Advanced material solutions for packaged optoelectronic devices

saes

making innovation happen, together

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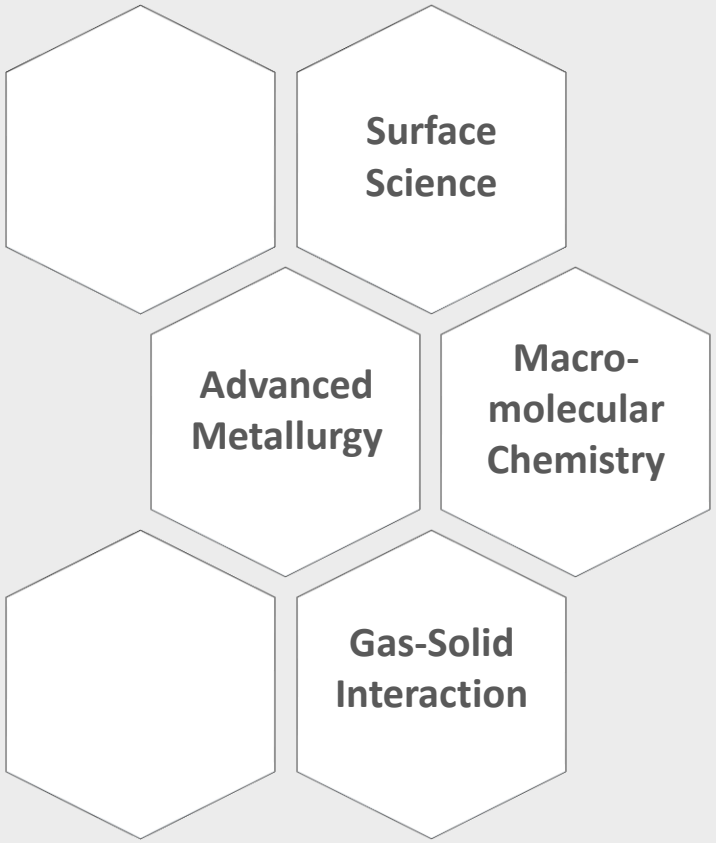
EPIC TechWatch at ECOC – Basel, September the 21st, 2022

AGENDA

- ✓ Photonic Packaging
- ✓ Potential Issues and Contaminants
- ✓ Getter solutions and main features
- ✓ Takeaways

