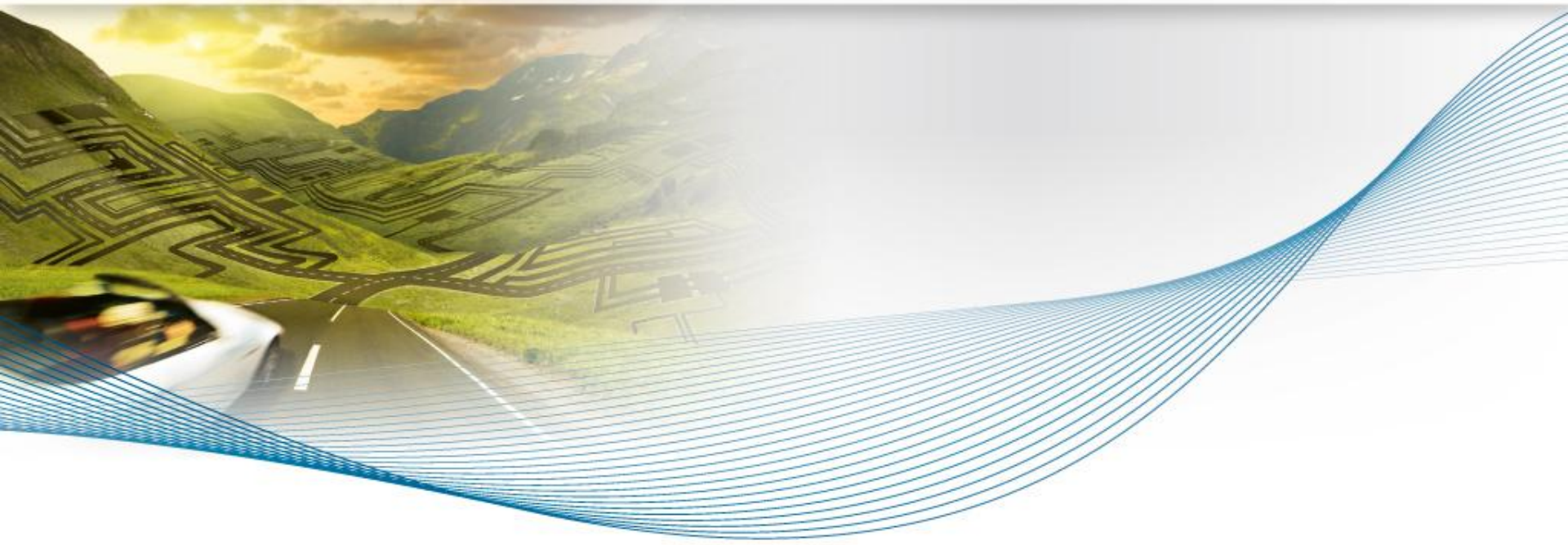

The LDS Process: Exploring New Avenues with Coatings

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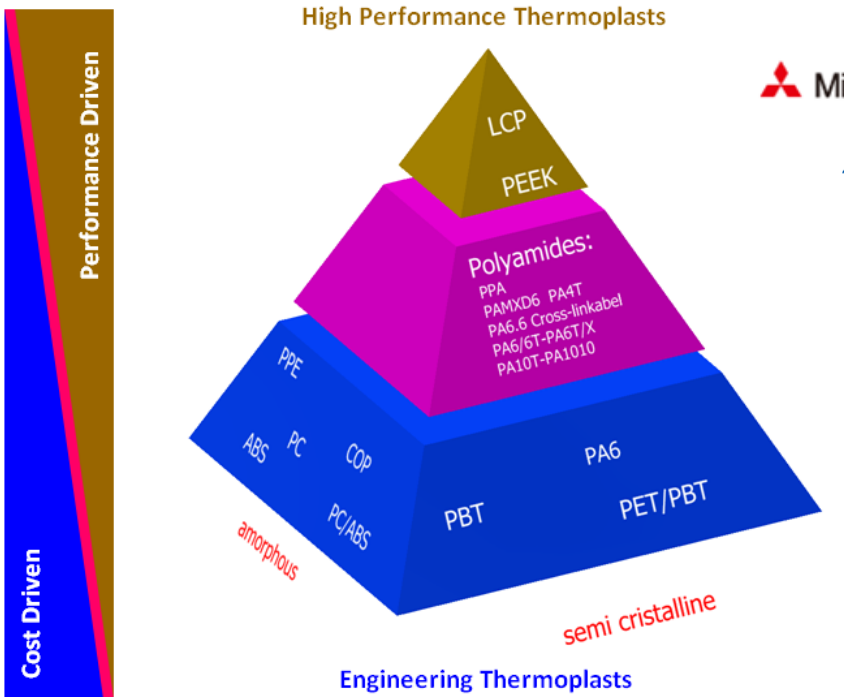
11th International Congress **Molded Interconnect Devices**, 24th-26th September 2014, Nuremberg-Fuerth, Germany

