

Parylene Coating

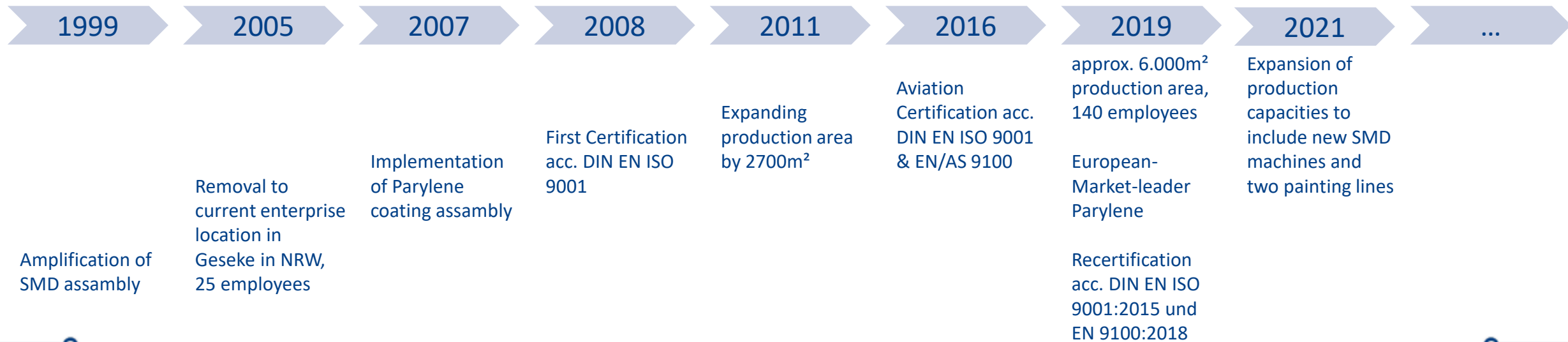
Permanent Sealing of electronic Components with extreme Requirements

Heicks Parylene Coating GmbH

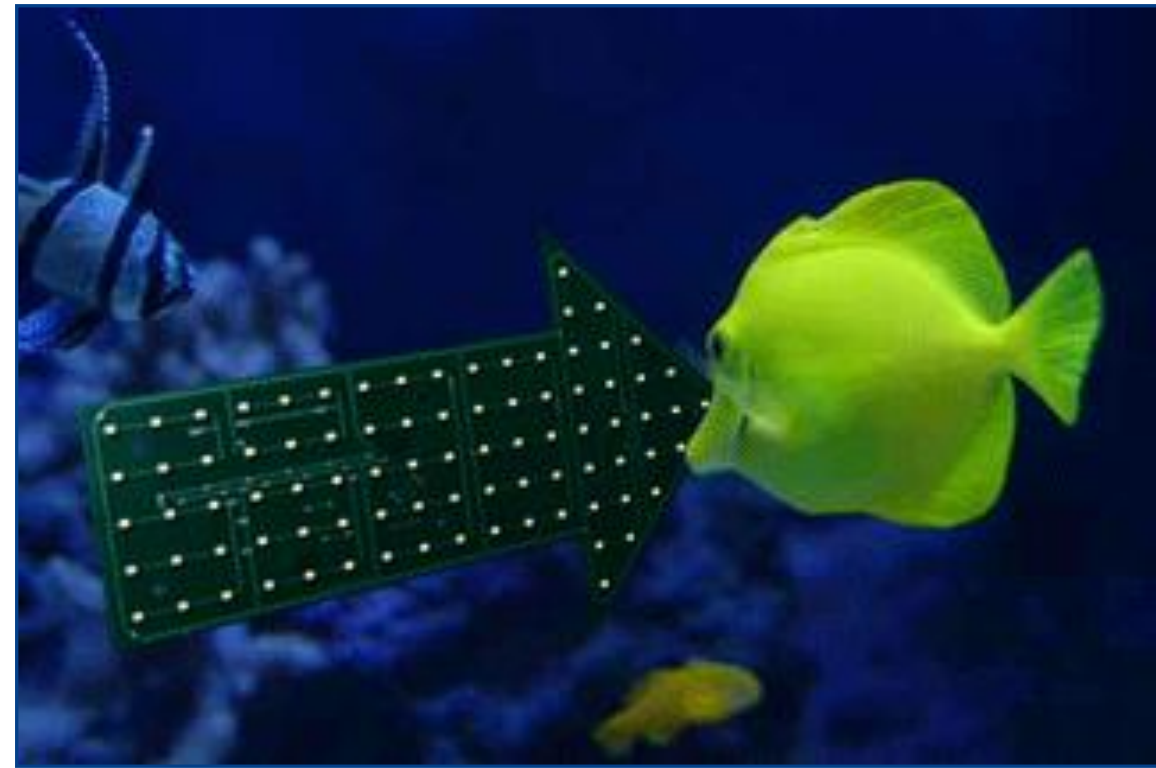
Dipl.-Ing. Rudolf Heicks



- ✓ Heicks Industrieelektronik GmbH, founded in 1986, is a medium-sized, owner-managed company with approx. 140 qualified employees.
- ✓ On more than 6000 m² production area we offer competent full service for high quality electronic components and assemblies.



- What... happens through exposure to moisture?
- How... can you protect electronic assemblies?
- How... does the parylene process take place?
- What... characterizes parylene coating?
- What... is the field of parylene coating?
- What... are the charges for parylene coating?

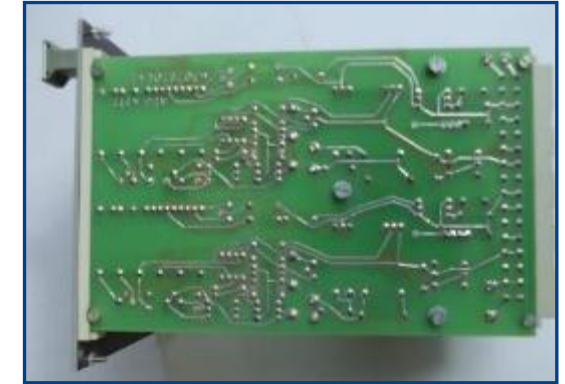
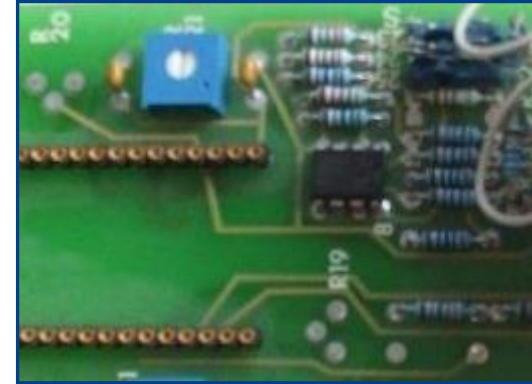


Assembly group coated with parylene

Increase of climate endangering

- Past

- Big components
- Large distance between traces
- Minor density of devices
- Minor exposure to climate



