Choosing Replacement Coatings

- Several trivalent and no-chrome options are available
  - – Trivalent chromates
  - – Trivalent with a sealer/topcoat
  - – Organic & Inorganic Coatings (chrome free)
  - – Paint (lead free)
  - – Alternative Metallic Alloys
- Cost dependent on selection of a process (chemical supplier) and **applicator** (plating/finishing shop)

Zinc-flake coatings

- Major coating suppliers
- Material specifics
- Methods of application
- Dip-spin specifics and best practices when applying these coatings to small parts.
- Issues experienced by OEMs when converting from conventional/traditional materials.

Zinc-flake coatings suppliers

- Dorken MKS Systems
- The Magni Group
- Nippon Dacro Shamrock (Japan)
  - Metal Coatings International (North Am.)
  - Dacral (Europe)
- Units Coatings (recently acquired by Atotech)

General comments about zinc-flake coatings

- The materials are normally licensed by the materials supplier to qualified applicators (many times the applicator must receive approval from the OEM as well)
- The materials are generally either water born or solvent born
- The materials can be applied over a variety of substrates- such as steel, stainless steel, aluminum, zinc die castings
- It is common to apply combinations of coating materials to achieve the desired coating system attributes for the specific application. (This is actually one the benefits of zinc-flake coatings).

Types of products these coating materials are used for

- Fasteners, springs, stampings, clips
- Hose clamps
- Fuel filler pipes
- Fuel tanks
- Brake lines
- Muffler/under hood/under body
- Brake rotors/drums/calipers
- Seat belt components
- Door lock components

(Some) Properties of zinc-flake coating systems

- No hydrogen embrittlement – when applied over properly prepared surfaces
- Consistent torque-tension qualities on threaded parts
- Corrosion resistance meets/exceeds all automotive requirements. (ASTM B117)
- Bimetallic corrosion resistance can be exceptional
- It's possible to paint and electro coat over different materials
- Good ductility can achieved
- Electrical conductivity is possible
- Performs well in cyclic corrosion tests (such as GM 9540P)
- Heat resistance is also achievable with many of these coating materials
- It's possible to apply these coatings over zinc and zinc-alloy plated materials – creating a unique – highly corrosion resistant finish.

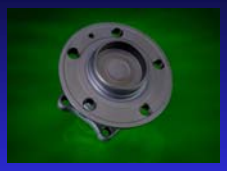
Application Methods/Advantages

- Complete range of application-technologies:

DIP-SPIN
DIP-DRAIN
SPINCOATING
SPRAY-COATING

- No hydrogen-embrittlement by the coating-process
- Good flow properties = easy to apply
- Excellent wetting and penetration
- Low curing temperatures

Dorken **Application Techniques** - Spray Coating



Use
- Even coating thickness req'ed
- Coating a specific area of a part
- Complex formed metal parts

Application
- HVLP-Spraying
- Electrostatic Spraying with high rotation nozzle
- Electrostatic Spraying with specially designed spray pistols

Application examples
- Side door impact bars, B-Pillars, A-Pillars, Bolts > M20
- Larger wheel bearings, brake rotors and drums

Advantages of dip spin coating

- Economical method for bulk processing small parts – i.e. fasteners, stampings, and springs
- Repeatable (Especially for threaded parts)
- Well suited for high production coating
- Transfer efficiency is high (normally over 98%)
- Possible to efficiently combine multiple combinations of coatings.

Issues Created by Dip Spin Processes

- Filled recesses/cupping areas
- Excess coating/build-up on threads
- Problems with small parts (M6 or smaller)
- Thread nicking
- Introduction of foreign material
- Cannot process nylon insert Lock Nuts or parts with high flat surface area (i.e. flat washers)
- Caution should be used on large/heavy parts
- Parts that tangle or nest together

Dip Spin Application Methods

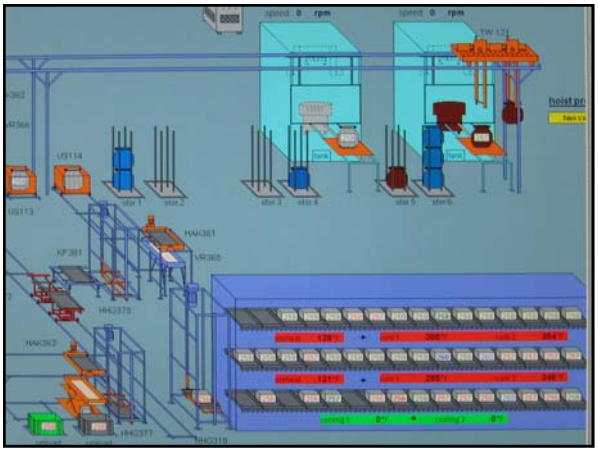
- Keys to the process
  - Control of viscosity
  - Emptying recesses/cupping areas
    - Tilting
    - RPM
    - Reversing
  - Curing
    - Temperature
    - Re-orientation during cure
  - Repeatability/reproducibility

