

**Leader in Thin Film Encapsulation**

# Innovative Dünnschicht-Schutzschichten für die Elektronik auf der Basis von Parylen



## SGO- LEITERPLATTENSEMINAR



Schweizerische Gesellschaft  
für Oberflächentechnik  
Société Suisse de Traitement  
de Surface

# THE COMPANY

- COAT-X (Switzerland) has been founded in 2016
- Privately held company
- Headquarters @ Microcity La Chaux-de-Fonds, Switzerland
- 10 engineers and technicians in Switzerland
- Business Development representatives in USA, Nordics



# OUR JAPANESE SUBSIDIARY



- **COAT-X Japan** has been founded in 2021
- Headquarters in Shinshiro
- 2 engineers and 2 sales person
- 1 PE-CVD coating machine
- 1 Helium diffusion tester



27.09.2023

COAT-X SST Presentation

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## Coating Services

(PE-CVD, CVD, ALD)

- Parylene-C, Parylene-F, Parylene-N
- Ceramic coatings ( $\text{SiO}_2$ , SiC,  $\text{SiO}_x\text{N}_y$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ )
- Multilayered combinations
- Masking/demasking
- ISO 13485, ROHS, REACH compliance

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## Solution Development Verification

- Hermeticity measurements
- Adhesion tests
- Corrosion tests
- Accelerated aging tests
- Network of experts for test outsourcing\*

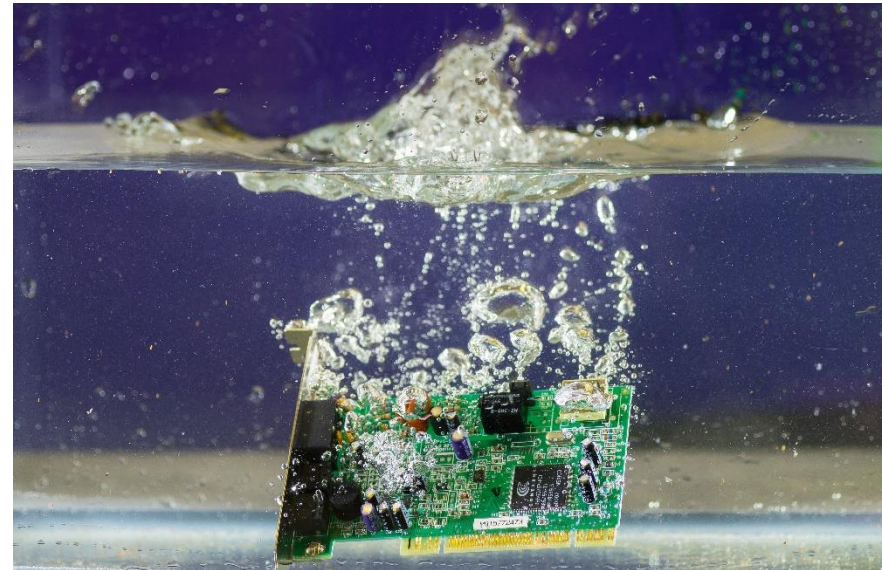
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## Technology Transfer

- Tailored reactor design
- Tech licensing
- Reactor renting & servicing
- Co-development and research partnership

# CERTIFICATION

- Certified quality management system ISO 13485 for medical devices
- Our parylene coatings comply with IPC A 610 and MIL-I-46058C standards for conformal coatings
- Conform to REACH and RoHS 2015/863/EU
  