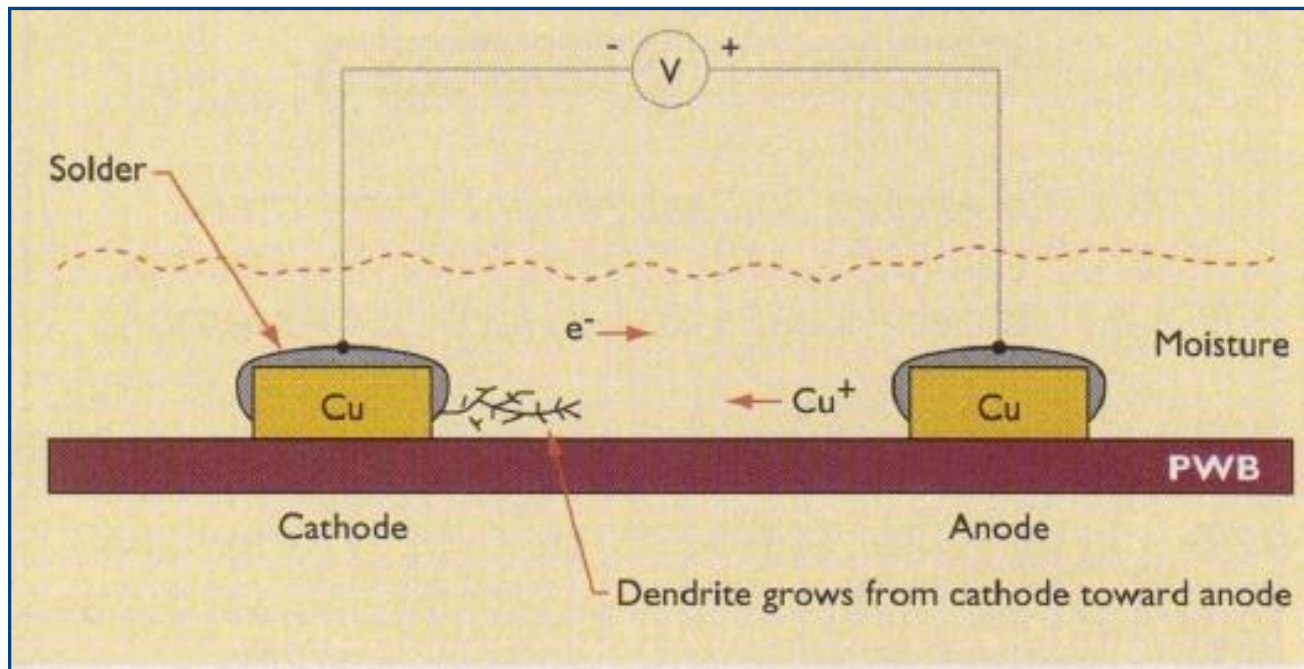
- Present

- Components are getting smaller
- Very slight distance between traces
- Density of devices is steadily encreasing
- Strong exposure to climate



Process of electronic migration

- Humidity & contamination (Fluxer/Salt/Fingerprints)
- Electronic migration
- Dissolution of metallization at the anode
- Dendritic crystallization at the diode

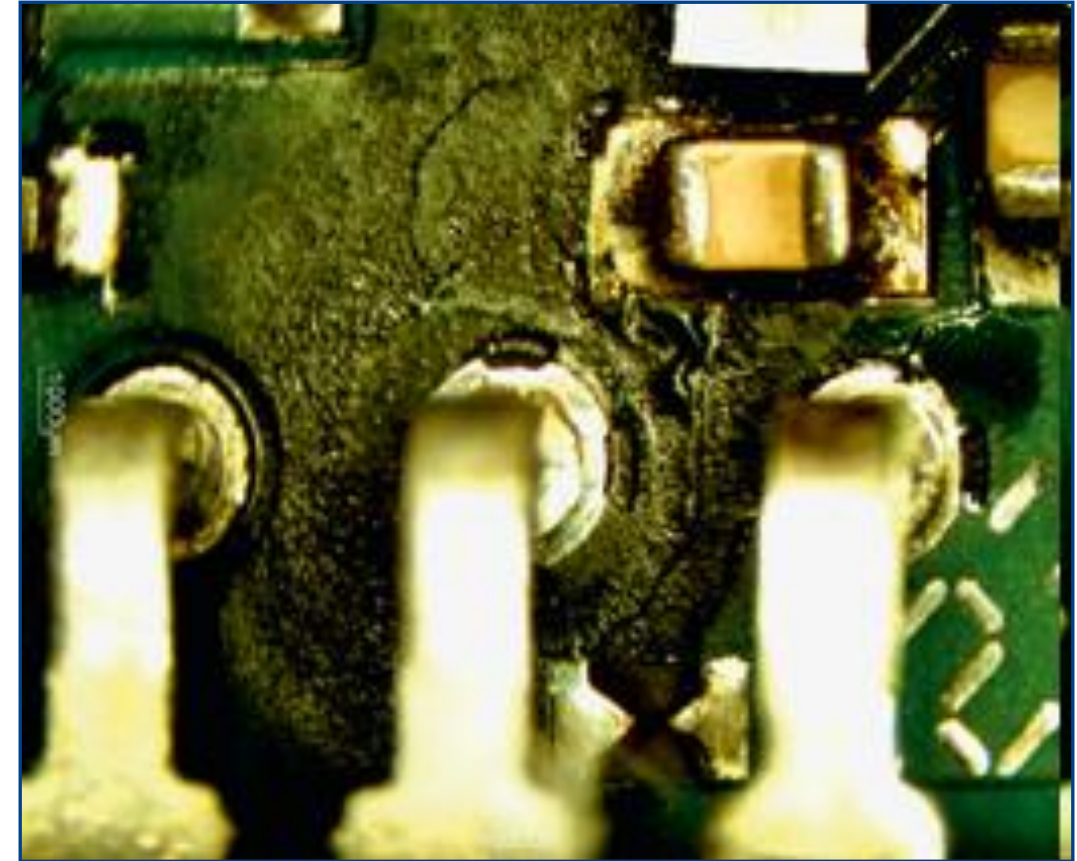


Source: EP&P/October 1999

Electronic migration

Exposure to humidity is the most frequent reason for failure of PCBs due to electronic migration.

→ This causes failures in performing or the total breakdown of the assembly group.

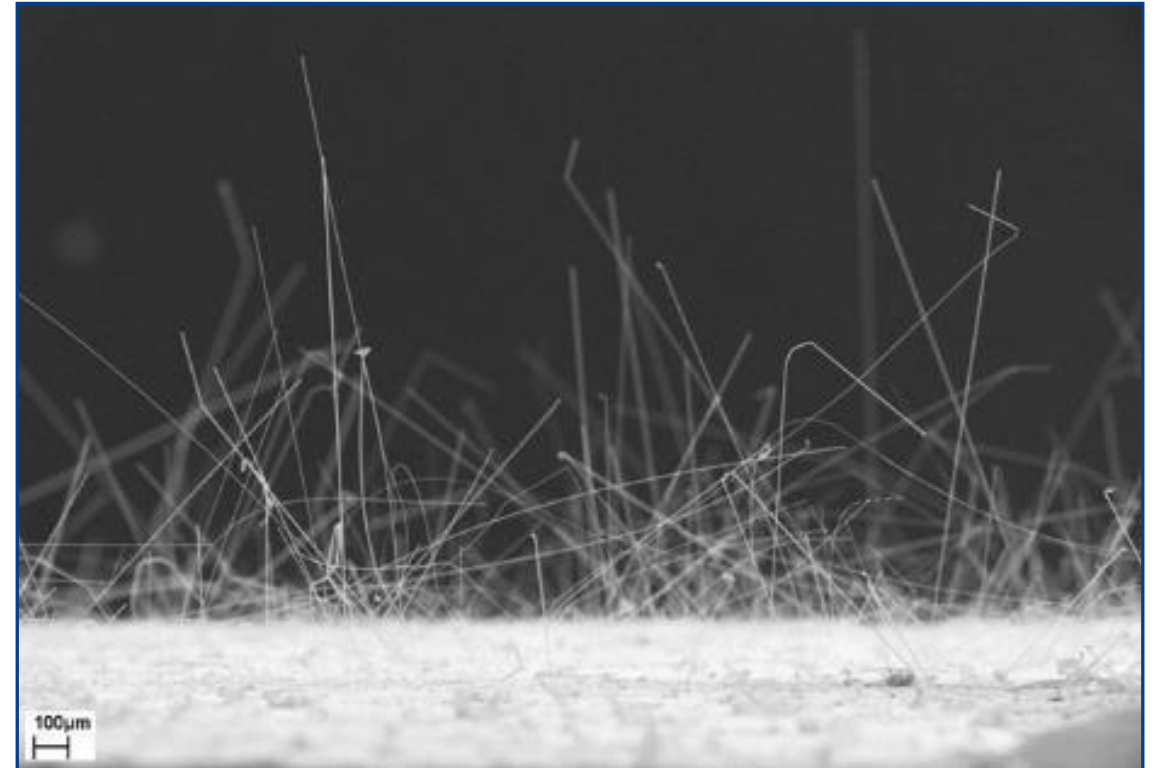


Electronic migration on an electronic assembly group (Source: AUCOTEAM GmbH)