LDS – Laser Direct Structuring

LPKF Laser & Electronics

Patented LDS process for the production of three-dimensional molded interconnect devices (MIDs)



Mitsubishi Engineering-Plastics Corporation

BASF The Chemical Company

sabic

PTS

EMS

RTP Company Imagineering Plastics

DSM

Ticona

EVONIK INDUSTRIES

Ensinger

LANXESS Energizing Chemistry

SINOPLAST

PolyOne

PREMIX

ZEON CHEMICALS

KINGFA

STYRON

LG Chem

LK ENGINEERING PLASTIC
LUCKY ENPLA CO., LTD

Granulates → **1. Injection molding** → **2. Structuring** → **3. Metallization**

LDS Coatings

Why use coatings with LDS capabilities?

- Freedom of choice regarding base material

  → Prototyping

  → Partial coating

- Enables to use metal substrates for LDS, for example:

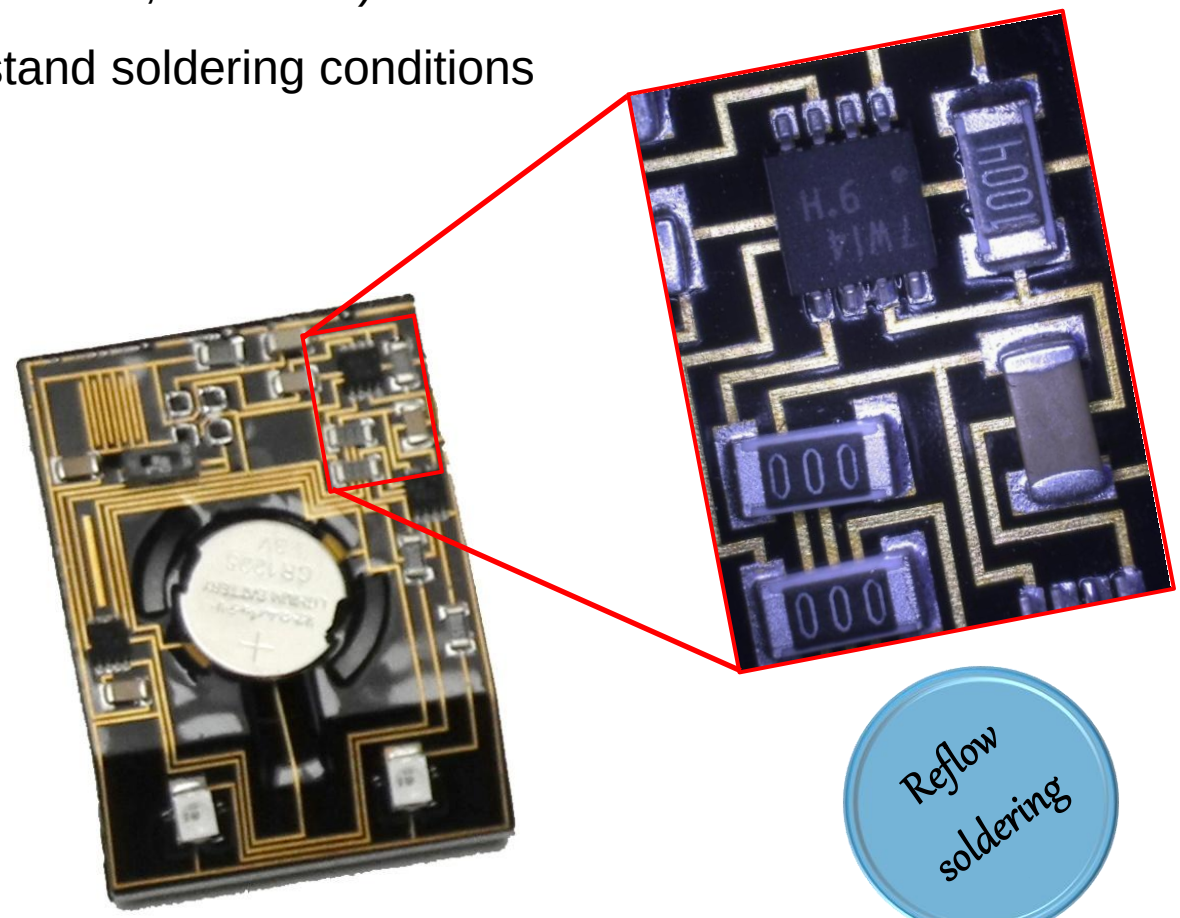
  → LED applications: heat sink

  → Electronics on metal parts

LDS-Paint and ProtoPaint LDS

- LDS Paint and ProtoPaint LDS can be used for (lead-free) reflow soldering at 260 °C
- Shear force*: **~82 N** (average value; out of 15)
- Base material needs to withstand soldering conditions