- All coatings are PFA-free
  
- Own analytical lab for water vapour and Helium permeation measurements



# COATING MACHINES AND CLEAN ROOM

- Three PE-CVD reactors
- One ALD chamber
- ISO 5 clean room



# TESTING LABORATORY

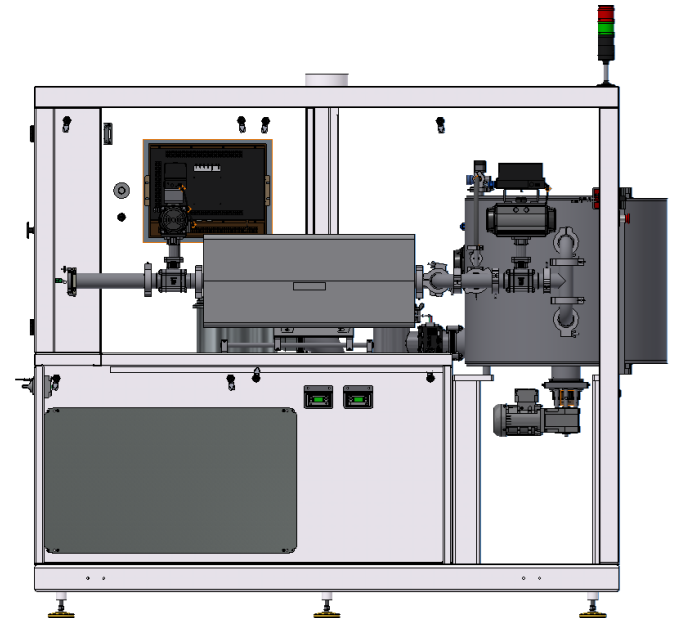
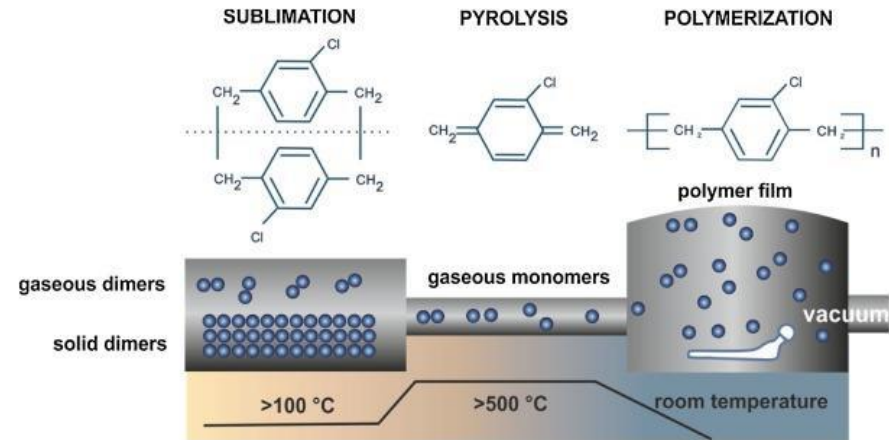
Laboratory for routine inspections and performance testing



# Parylene Process

CVD coating process is divided in **3** steps:

- Sublimation of a powder of Parylene dimers
- Pyrolysis of the dimer to monomers
- Gas phase polymerization and deposition under vacuum





# OUR COATING PORTFOLIO

Moisture protection



Hydrophobic/Hydrophilic  
nano-coatings



Ceramic  
SiO<sub>2</sub>, SiC, SiON  
By PE-CVD



Parylene coatings  
N, C, VT4, AF4



Parylene/ceramic  
composite  
by PE-CVD



**NEW!**  
Parylene/ceramic  
composite  
by ALD/CVD



# APPLICATION AND MARKETS

Our technology of thin film encapsulation is applied on:

- PCB, PCBA, rigid and flexible
- Sensors, actuators
- Sensitive materials and components

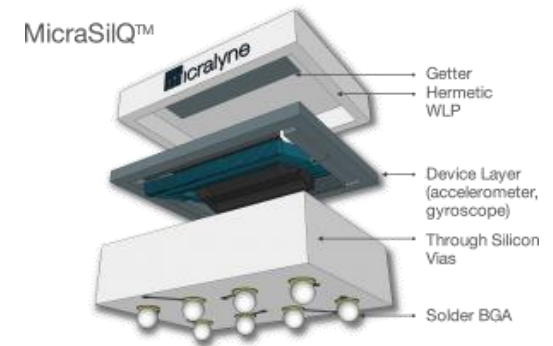
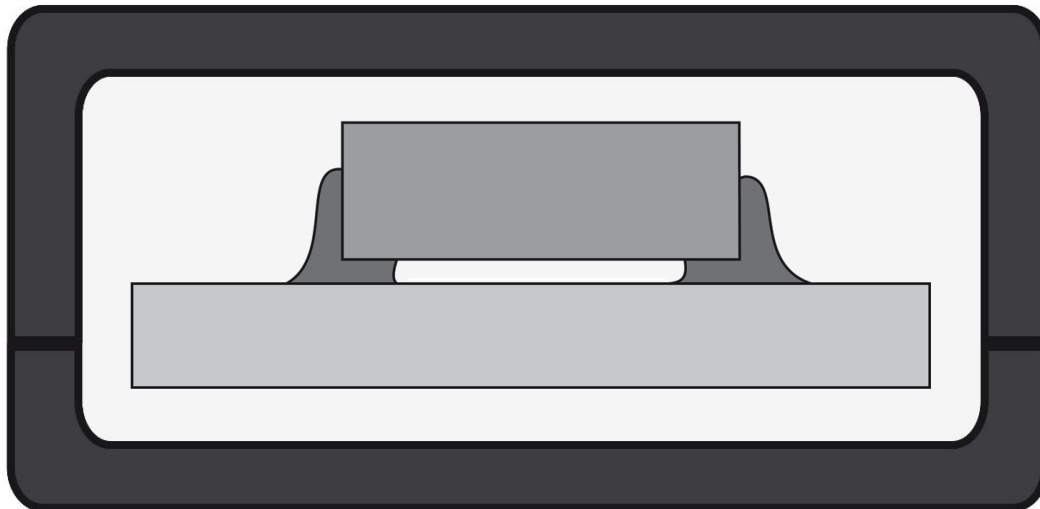
Our markets are:

- Medical device
- Biotechnology
- Food
- Aerospace and space
- Communication
- Automotive
- Watches and jewelry