Whisker formation

- Antimony, cadmium, indium, zinc and tin have an increased tendency to whisker
- Whisker arise in assemblies sometimes after years in operation
- whisker growth occurs increased on components or printed circuit boards, which are subject to mechanical stress.

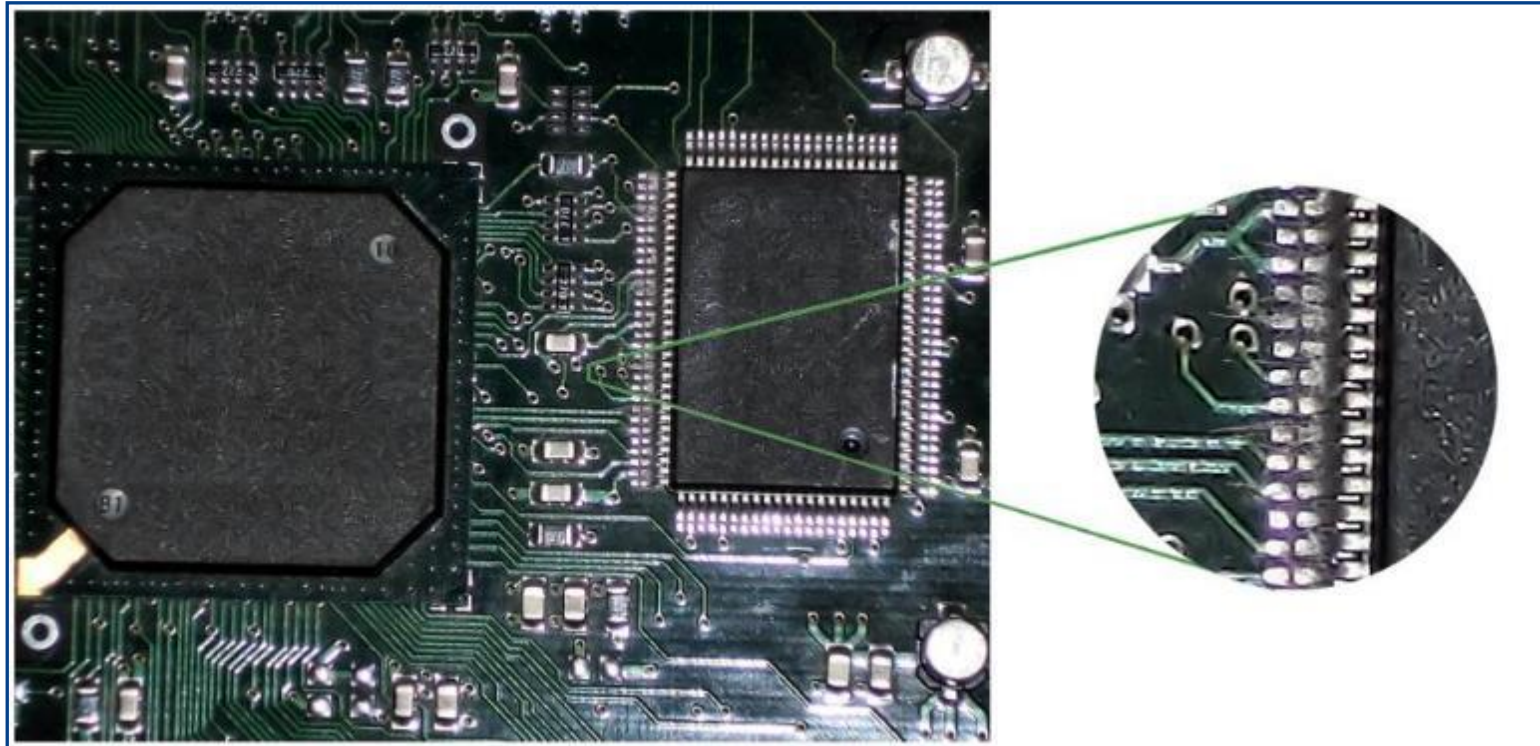
(Weichlöten in der Elektronik. Eugen G. Leuze, Saulgau 1991)



Dramatic whisker growth which can happen in certain circumstances (Source: Raytheon Analysis Lab, McKinney Tx.)

Whiskerbildung

- whiskers forms especially easy in assemblies that have been processed with lead-free tin solder (<95% tin).





(Source: F169BBS News about e-biz, politics, crime, women and everything else.)

Parylene prevents whisker formation

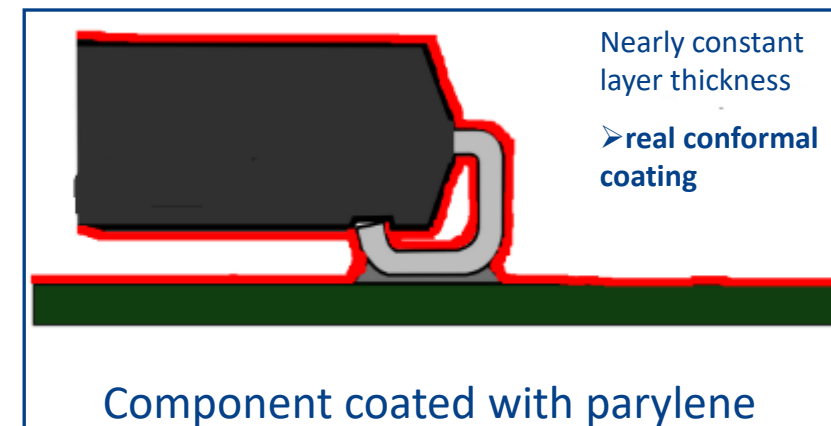
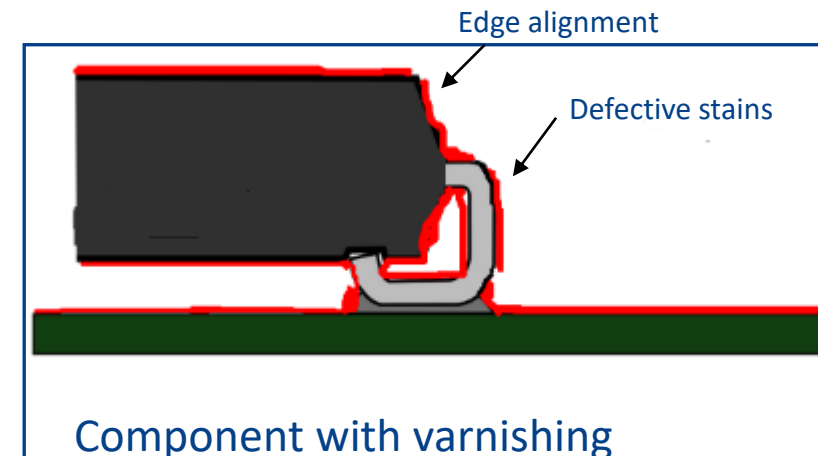
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CVD Process = nearly everywhere the same layer thickness