Recent Innovations

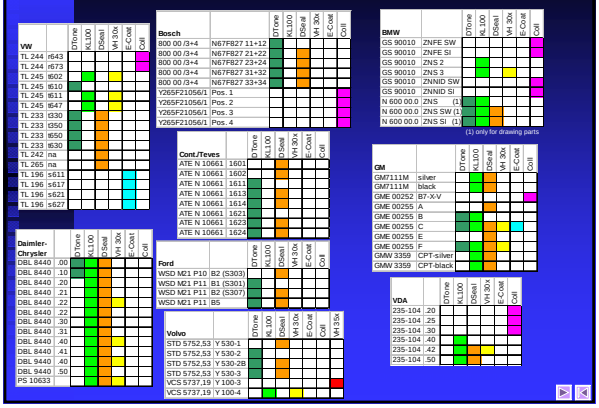
- Complete computer control by customer part number (unique recipe by part). This also results in complete historical collection of data by part as well
- Inspections of coating baskets after XX cycles
- Required operator acknowledgements of inspections of load chutes/hoppers, empty baskets and baking trays before introducing a new lot (resulting in a reduction of foreign material)
- Gentle material handling during transfers from chutes and baking trays
- Reduction in labor – due to continuous processing – including mistake proofing in multi-coat processes

Continued

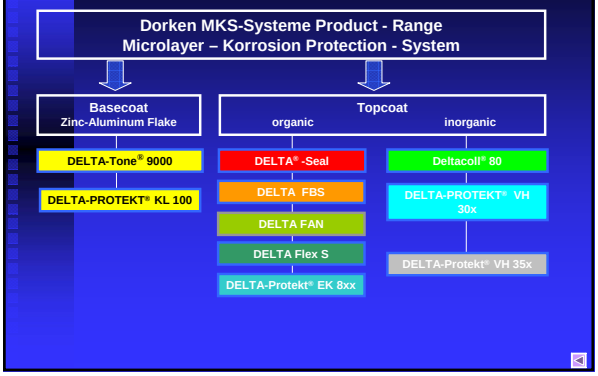
- Required cooling cycle – resulting in part temperature back to room temp prior to next coat
- Jacketed paint pots are cooled and temp controlled automatically. Pots also have a unique "electrical pin" configuration for each pot. This allows the software to acknowledge the correct paint is available for the recipe that is in process.
- Paint room itself is also temperature controlled and regulated not to exceed 78 deg. F.
- Paint room is surrounded by walls from floor to ceiling to capture fugitive VOC's
- Regenerative Thermal Oxidizer (RTO) is employed to destroy VOC's



Dorken MKS Global automotive standards



Products - overview



DELTA® -TONE / DELTA-PROTEKT® KL 100 Description

Multiplication of the corrosion-resistance in comparison to electroplated zinc

DELTA® -TONE / DELTA-PROTEKT® KL 100 Description

- inorganic Zinc / Aluminum-Flake-Basecoat
- for steel substrates
- non electrolytical applied
- specified according to ISO 10683
- dry film-thickness 5-15µm
- silver-colored
- Basecoats are conductive

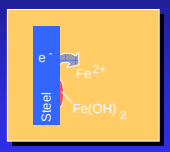
DELTA® -TONE / DELTA-PROTEKT® KL 100 Properties

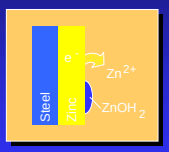
- cathodic protection for all kinds of parts (fasteners ≥M6)
- excellent prevention of ground-metal corrosion (red rust) by

  sacrificial galvanic corrosion protection
  barrier-effect of overlapping zinc – and aluminumflakes
  self healing-effect (migration of zinc-corrosion-products)
- good heat-resistance
- good resistance against oil, gasoline, organic-solvents, brake-fluid

DELTA® Tone 9000 DELTA-PROTEKT® KL100

Mechanism of corrosion protection





DELTA® -TONE / DELTA-PROTEKT® KL 100 Properties

Suitable for high-strength Steel

No risk of hydrogen - induced stress cracking corrosion

Low curing temperature (180 - 240 °C / 356 - 464 °F) ⟶ no danger of structural changes

DELTA-PROTEKT ® VH 300 topcoats Description

- Water-based, inorganic silicate-based topcoat
- Engineered for use on DELTA®-TONE 9000 or DELTA-PROTEKT® KL 100
- Dry-film coating-thickness 2 to 3µm
- Transparent
- Available with internal lubricants

DELTA-PROTEKT ® VH 300 topcoats Properties

- topcoat for a wide range of parts
- good suitability for bolt-washer assemblies
- good suitability for recessed parts
- increase of corrosion-resistance by barrier-effect
- good resistance against chemicals like acids, basics, cleaners, oils, gasoline etc.
- high-temperature-resistance >200°C / >392°F

DELTA - SEAL® topcoats Description

- organic high crosslinked epoxy topcoat
- Use on top of: DELTA-TONE, DELTA-PROTEKT KL 100, alloyed / unalloyed and zincphosphated steel electroplated and mechanical zinc, aluminum
- dry film thickness 5 – 10µm
- several colors available
- available with integral lubricants