# THE PROBLEM...

Packaging challenge for electronic or medical devices:

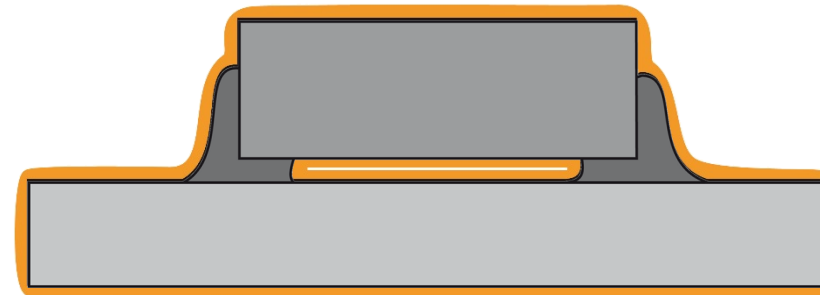
- Limitation in miniaturization
- Complex welding process
- Rigid and non-flexible
- Cost intensive



## ...THE SOLUTION

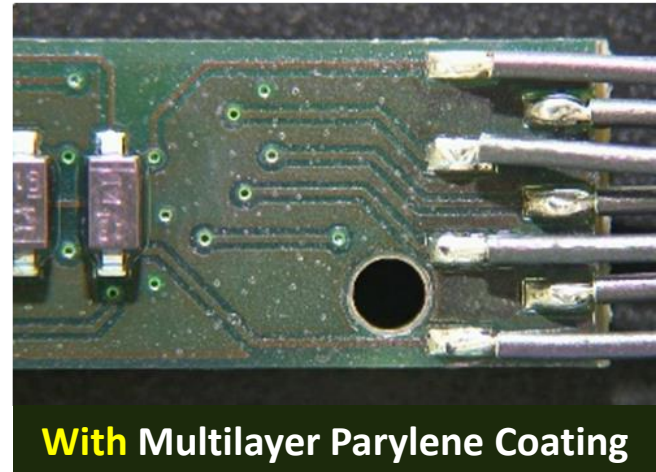
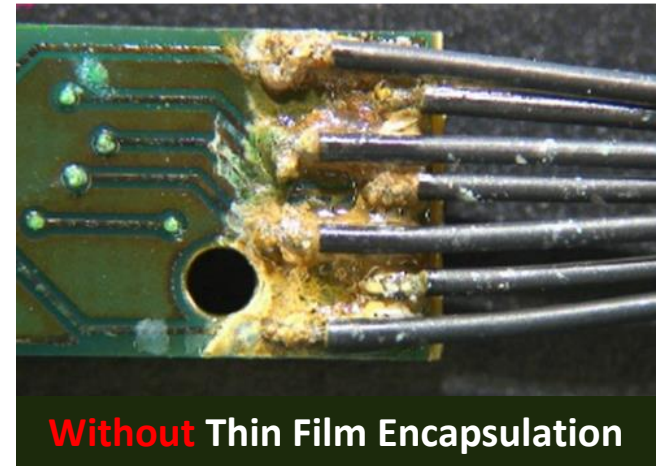
### Thin Film encapsulation with Parylene:

- Thinner and lighter protection (a few microns)
- Transparent / flexible protection, compatible with thin flexible PCB's
- Temperature resistant (up to 450°C), compatible with solder reflow processes
- Truly 3D conform, compatible with high AR
- Room temperature process, no damage to electronics, no shrinkage
- Up to 10'000 times more waterproof than Epoxy!



# COAT-X SOLUTION – WHAT IS UNIQUE

- Superior performance barrier coating (liquid & gas)
- 3D conformal protection of complex microstructures
- Single reactor, room temperature, batch process
- Transparent, flexible and biocompatible