	Fluorpolymere	Varnishing	Parylene	Moulding
	Immersion in coating bath	Painting, Dip coating, Selective Varnishing	Vacuum process with 5 different powders	Potting with epoxy resin, polyurethane or silicone
 Advantages	<ul style="list-style-type: none"> • ultra thin transparent layer starting with 0,5-1µm • No health hazard • No environmental impact • Plugs do not need to be masked 	<ul style="list-style-type: none"> • Low priced • Quick process term 	<ul style="list-style-type: none"> • ultra thin transparent and pinhole free layer starting with 0,2 µm / 5µm to 25µm • No degassing of dissolvent/plasticizer • Absolute biocompatible and biostable • Chemically steady • Low weight • High temperature stability • Prevents whisker formation • Process takes place on ambient temperature • Texture conserving (real conformal Coating) • Excellent electrical isolation, high voltage resistance • Highest protection against corrosion • Immediately after the process, the parylene has its final properties • No aging 	<ul style="list-style-type: none"> • Strong protection against humidity due to very thick coating • Stabilisation of components
 Detriments	<ul style="list-style-type: none"> • Protection limited • Hollow bodies such as relays and switches can become full in the dipping process and can be emptied poorly • dipping grooves • Relay contacts that have no sliding contacts can be isolated. 	<ul style="list-style-type: none"> • Protection limited • emission of dissolvent is possible • not free of pinholes • uneven layer thickness • edge alignment • nearly no wetting of components 	<ul style="list-style-type: none"> • Process under vacuum (components have to be vacuum proof) • Long process term • Not permanently UV-resistant 	<ul style="list-style-type: none"> • Long (setting) hardening period • high weight • degassing is possible • limited thermo-mechanical reliability

SMD - Assembly

- Usually assembly groups are protected against environmental influences by epoxy, urethane, silicone and acrylic paint systems. However, the protective effect often is not sufficient in case of strong load.



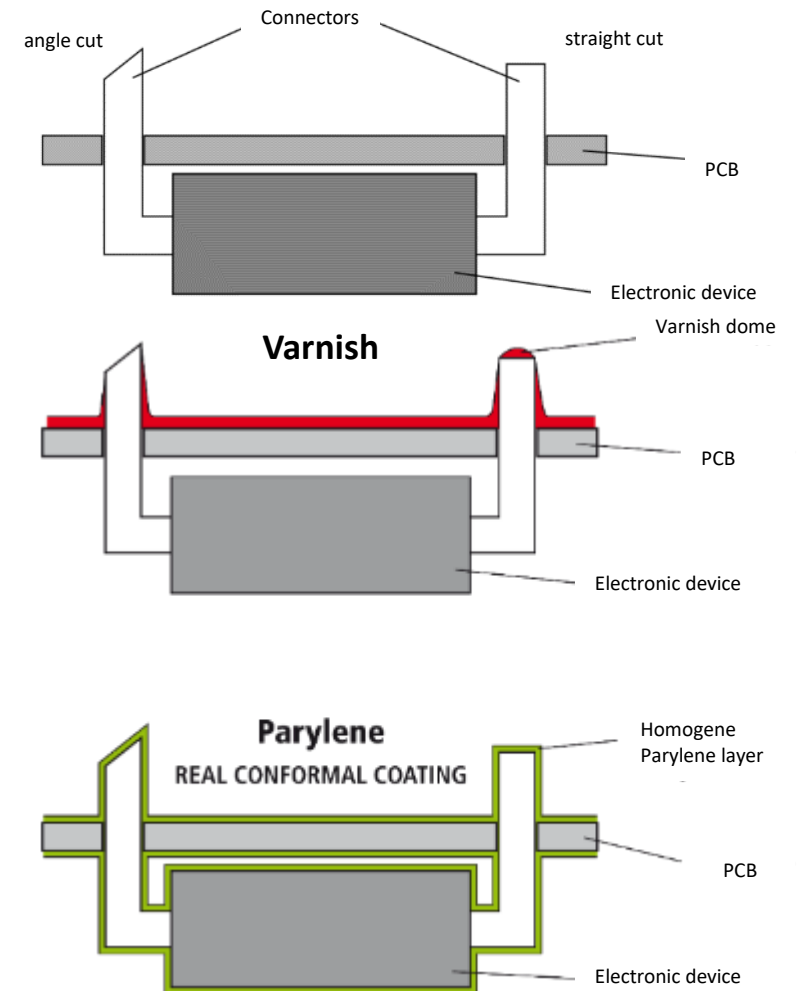
THT - Assembly

Reasons:

- Defective stains in varnish by pores or edge alignment
- Unsufficient density of permeability against water steam or hazardous gases

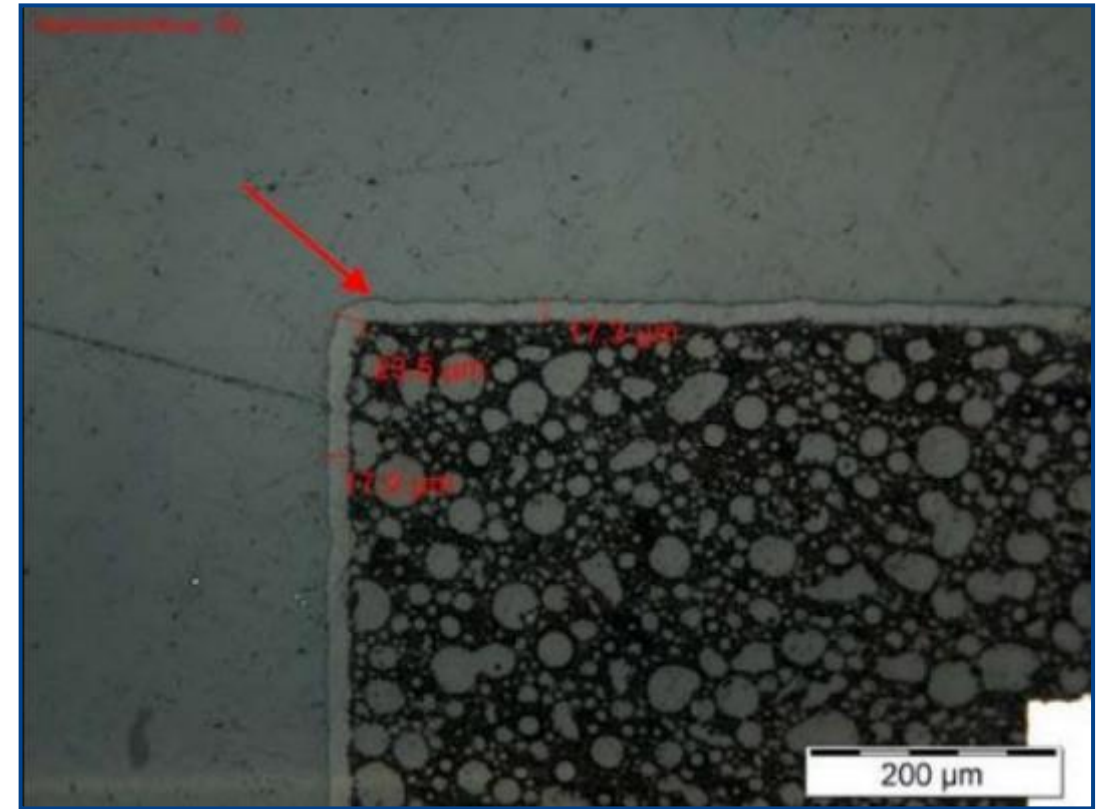
In this case a polymer layer (parylene) separated in the vacuum process can protect the necessary reliability of the assembly

group .