SAES: an Advanced Material Company

FROM OUR KEY CORE COMPETENCES



Our

ADVANCED FUNCTIONAL MATERIALS

Functional Metals

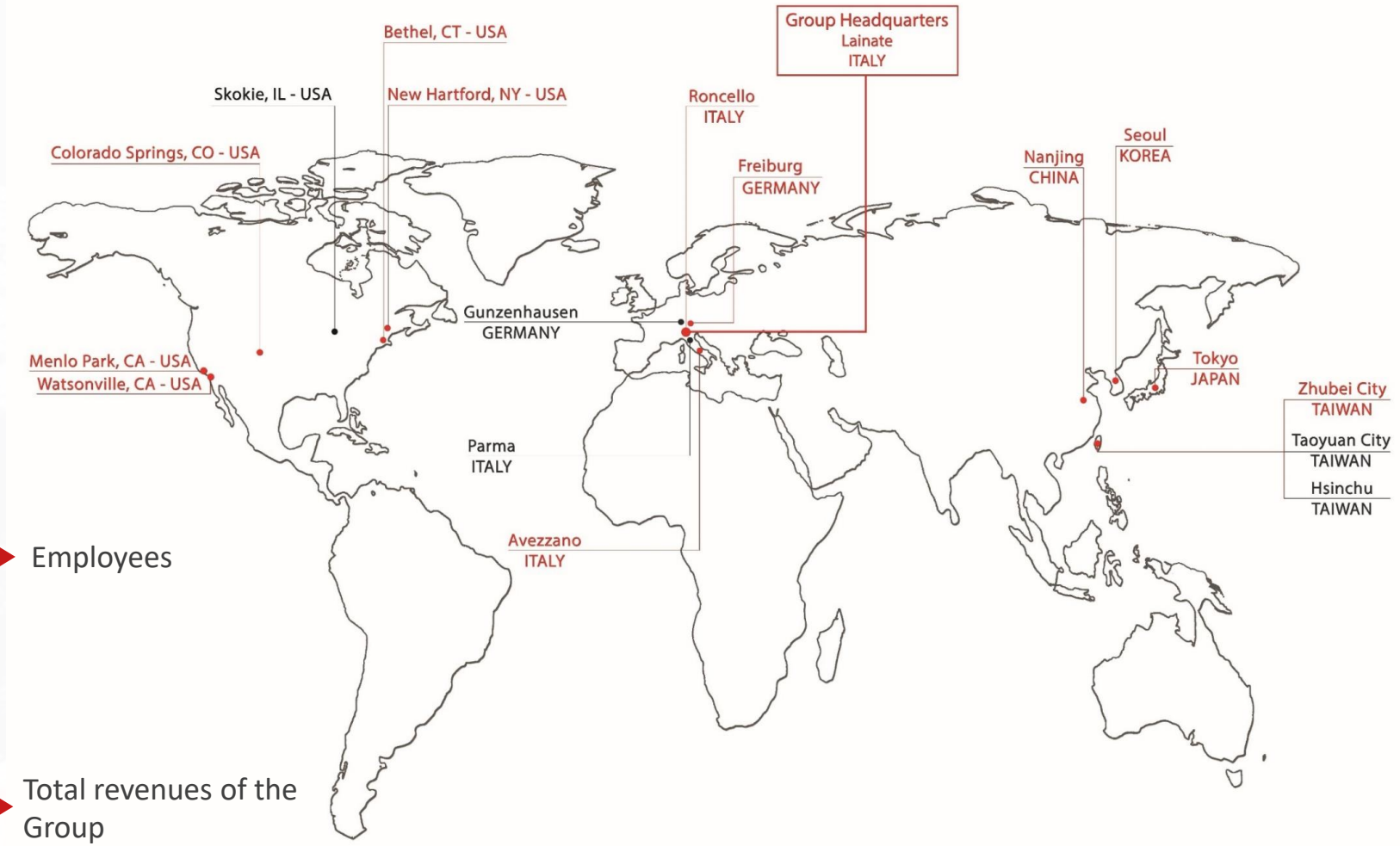
- Getter Alloys
- Alkali Metal Dispensers
- Sintered Heat Sink submounts
- Shape Memory Alloys

Functional Chemicals

- Inorganic & Organic Getters
- Advanced Polymers
- Advanced Composites

The Group at a glance

The parent Company SAES Getters S.p.A. is listed on the Italian Stock Exchange Market, STAR segment, since 1986.



80 Years A long history of innovation

~1,100 Employees

10 Production sites worldwide

> 198 M€ Total revenues of the Group

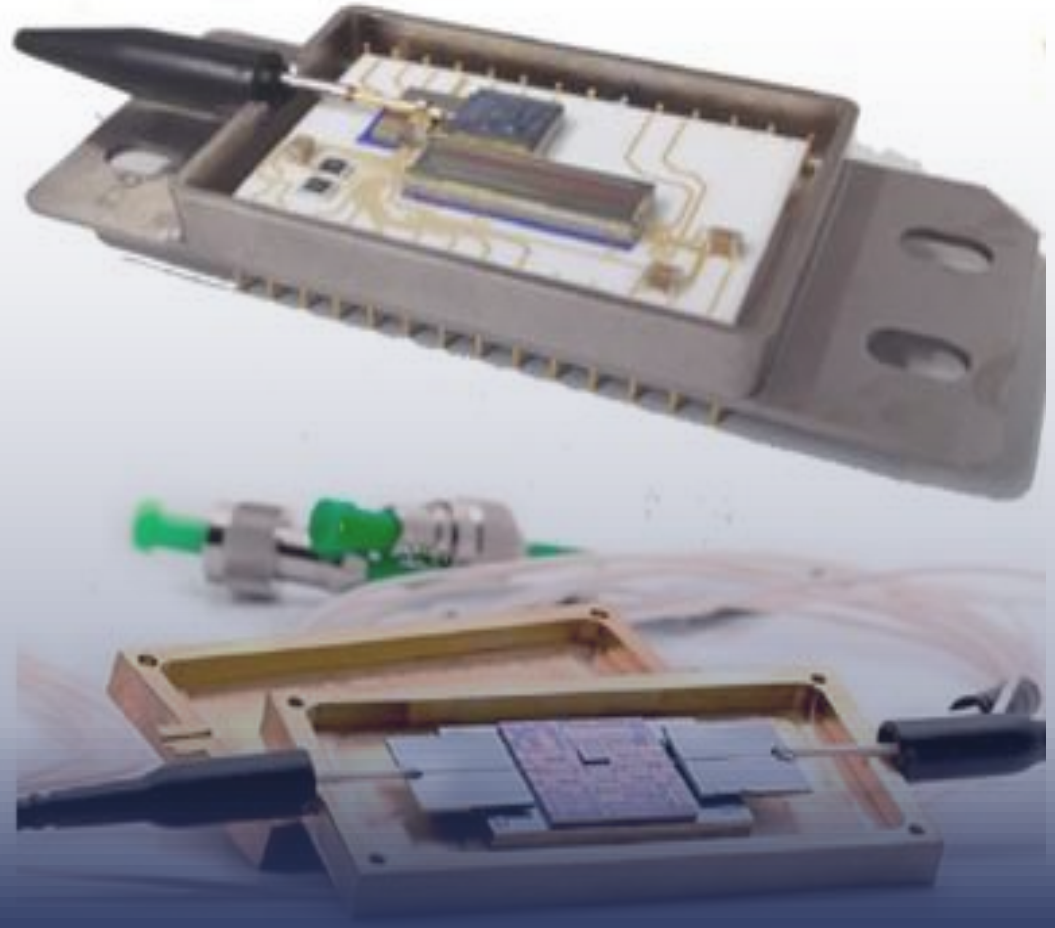
R&D Our first values are Research & Innovation

