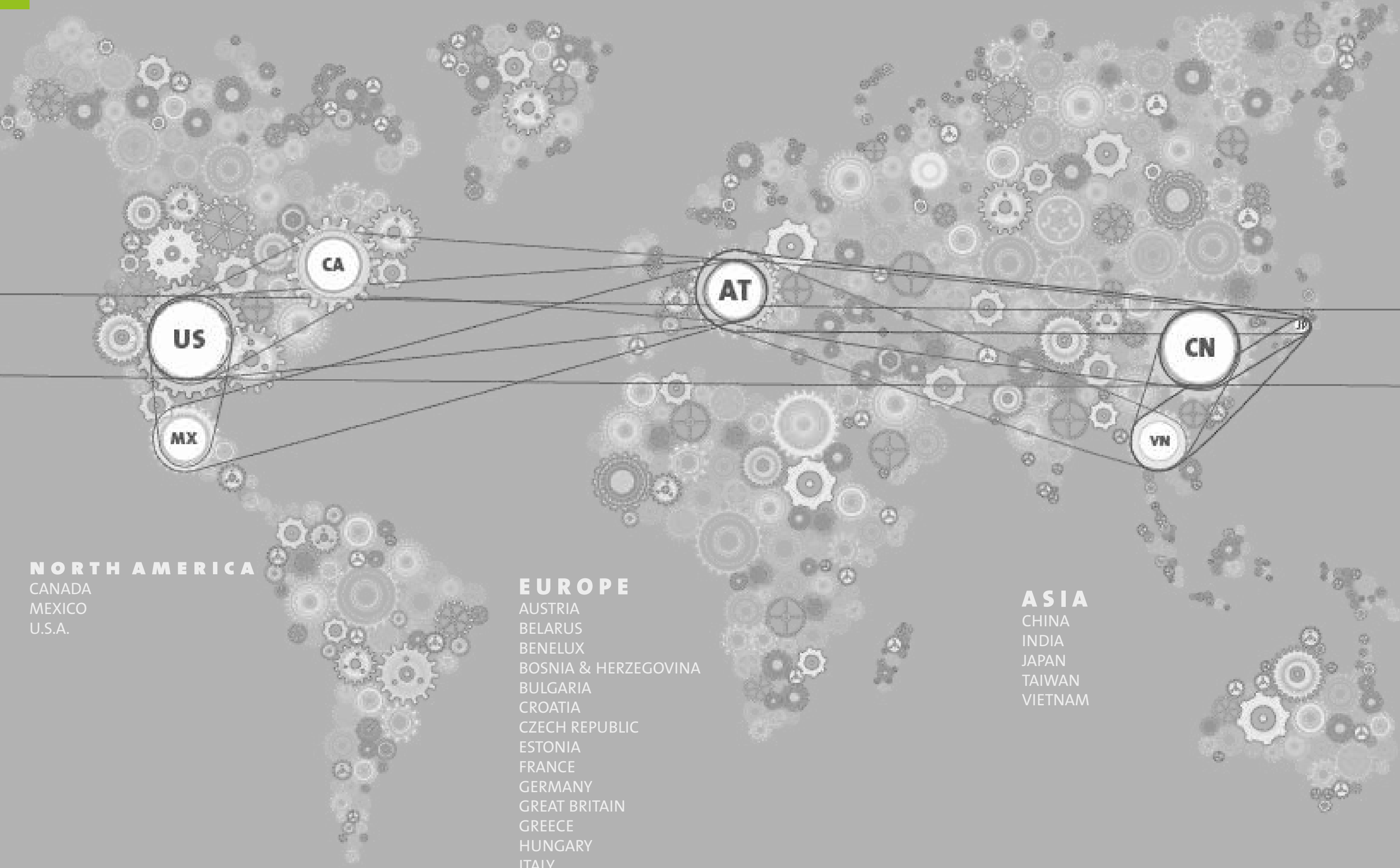

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