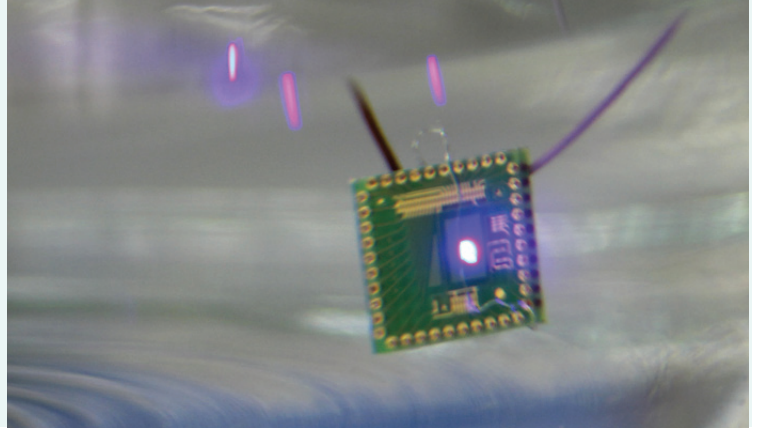
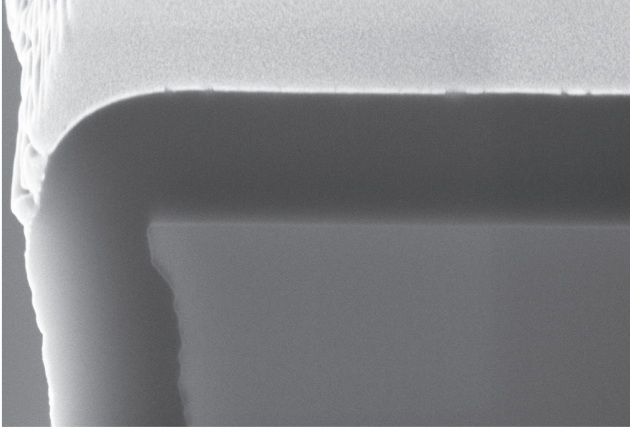


# THIN FILM ENCAPSULATION USING 3D CONFORMAL PARYLENE® DEPOSITION



## Contact

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#### Figures:

SEM image of cross section of 600 nm Parylene C  
on a silicon pillar. (left)

LED on PCB coated by Parylene in 5 m% NaCl  
solution. (right)

Photo acknowledgments: Fraunhofer ENAS

All information contained in this datasheet is preliminary and subject to change. Furthermore, the described systems, materials and processes are not commercial products.

3D conform Parylene coatings are extremely thin, non porous / pinhole-free polymeric coatings for many different purposes and provide high-value surface treatment properties.

#### Highlights:

- Excellent moisture, chemical and dielectric barrier
- Hydrophobic
- Optical transparent
- Chemical inert
- Thermal stability
- Dry-film lubricity
- Biocompatible

#### Parylene CVD Process (Gorham Process):

- Deposition at ambient temperatures
- Pinhole-free at  $d > 0.2 \mu\text{m}$
- Uniform layer thickness
- Self-initiated reaction
- Un-terminated
- No solvent or catalyst required
- Yield of 100 % monomer above 550 °C in vacuum (using [2,2]p-cyclophane)
- No by-products

#### Parylene Deposition at Fraunhofer ENAS

- Plasma Parylene LC 300 RW
- Chamber dimensions:  $\varnothing 350 \text{ mm}$  and 350 mm high with rotary table
- Process pressure: 2 – 5 Pa
- Plasma treatment: Ar, O<sub>2</sub>
- Other surface treatment: Silanization (A-174)
- Facility located in clean room environment
- Deposition of Parylene C, F and other types
- Patterning by different technologies

#### Applications:

- Electronics (dielectric coatings for circuit boards, packages for MEMS, protective coatings for organic electronics)
- Medical (biocompatible encapsulation coatings for implantable and non-implantable devices)
- Automotive (protective coatings for sensors/electronics)
- Micromechanical systems/sensors
- Semiconductor industry
- Analytics
- Barrier layers (e.g. filter, membranes)
- Chemical industry (glue, paint, gum)
- Abrasion and corrosion protection
- Bonding

	Parylene				
	N	C	D	F	AF4
Melting point [°C]	410	290	380	> 460	> 500
Continuous temperature [°C]	90	125	160	190	350
Temporary peak temperature [°C]	120	200	300	300	450
Tensile strength [MPa]	45	69	76	52	52
Yield point [MPa]	43	55	62	34	34
Tensile modulus [MPa]	2400	3200	2800	2500	2.500
Strain to rupture [%]	250	200	200	200	200
Yield strain [%]	2,5	2,9	3	2	2,0
Density [g/cm <sup>3</sup> ]	1,11	1,289	1,418	1,32	1,32
Dynamic friction coefficient	0,25	0,29	0,31	0,13	0,13
Refractive index	1,661	1,639	1,669	1,559	1,559
Short-term dielectric strength [V/mil @ 1 mil]	7000	5800	5500	5500	5.500
Dielectric constant @ 1 kHz	2,65	3,1	2,82	2,1	2,20
Dielectric constant @ 1 MHz	2,65	2,95	2,8	2,16	2,17
<b>Gas permeability @ 23 °C [(cm<sup>3</sup> x mm)/(m<sup>2</sup> x 24 h x atm)]</b>					
N <sub>2</sub>	7,7	0,37	1,77	4,85	4,80
O <sub>2</sub>	11,81	2,8	12,6	23,5	23,00
H <sub>2</sub>	212,6	43,31	94,49	n/a	n/a
H <sub>2</sub> O [(g x mm) / (m <sup>2</sup> x 24h)] @ 37 °C 90 %RH	0,59	0,06	0,1	0,23	0,22
Thermal expansion coefficient [ppm/°C]	69	35	38	36	36
Thermal conductivity @ 25 °C [W/(m x K)]	0,12	0,082	n/a	0,096	0,096