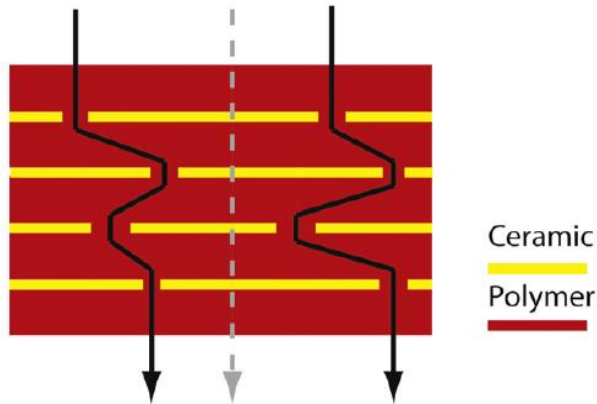
# Technical Datasheet



	Parylene XPC	Parylene XPN	Parylene XPD	Parylene XPF1	Parylene XPF2	SiO2 XCR	Multilayer ML3	Method ASTM
Density (g/cm <sup>3</sup> )	1,29	1,10-1,12	1,42	1,3-1,5	1,65	2,17-2,65	-	D1505
Index of refraction (n <sub>D</sub> <sup>23</sup> )	1,64	1,66	1,67	1,56	1,57	1,40-1,50	-	Abbe refractometry
Transmission visible range (%) (380-750nm)	>90	-	-	-	-	>85	>85	UV-Vis Spectrophotscopy
Friction Coefficient Static	0,29	0,25	0,35	0,15	0,39	-	-	D1894
Friction Coefficient Dynamic	0,29	0,25	0,31	0,13	0,35	-	-	D1894
Temporary peak temp. (°C) (100.000 h)	80-100	60-80	100-120	350	140-200	1050	-	-
Durable heat Resistance (°C) (1.000 h)	115	95	130-135	450	250-350	-	-	-
Melting point (°C)	290	420	380	>500	435	-	-	DSC
Dielectric Constant (1 MHz)	2,95	2,66	2,8	2,17	2,35	-	-	D150
Breakdown voltage DC (V)								
1um	1100	500	-	-	-	-	-	-
10um	3500	4000		-	-	-	-	
25um	5800	7000		-	5500	-	-	
Hardness Rockwell (HR)	80	85	80	122	-	-	-	-
WVTR (g.mm)/(m2.day)	0,1	0,75	0,12	0,28	0,32	-	6,00E-04	F1249-06

# Multilayer vs. Single layer

- Gas or water permeation through the multilayer is reduced thanks to the high molecular density of SiO<sub>2</sub> interlayers.



# Multilayer vs. Single layer

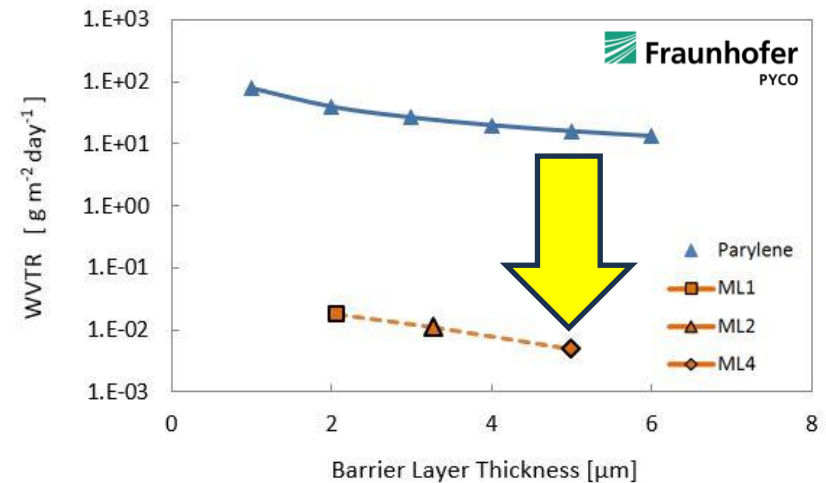
Water vapour transmission rate (WVTR) of a 5  $\mu\text{m}$  SINGLE LAYER of Parylene C is:

$20 \text{ g/m}^2/\text{day}$

While for a 5 $\mu\text{m}$  composite MULTILAYER is only :

$4 \cdot 10^{-3} \text{ g/m}^2/\text{day}$

Our multilayer PE-CVD composite is **3 orders of magnitude tighter** than pure Parylene C