1. Coating
2. Curing
3. Laser-Structuring
4. Metallization (Cu/Ni/Au)
5. Assembly
6. Reflow soldering

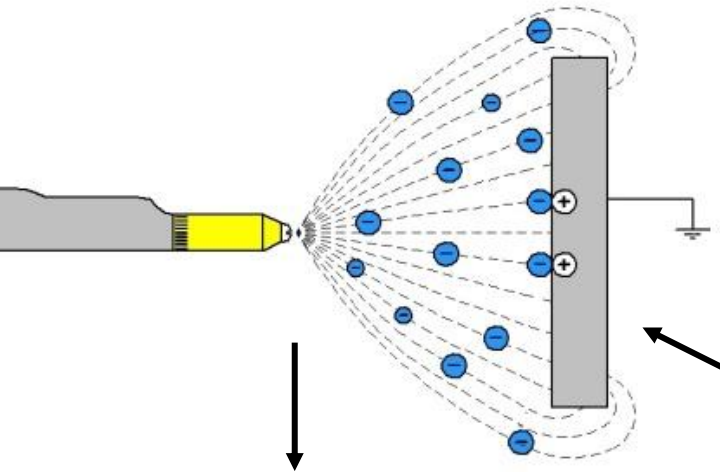


*Convection, CR1206, SAC305

What is powder coating?

- Free-flowing, dry powder
- Applied by electrostatic spraying on electrically conductive materials
- After spraying, the powder coating is cured in an oven
- In the oven: coating melts and chemically reacts → result: closed, smooth coating layer

How Are Powder Coatings Applied?



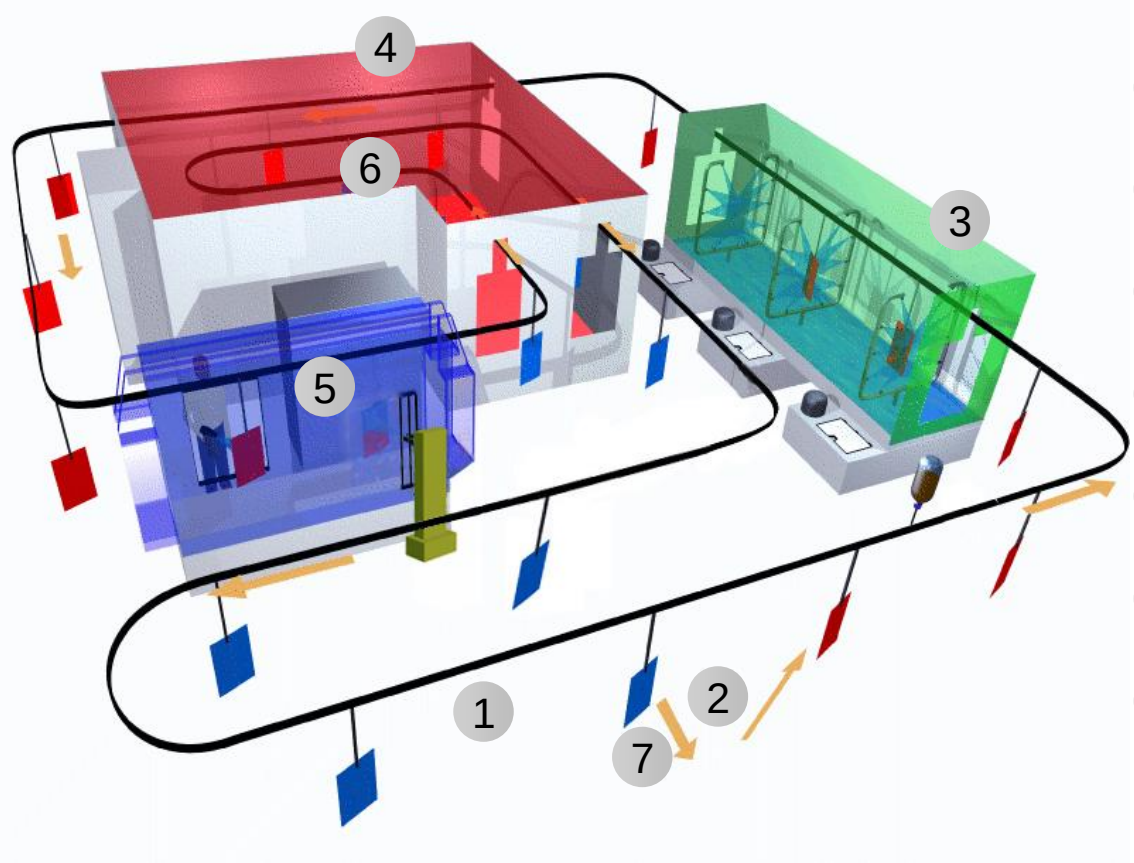
- Positively charged substrate
- Powder particles directed by electric field
- Negatively charged powder adheres to substrate until curing