coating thickness on electronic devices

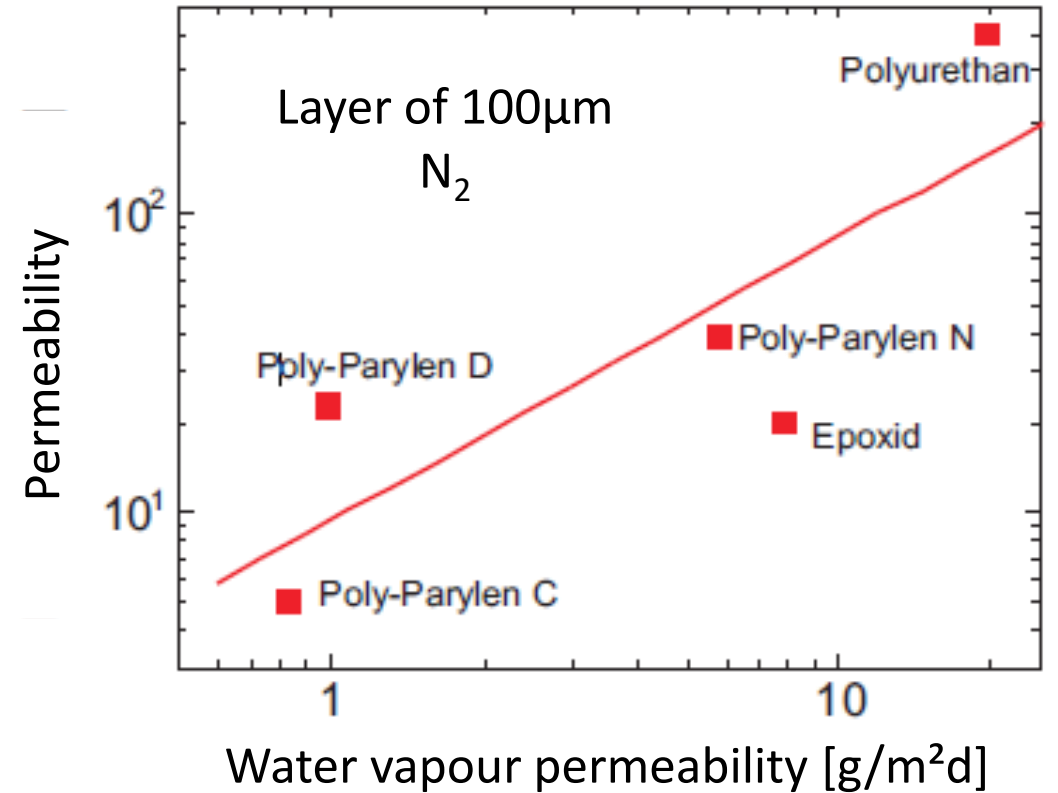
- homogeneous layer thickness provides all-round protection
- In the edge region the desired layer thickness remains
- The parylene coating reaches thin and deep gaps and even covers tops
- The coating is virtually non-porous and structure preserving



Resistance of different layers to 0,9% saline solvent

Polymer	Coating method	Layer thickness [µm]	Time until total breakdown
Poly-Parylen C	CVD	25	> 30d
Epoxid	Dip coating	100 ± 25	6 h
PVC	Dip coating	100 ± 12,5	8 h
Polyurethan	Dip coating	100 ± 12,5	6 h
Silicon	Dip coating	75 ± 12,5	58 h
Teflon	Spraying	75	6 h

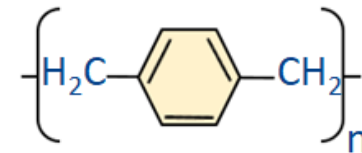
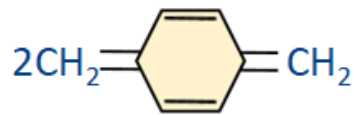
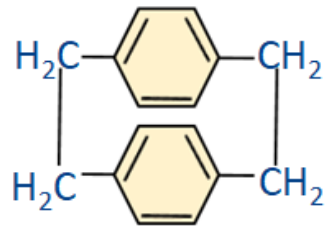
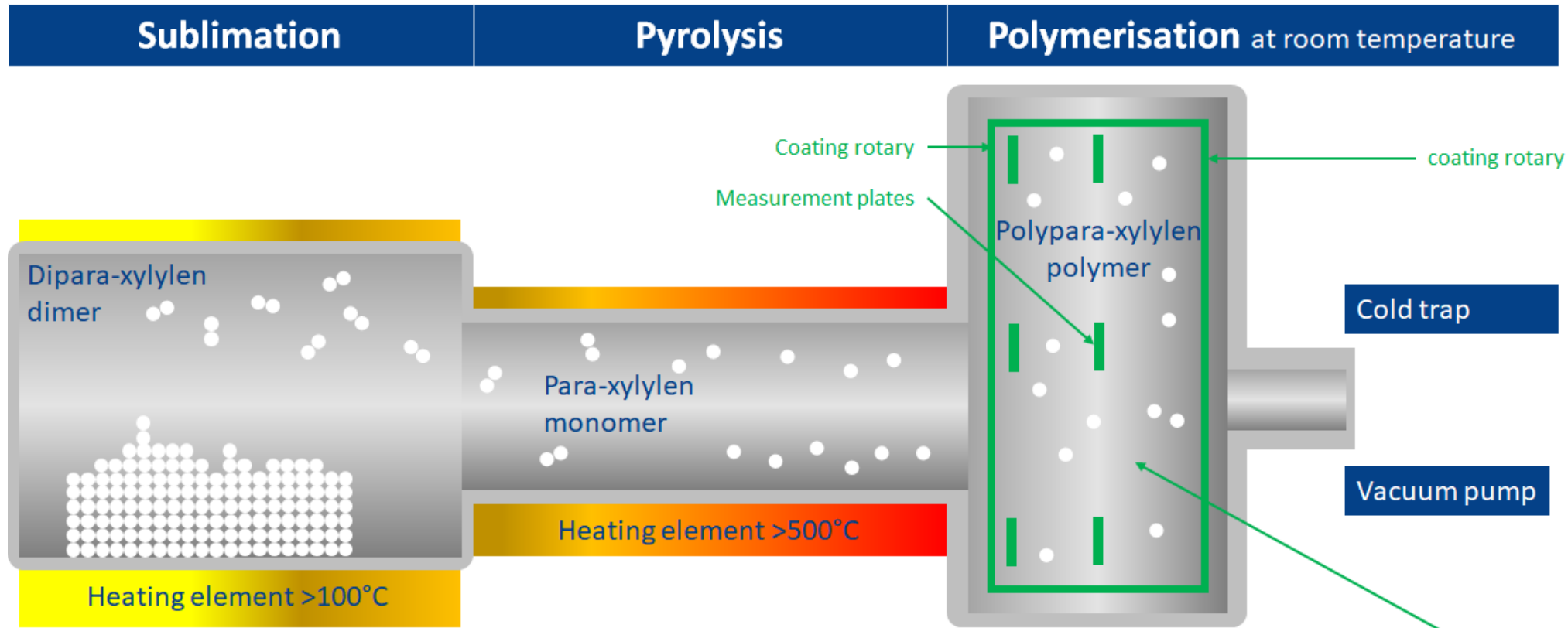
Source: G. Mordelt, P. Heim: High-Tech-Beschichtung der Zukunft, Metalloberfläche 52(5), 368 – 371 (1998)