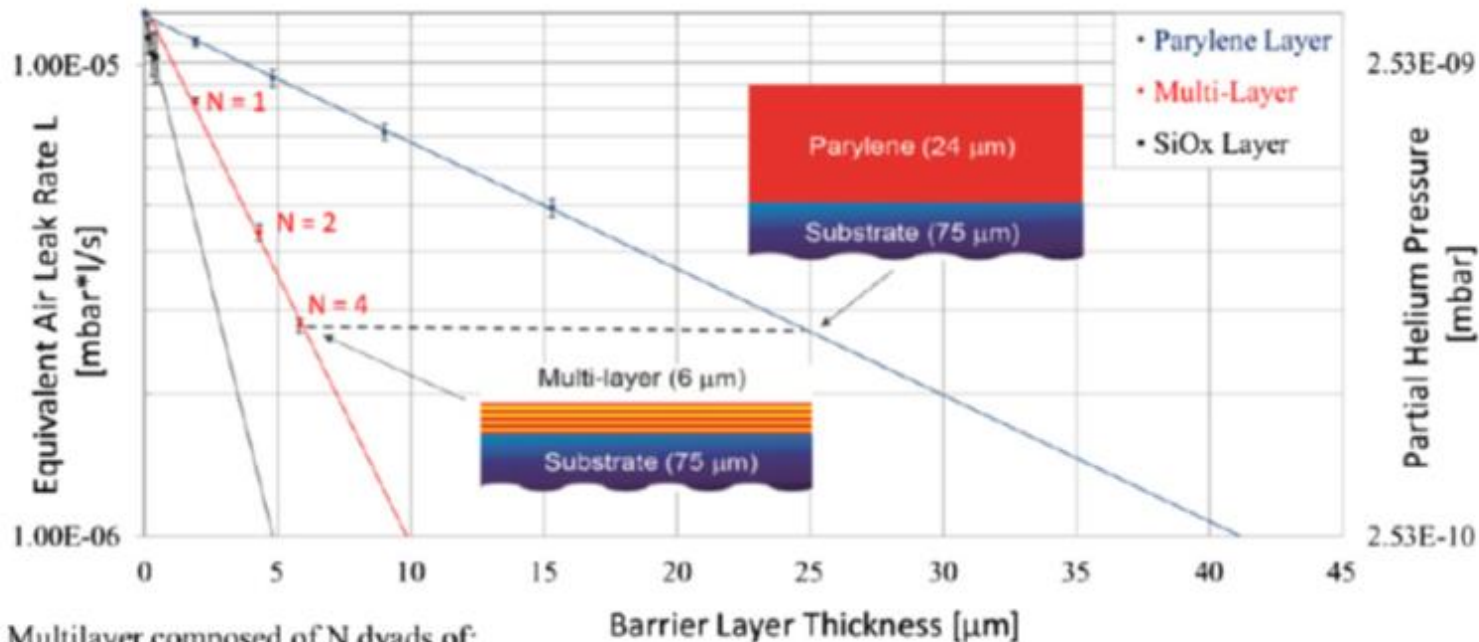
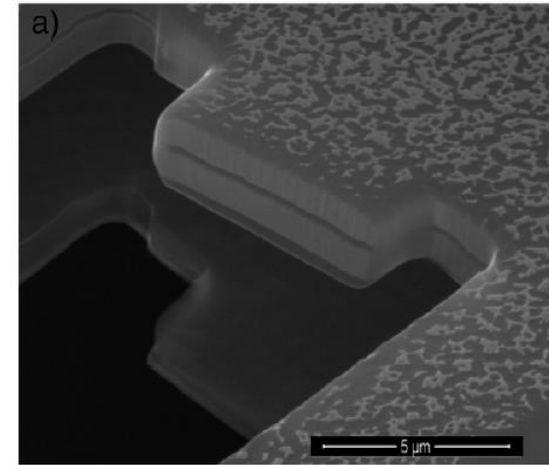


WVTR at 38°C and 90% RH



# Multilayer vs. Single layer (cont.)

Multilayers of Parylene and SiO<sub>2</sub> provide much tighter encapsulation than single Parylene layer or allow thickness reduction and faster deposition to ensure similar tightness



Multilayer composed of N dyads of:  
Parylene thickness : 1 μm  
SiO<sub>x</sub> thickness: 240 nm

# Multilayer vs. Single layer

## *Water permeation measurements (WVTR) according ASTM F 1249*

<b>Materials</b>	<b>WVTR</b> [g um m <sup>-2</sup> day <sup>-1</sup> ]	<b>Improvement</b>
Silicone	25000	625000
Acrylic	14000	350000
Polyurethane	1500	37500
Epoxy	950	23750
Parylene N	590	14750
PET	500	12500
Parylene C	80	2000
SiO <sub>x</sub> (Single layer)	15	375
<b>Multilayer</b>	<b>0.04</b>	<b>1</b>

→ A 10 µm Multilayer has the same protection performance than an epoxy layer of 2 cm and a silicone layer of 60 cm.

# NEW ALD Technology

Using the ALD technology, very dense films of ceramics are produced that can be combined with parylene to build ultra tight composite barrier coatings.

For example, a WVTR of

$$5.7 \cdot 10^{-5} \text{ g/m}^2 \text{ day}$$

was recently measured for film of 4  $\mu\text{m}$  on a PET membrane.

The new ALD composite is **2 orders of magnitude tighter** than our PE-CVD composite.

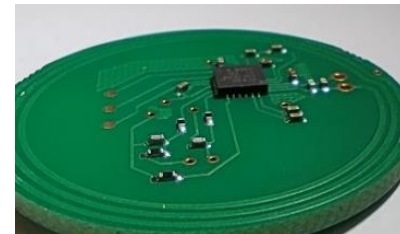


# Protection of implantable electronic with multilayer parylene coating

- RF tags including sensing capabilities have been **encapsulated with a 10-micron multilayer coating** from COAT-X. It combines alternating Parylene and ceramics layers. No other packaging material nor casing was used.
- The multilayer coating was prepared using COAT-X **proprietary PE-CVD technology**.
- An **accelerated aging test** protocol was developed to demonstrate the long-term performance of the technology in the human body. The devices have been immersed at 87°C in Phosphate Buffered Solution (PBS) for several months to **simulate years of implantation**.
- Contactless interrogation of the RF tag was performed on a regular basis to verify proper function of the device.