DELTA - SEAL® topcoats Properties

- topcoat for all kinds of parts (fasteners ≥ M6)
- increase of corrosion-resistance by barrier-effect
- increase of resistance against industrial climates (Kesternich and analogue tests, i.e. ISO 6988)
- reduction of galvanic corrosion
- good resistance against chemicals like acids, basics, cleaners, oils, gasoline etc.
- temperature-resistance 150°C / 302°F

DELTACOLL® topcoats Description

- inorganic, silicate and titanium based sealer
- For use on top of: zinc / zinc alloy electroplated + passivation
- Dry-film thickness 2-4µm
- Available in black and transparent
- Available with integral lubricants

DELTACOLL® topcoats Properties

- topcoat for all kinds of parts (fasteners < M6 possible)
- increase of corrosion resistance by sealing effect
- resistance against chemicals like acids, basics, cleaners, oils, gasoline etc.
- high temperature-resistance up to 200°C / 392°F
- passivation film is sealed – so it's insensitive to a temperature of up to 150°C / 302°F
- Lubricated product meets coefficient of friction range of the VDA

Zinc flake-Systems Suitability for substrates

System	Steel	High-Strengh-Steel (> 1000 N/mm²)	Aluminium	Stainless Steel
DELTA®-TONE 9000	++	++	o	o
DELTA®-TONE 9000 + DELTA®-SEAL	++	++	++*	o
DELTA®-TONE 9000 + DELTA-PROTEKT® VH 30X	++	++	+*	o
DELTA-PROTEKT® KL 100	++	++	o	o
DELTA-PROTEKT® KL 100 + DELTA®-SEAL	++	++	++*	o
DELTA-PROTEKT® KL 100 + DELTA-PROTEKT® VH 30X	++	++	+*	o

* Sacrifical protection of Al

+++ = exceptionally well suited ++ = very well suited + = well suited
o = conditionally suited - = unsuited

Zinc flake-Systems corrosion-protection

System	Min. Dry-film-thickness (Basecoat) [µm]	corrosion-resistance [hrs]
DELTA®-TONE 9000	8 12	480 960
DELTA®-TONE 9000 + DELTA®-SEAL	8 + 6 12 + 6	600 >1000
DELTA®-TONE 9000 + DELTA-PROTEKT® VH 30X	8 + 2 12 + 2	600 >1000
DELTA-PROTEKT® KL 100	8 12	600 >1000
DELTA-PROTEKT® KL 100 + DELTA®-SEAL	8 + 6 12 + 6	>720 >1000
DELTA-PROTEKT® KL 100 + DELTA-PROTEKT® VH 30X	8 + 2 12 + 2	>720 >1000

Zincflake-Systems temperature - resistance

System	temperature-resistance
DELTA®-TONE 9000	150°C
DELTA®-TONE 9000 + DELTA®-SEAL	150°C
DELTA®-TONE 9000 + DELTA-PROTEKT® VH 30X	150°C
DELTA-PROTEKT® KL 100	300°C* 180°C
DELTA-PROTEKT® KL 100 + DELTA®-SEAL	260°C* 180°C
DELTA-PROTEKT® KL 100 + DELTA-PROTEKT® VH 30X	300°C* 200°C

* Tested per Ford-requirement – temperature-stress duration: 12h

Zinc flake-Systems Overview Properties

System	corrosion-resistance	temperature-resistance	chemical resistance	color
DELTA®-TONE 9000	+++	+	○	silver
DELTA®-TONE 9000 + DELTA®-SEAL	+++	+	+++	silver, black colors
DELTA®-TONE 9000 + DELTA-PROTEKT® VH 30X	+++	+	+	silver
DELTA-PROTEKT® KL 100	+++	+++	○	silver
DELTA-PROTEKT® KL 100 + DELTA®-SEAL	+++	+++	+++	Silver, black colors
DELTA-PROTEKT® KL 100 + DELTA-PROTEKT® VH 30X	+++	+++	+	silver

+++ = exceptionally well suited ++ = very well suited + = well suited
o = conditionally suited - = unsuited

Sealing-Systems corrosion protection

Saltspray-test 240 hrs acc. to DIN 50021-NSS

Zn (8µm) + passivation Cr III

Zn (8µm) + passivation Cr III+ DELTACOLL® 80 GZ

- DELTACOLL® fulfills the requirements of specifications like: GMW 3044, GME 00252, DBL 8451, VW-TL 217, VW-TL 244 and of several other OEM / TIER-suppliers

Sealing-Systems corrosion protection

Salt spray-test 840 hrs acc. to ASTM B-117

Zn + passivation Cr III + DELTA®-SEAL

Galvanic corrosion - protection

DELTA-PROTEKT KL 100 + DELTA-SEAL

Zn – yellow chromate

low Average Pit Volume < 2mm³

high Average Pit Volume > 700mm³

OEM Conversion Issues

- Corrosion Resistance
- Torque Tension Requirement
- Color and Appearance
- Part Performance
- Specification Reduction
- Spare Parts
- Carry Over Parts
- Part Number Changes
- Test Methods
- OEM acceptance/recognition
  - Global availability

Thank you

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