Conductive substrates (aluminum, steel, brass, conductive thermoplastic materials)

6-Axis powder coating robot

source: MS Oberflächentechnik AG

Typical Powder-Coating-Line



1. Overhead conveyor
2. Assembly station
3. Wet cleaning station
4. Drying station
5. Powder coating station
6. Baking station
7. Finished parts

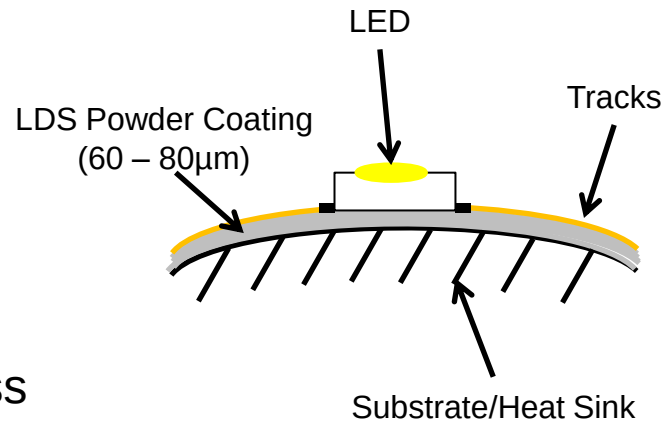
Advantages of Powder Coatings

Several advantages of powder coatings over liquid coatings:

- Powder coatings do not emit volatile organic compounds (VOC), no solvents needed.
- Powder coating overspray can be recycled and thus it is possible to achieve nearly 100 % use of the powder.
- It is easier to coat complex shaped parts with powder coating.
- Full layer thickness achievable in one step.

LPKF LDS PowderCoating

- White LDS PowderCoating
- LDS additive is already in the powder
- Electrostatic spraying
- Different electrically conductive substrate materials: metal, plastics,…
- After coating and curing standard LDS process
- Insulating layer (>55µm)
- Appropriate for reflow soldering at 240 – 270 °C



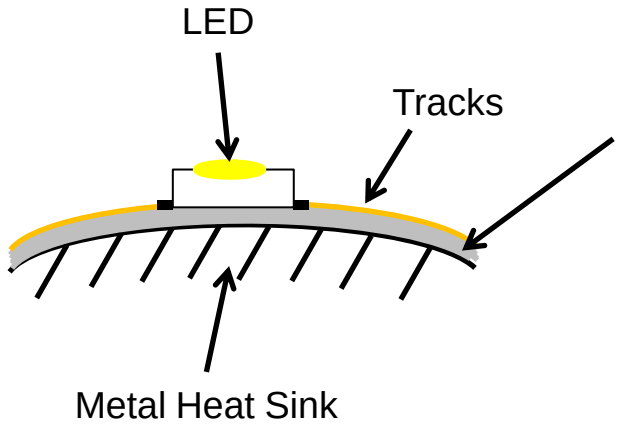
LPKF LDS PowderCoating

	LPKF LDS PowderCoating PU 100	LPKF LDS PowderCoating PES 200
Base	Polyurethane	Polyester Resin
Color	White, glossy	White, matt – silk matt
Curing Temperature	20-25 min @ 200 °C	10-15 min @ 200 °C
Max. temperature for reflow soldering	270 °C (5s)	240 °C (5s)
Dielectric strength[1]	77,7 kV / mm	63,7 kV / mm
Thermal resistance[2]	3,55 K / W	4,04 K / W
Recommended layer thickness	60 – 80 µm	80 – 100 µm
UL 94	V-0	V-0

[1] acc. DIN EN IEC 60243-1: 1999-03 after plating process
[2] Bergquist HPL 1: 4,18 K/W

LPKF LDS PowderCoating: breakdown voltage

Layer thickness depends on required breakdown voltage



Layer thickness of LDS PowderCoating:

LPKF LDS PowderCoating	Breakdown Voltage	Recommened Layer Thickness
PU 100	4 kV	60 µm
PES 200	4 kV	80 µm

Dielectric Strength LPKF LDS PowderCoating PU: 77,7 kV / mm

Dielectric Strength LPKF LDS PowderCoating PES: 63,7 kV / mm

Measurements acc. DIN EN IEC 60243-1: 1999-03 (KuZ Leipzig)

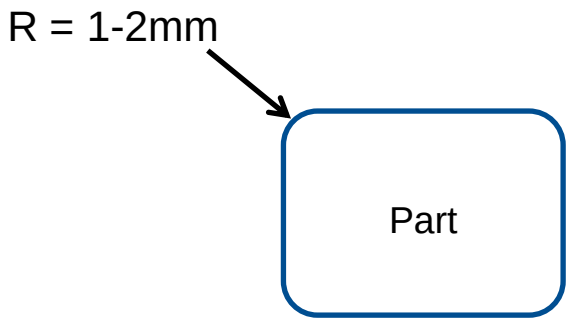
Comparison of LDS PowderCoatings, LDS Paint and LDS plastics

Chemical stability	Temperature stability	Curing temperature	Coating of sharp edges	Adhesion of traces
PU > PES	PU > PES	PES☺ PU😐	PES > PU	PES > PU

	Advantages	Disadvantages
PowderCoating vs LDS plastics	Mechanical characteristics of substrates	Additional process step
	Thermal management	
PowderCoating vs LDS Paint/ProtoPaint	No VOC (volatile solvents)	Curing temperature
	No Overspraying, powder can be re-used	

LDS PowderCoating: Design Rules

- Edge radius of part needs:
  PowderCoating PU 100 = 2 mm
  PowderCoating PES 200 = 1 mm
  → smaller radius needs to be tested by customer



- Recommended layer thickness:

  PowderCoating PU 100: 60 – 80 µm

  PowderCoating PES 200: 80 – 100 µm

- Part needs to be dry and clean before coating: free of grease/other lubricants, rust/oxidized layer
- Substrate needs to be electrically connected to the conveyor belt to apply charge
- Part needs to be completely coated

Application of LDS PowderCoating: Daytime Running Light

Example model

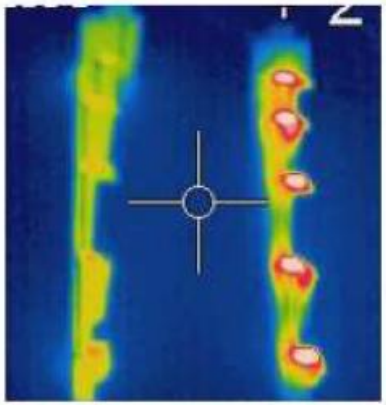
Application of LDS PowderCoating: Daytime Running Light

LPKF Laser & Electronics

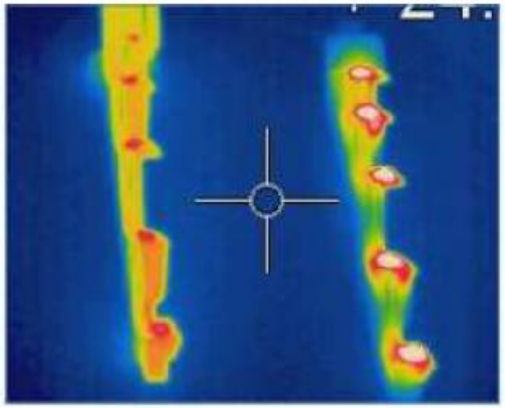
Reliability Tests*:

- Temperature Cycle Test: -40 °C – 150 °C (100 cycles)
- Warm-Humidity-Test: 85 °C / 85 % (168 hours)
- Vibration with Temperature Cycle Test (8 hours xyz-direction)
- Shear Force Measurement of Components (118 N)

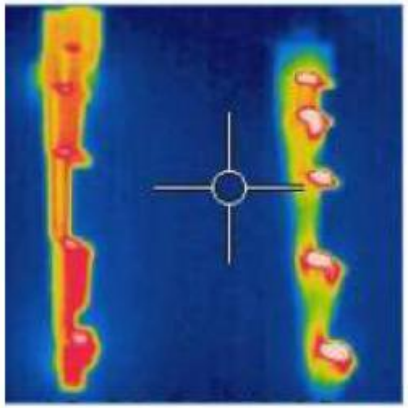
t = 0



after 8h



after 24h



left: PowderCoating@aluminum
right: plastic specimen

Zollner

* Bachelor thesis Matthias Schoierer / Zollner Elektronik AG

Thank you for your attention!

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