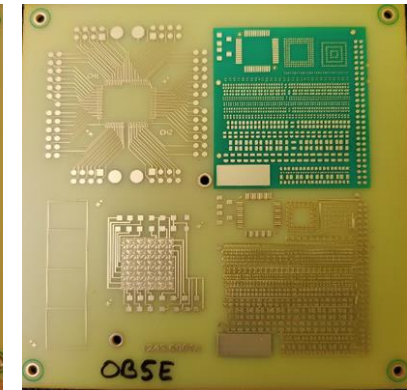
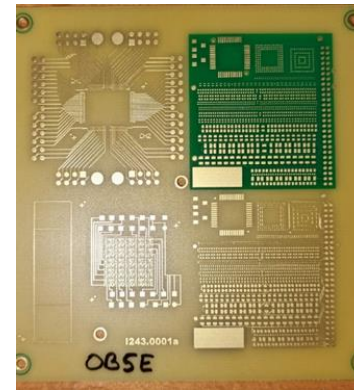
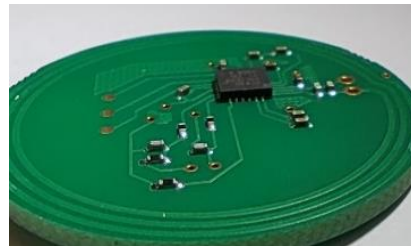
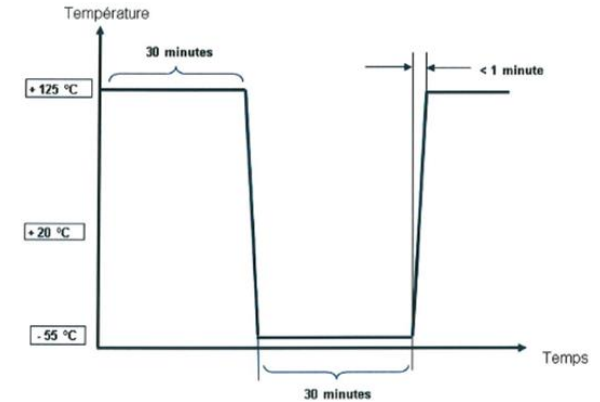
Test PCB platform comprising an RF communication block with antenna and temperature sensor



After more than 10 years of simulated implantation all tags are still fully functional. Working with the Wyss Center to reach 20 years of implantation.

# Thermal cycling of various PCB's with multilayer parylene COAT-X coating

- Various types of PCB have been encapsulated with COAT-X multilayer parylene coating and submitted to thermal cycling.
- Up to 1000 cycles have been performed and the surfaces inspected.
- The coating is very robust on all PCBs, including on solder masks
- It demonstrate the high tolerance of the technology towards large temperature cycles, without delamination or cracks

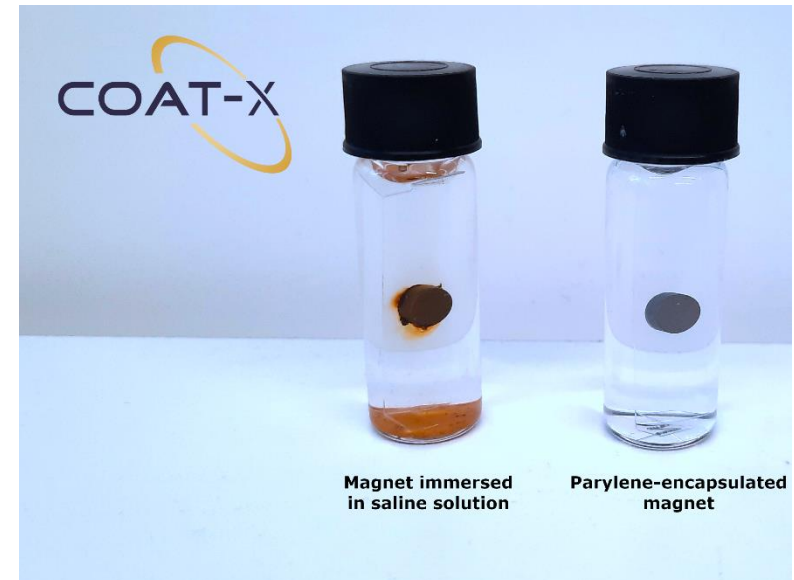


Electronics still functional up 1000 cycles  
No damages to the protecting multilayer film and could be observed

# CORROSION PREVENTION: COATED MAGNETS

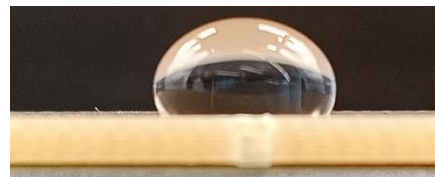
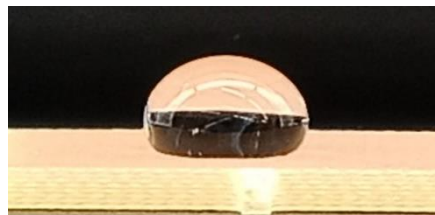
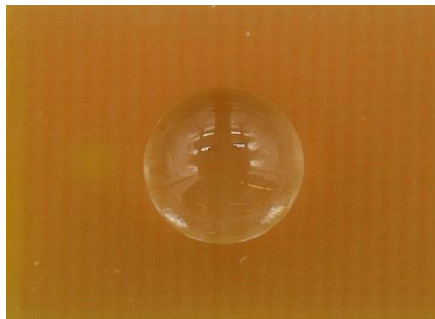