Source: Encyclopedia of Polymer Science and Engineering, p. 1004 (1989)

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Coating process



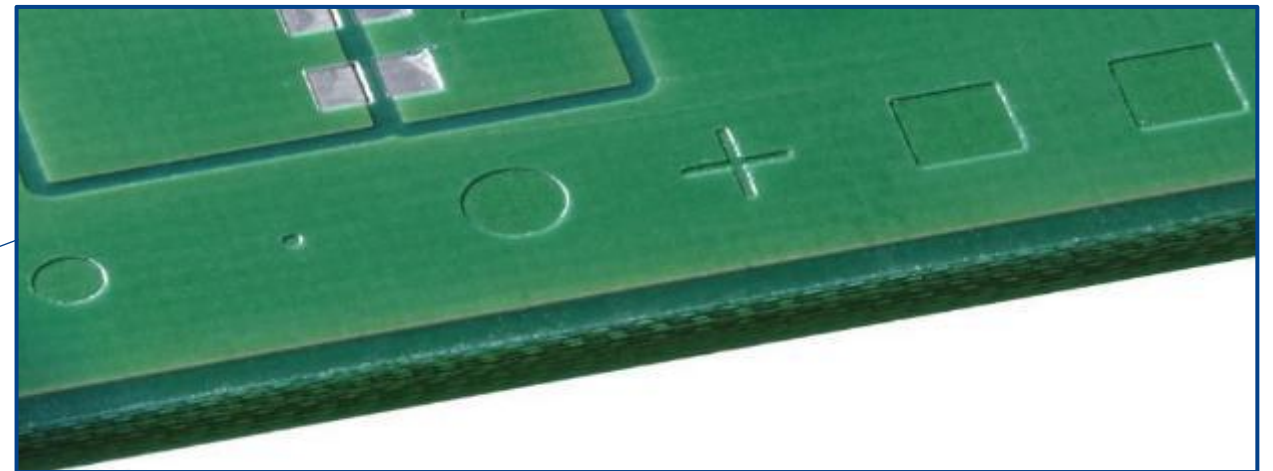
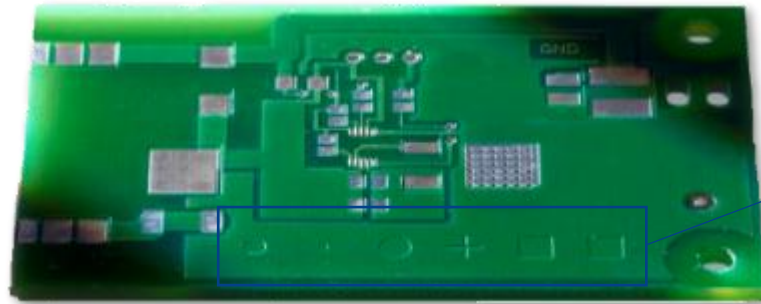
Coating is carried out at room temperature in the vacuum chamber

Coating process

1. Cleaning of assembly group
2. Manually masking of patches to stay uncoated
3. Parylene process in vacuum chamber for a period of 12-20 hours
4. Manually demasking of uncoated patches
5. Demasking of coated patches with **special laser**
6. Optical inspection of parylene layer
7. Documentation of process parameter

Removal of parylene

- Manually protection with special protective masks
- Manually removal of protective mask after parylene coating
- Demasking of coated patches with **special laser**



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Characteristics

- Hydrophobe (water repellent) surface
- Chemically resistant with barrier impact against organic and in-organic substances (acids, solutions, gases, water steams)
- Electrically isolating, high proof voltage (5 kV at 25 μm Parylene „C“)
- Bio-compatible und bio-stable coating
- Prevents whisker formation
- Thin, transparent, pinhole-free layer starting from 0,2 μm
- Very good gap penetration and edge covering capability (up to 99% of layer thickness) for complex substrates
- Excellent protection against corrosion
- Homogene layer formation
- No gassing of solutions or plasticizers
- Friction proof 92 A Shore
- MIL specification MIL-I-46058C
- FDA approval (official food control through medical products agency of USA)



Types of parylene

- C** very good electrical and physical characteristics, high impact as barrier < 100°C
- N** high dielectric and strongest coating penetration < 70°C, very good fissility (Spaltgängigkeit)
- D** high barrier impact (swelling behaviour) and temperature protection < 150°C
- F** good electric characteristics und temperature protection > 200°C, good gap penetration capability, minor coefficient of friction
- AF** high UV-resistance, good electrical characteristics > 350°C, high barrier impact, very good fissility, minor coefficient of friction
- HT** Brand name of Special Coating Systems

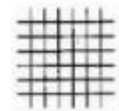
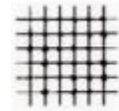
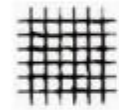
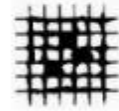