- Corrosion-sensitive permanent magnets are protected with the thin-film encapsulation technology of Coat-X
- Electrochemical dissolution of the metallic alloy is prevented
- Applied to surgical electro-motors, this allows resistance to hundreds of sterilization cycles

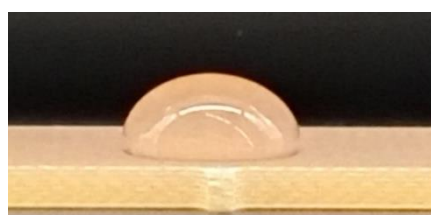
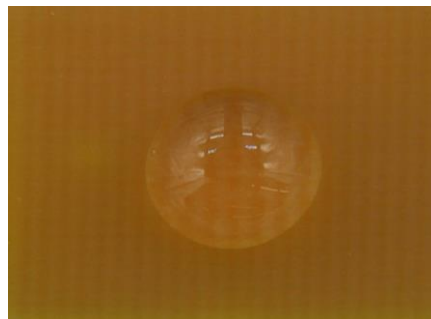


# Surface functionalization

Hydrophobic nanocoating



No coating



Hydrophilic nanocoating

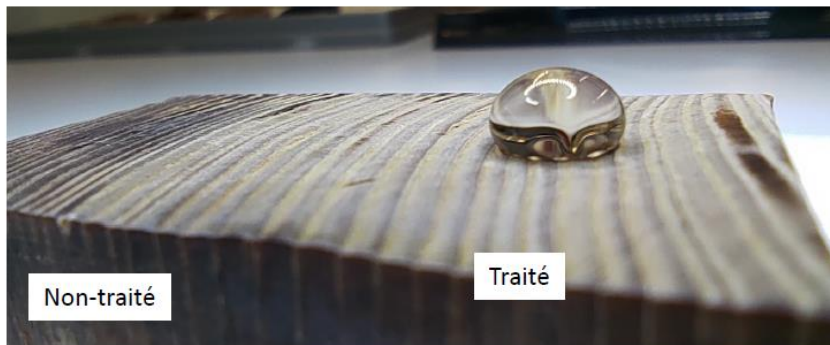


FR4 epoxy-based substrate

# Surface functionalization

## SUPER HYDROPHOBIC COATING

- Hydrophobic very thin ceramic films make any surface water repellent.
- Fluorene free
- Biocompatible
- OEKO-TEX validated
- Compatible with organic materials





# COAT-X IS A CVD EQUIPMENT PROVIDER

COAT-X develops and manufactures CVD and PE-CVD production equipment

- Tailored-made to meet specific customer requirements
- Large chamber for better productivity
- Fully automated an integrated processes (activation, Parylene and ceramics deposition)
- Development and verification of application-specific recipes



# CX-300 Parylene Coating Machine

- Coat-X proposes the **CX-300** coating machine with a deposition chamber of 265L
- CVD process is fully **automated**, and all sub-processes are **integrated** in one cabinet.
- The machine is **compact with a small footprint.**

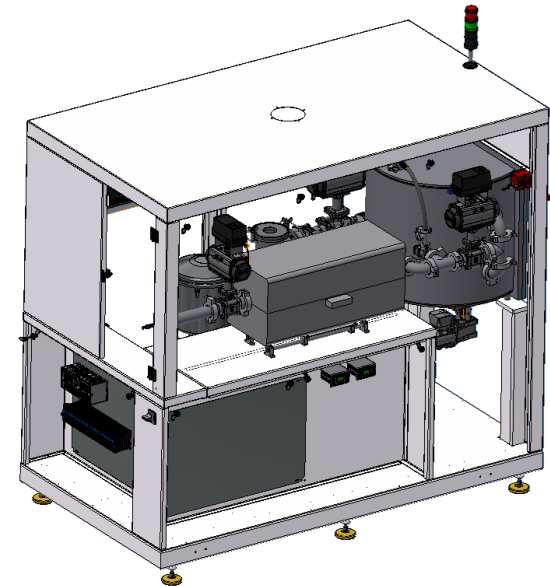
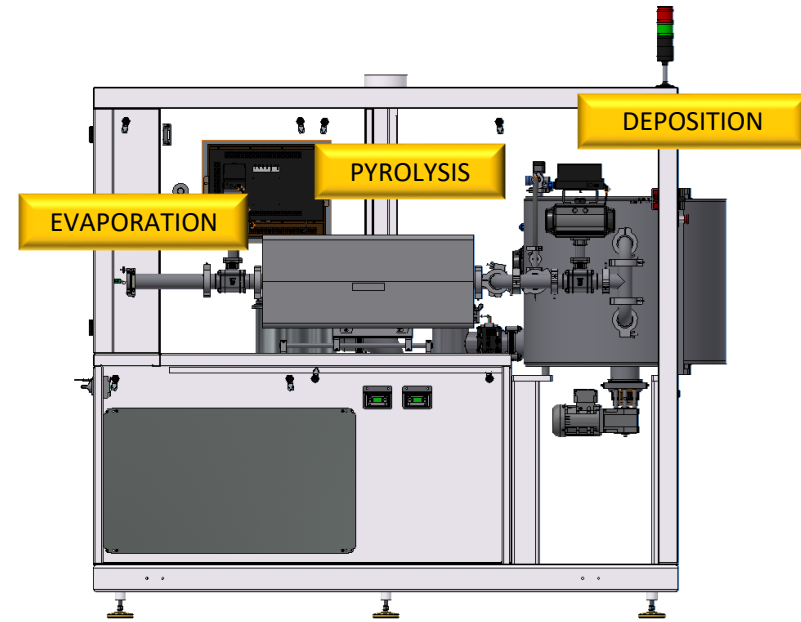


# CXP-300 Compact and accessible design

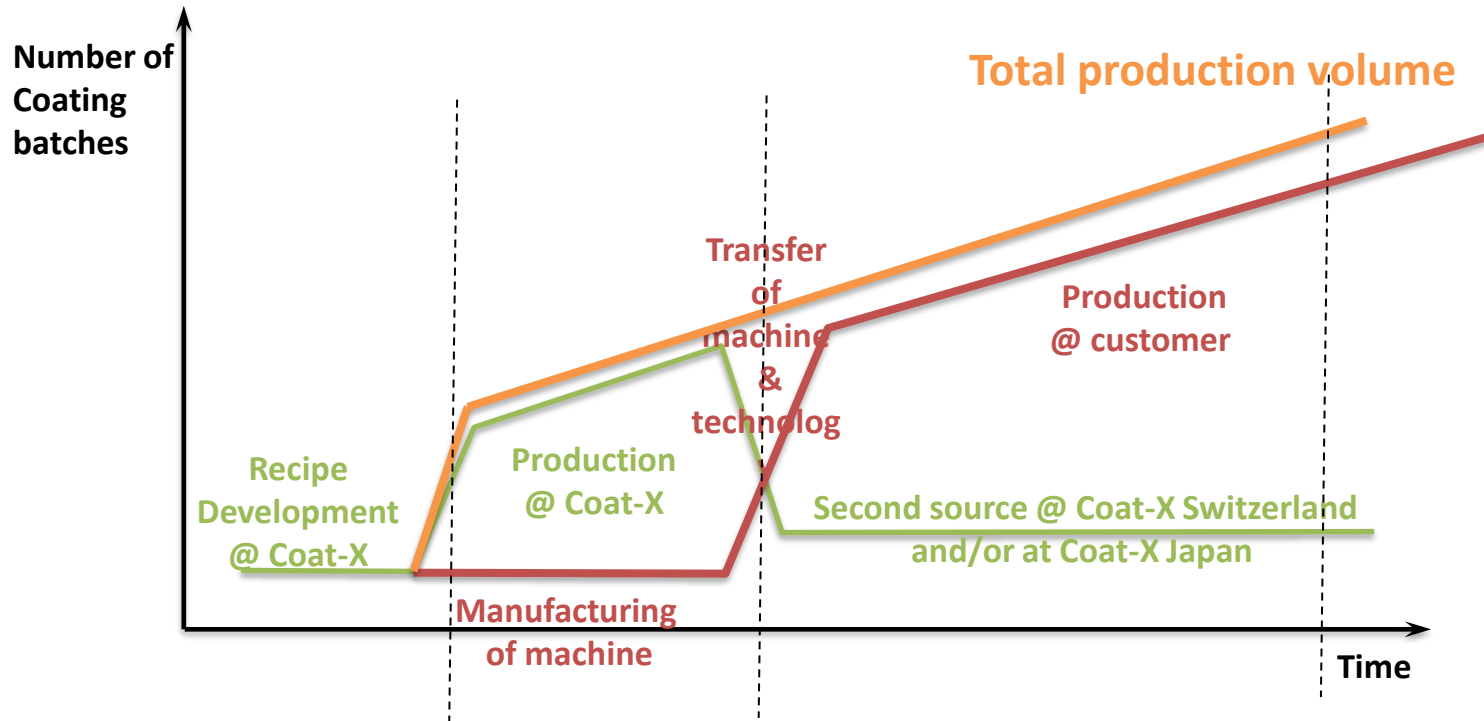


# CXP-300 Process integration

- Evaporation tube, pyrolysis oven and deposition chamber are **in line**
- Cold trap and pump are integrated within the cabinet
- Power supply and automation are just below process chambers



# Equipment implementation model



CONFIDENTIAL

# Thank you!

If you have any question please let us know

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