USP CLASS VI ISO-10993-6

FDA: MAF 1176

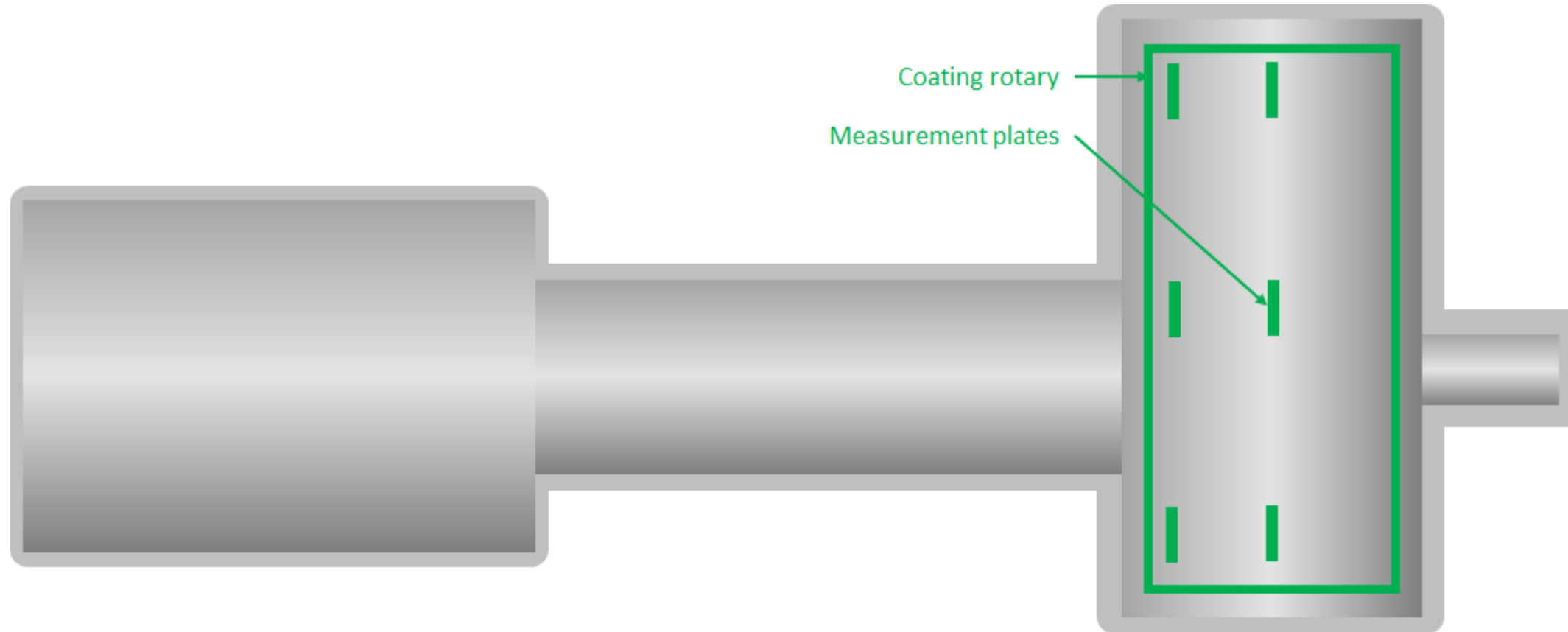
MIL Specifications: MIL-I-46058C

Adhesion

- The cross-cut test is a very rapid and simple method to assess the adhesion of coating systems.
- Using a 25mm wide semitransparent pressure sensitive tape with an adhesive strength of 43 ± 6 g/mm
- The grating pattern consists of a 10x10 grid of squares of 1mm^2
- The center of the strip is placed over the grid pattern and smoothed by a finger
- Within 90 seconds after application of the tape, this is stripped off with a smooth motion at an angle of 180°
- The evaluation of the examination is carried out visually with the naked eye, by comparing with Table 1

Description	Surface	Grading ISO	Grading IPC-TM-650
The edges of the cuts are completely smooth, none of the squares of the lattice is detached.		GT 0	5B
At the intersections of the grid lines small fragments of the painting chipped off; chipped off surface about 5% of the sections.		GT 1	4B
The painting chipped off along the edges of cut and/or at the intersections of the grid lines; chipped off surface about 15% of the sections.		GT 2	3B
The painting chipped off along the edges of cut partly or in broad strips and/or the painting from individual sections totally or partly chipped off completely; chipped off surface about 35% of the sections.		GT 3	2B
The painting chipped off along the edges of cut in broad strips and/or of individual sections totally or partly; chipped off surface about 65% of the sections.		GT 4	1B
Each degree of flaking that cannot even be classified by classification 4.		GT 5	0B

Layer thickness measurement within the vacuum chamber



Certifications

TÜVNORD

Certificate

Management system as per
EN 9100:2018
(technically equivalent to AS9100D and JIS Q 9100:2016 and in conformity with the requirements of ISO 9001:2015)

The Certification Body TÜV NORD CERT GmbH hereby confirms as a result of the audit, assessment and certification decision according to EN 9104-001:2013 and ISO/IEC 17021-1:2015, that the organization

Heicks Industrieelektronik GmbH
Am Schwarzen Weg 25-31
59590 Geseke
Germany

Heicks
Industrieelektronik GmbH

Details of certification structure „Campus“ according to the annex

operates a management system in accordance with the requirements of EN 9100:2018 and will be assessed for conformity within the 3 year term of validity of the certificate.

Scope

Development and manufacture of electronic and mechanical assemblies with Parylene, Coating, Sealing or Vacuum sealing process; Permanent Sealing of Electronic Assemblies; Cable and Harness Assembly

Certificate Registration No. 44 117 151674 Issue date 2025-03-18
Audit Report No. 3538 0201 Expiry date 2028-03-17
Initial certification 2025

Essen, 2025-03-10 V. Topfwa
Certification Body at TÜV NORD CERT GmbH

TÜV NORD CERT GmbH
Am TÜV 1, 45307 Essen
www.tuev-nord-cert.com

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Heicks
Parylene Coating GmbH

operates a management system in accordance with the requirements of EN 9100:2018 at the location

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59590 Geseke
Germany

and will be assessed for conformity within the 3 year term of validity of the certificate.

Scope

Permanent Sealing of Electronic Assemblies

Certificate Registration No. 44 117 151674-001 Issue date 2025-03-18
Audit Report No. 3538 0201 Expiry date 2028-03-17
Initial certification 2016

Essen, 2025-03-10 V. Topfwa
Certification Body at TÜV NORD CERT GmbH

This certificate is valid in conjunction with the main certificate.

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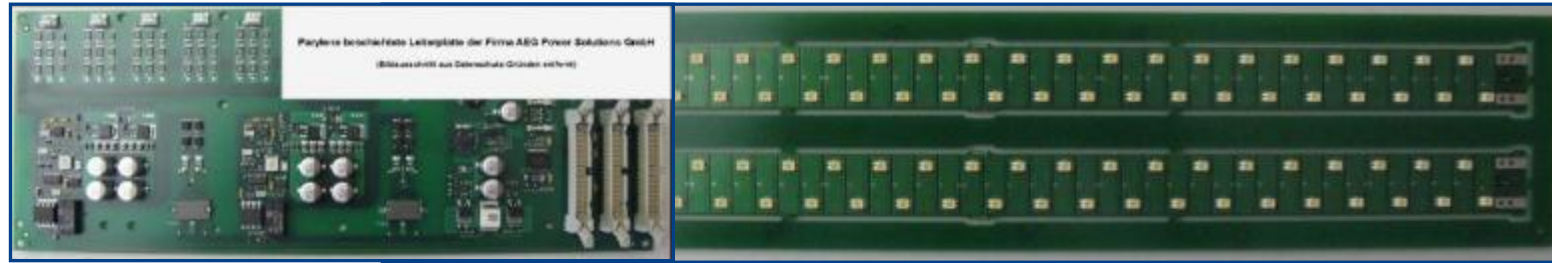
Applications

- Electronic industry, especially printed circuit boards
- Aerospace industry
- Plastic and metal industry
- Medical engineering like cardiac catheter and stents
- Automotive
- Railway engineering
- Mining industry
- Protection of documents
- Dissection of insects

All vacuum apt materials are suited for coating

- rubber
- glass
- metal
- ceramic
- plastic
- silicone

Example of application



HIMA Paul Hildebrandt GmbH + Co KG



HIMA Paul Hildebrandt GmbH + Co KG

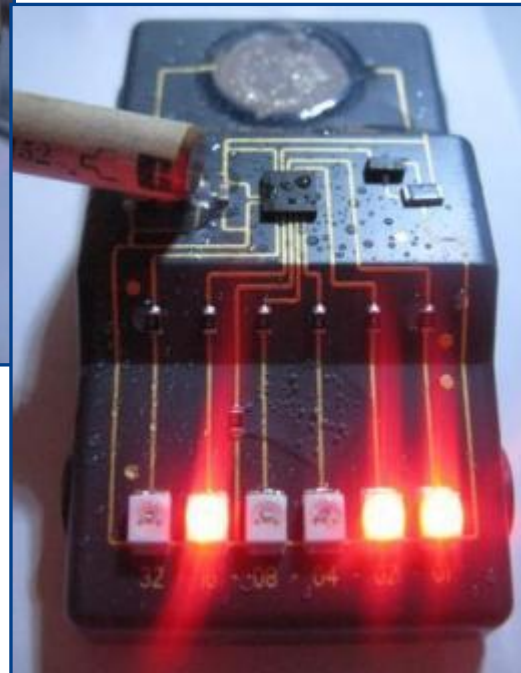
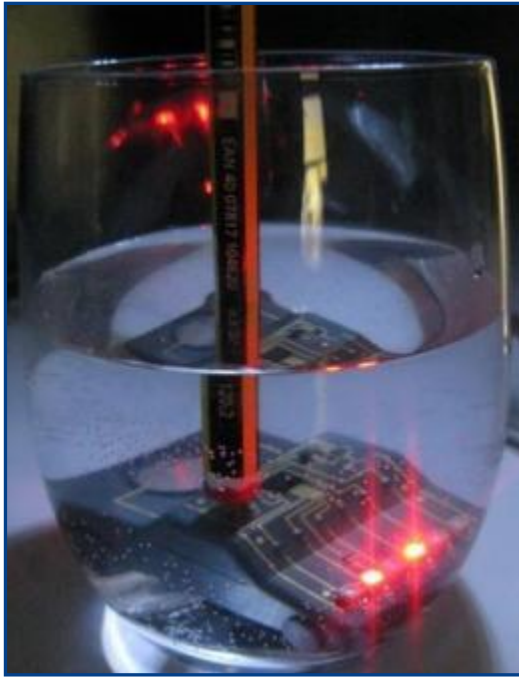
Example of application

Electronic manufacturing for UAVs (Unmanned air vehicle)

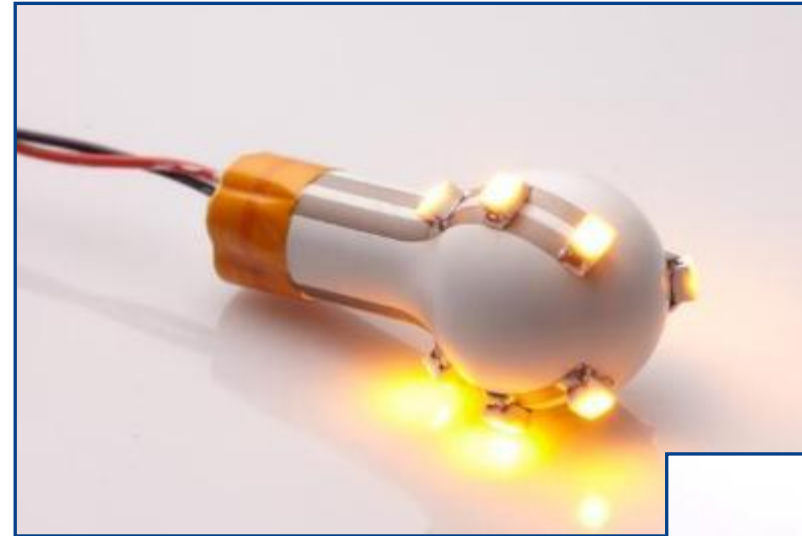


Example of application

3-D MID (Molded Interconnect Device) Demonstrators



Forschungsvereinigung Räumliche
Elektronische Baugruppen 3-D MID e.V.
FAPS – Lehrstuhl für
Fertigungsautomatisierung und
Produktionssystematik



Metal surface in form of a „light bulb“ with traces
out of powder coating
LPKF



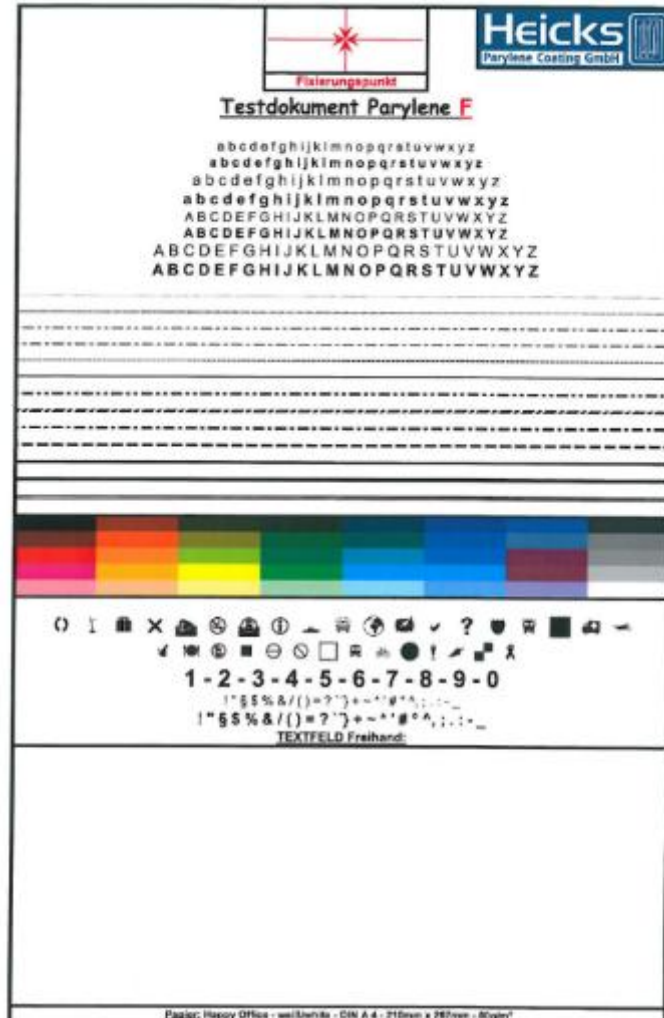
Example of application

Butterflies and beetles



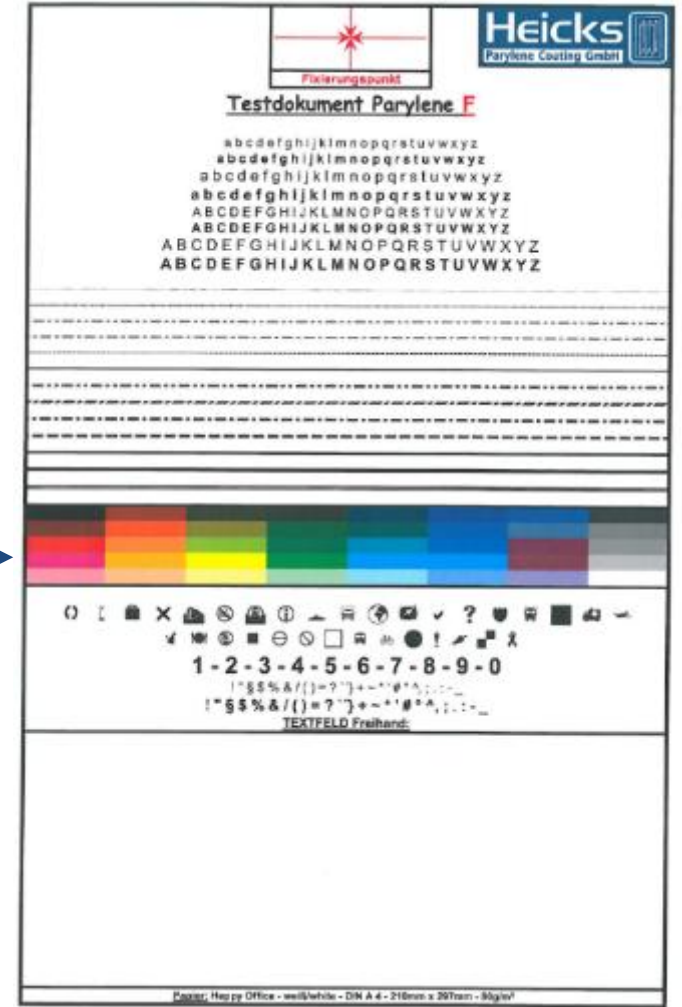
Example of application

test documents



← uncoated

→ coated with Parylene F



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- Parylene process takes place in dimensional limited vacuum chamber
- Number of patches to remain uncoated determines the price
- Price of parylene powder in use (N,C,D,F,AF) determines the price
- Parylene process usually is more expensive than varnishing
- Parylene process usually is cheaper than moulding

Thanks for your attention



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Tel. 0 29 42 / 9 79 26 – 0

Fax 0 29 42 / 9 79 26 – 150

info@heicks.de

www.heicks.de