Quality All the Group factories are certified according to proper ISO/DIN standards related to their own business field

Photonic Packaging

- **Proper packaging** is a key-step to obtain good quality photonic devices: optical, electrical, and thermal needs require important efforts to assure performances and reliability of the systems

- **Goals of the Packaging:**
  - Ensure Interconnections for Inputs-Outputs, Interaction with environment:
    - Electrical signals,
    - Optical signals (transparent windows, optical waveguides, fibers)
    - Pressure, Gases, etc.
  - Protect devices from environment (mechanical stability, protection from dust)
  - Provide correct atmosphere for proper functioning (vacuum, nitrogen, avoid moisture and contaminants)

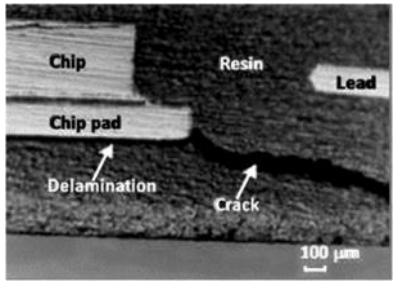


L.Carroll, P.O'Brien et al. Appl.Sci. 2016, 6,426 doi:10.3390/app6120426

Several Issues related to contaminants

✓ **Packaged photonic devices** may suffer problems related to gaseous contaminants: moisture, Hydrogen, volatile organic compounds (VOCs)

Device	Gaseous Contaminants	Induced Problems
Laser Diodes	VOCs	Performances degradation
Laser modules, Optical devices	Moisture	Condensation, oxidation, corrosion on contacts, shorting, swelling
Optical transmitters/receivers, Transceivers, Multiplexers, etc.	Moisture, Hydrogen	Oxidation, corrosion, swelling, dark current increase; Electric changes, Signal attenuat.
Optical fibers	Hydrogen	Signal shift & attenuation, moisture formation



✓ **Critical levels of main contaminants in devices: H_2O > 5000ppm; H_2 > 1000ppm**

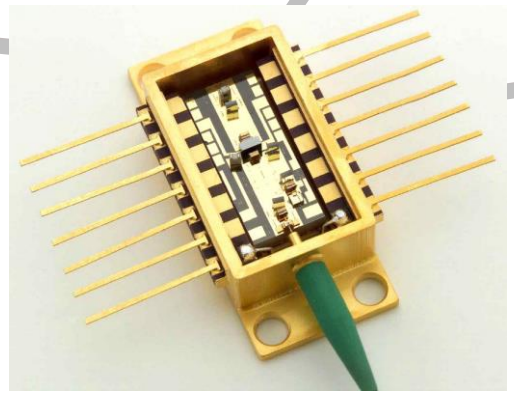
Gas sources inside packaged devices

Moisture

- By product die attach adhesive curing
- Desorption from porous or polymeric materials
- Reaction of H_2 with oxide layers
- Contamination of backfilling gases (N_2, air, He)

Hydrogen

Desorption from:
- Metals
- Plating



https://www.sandia.gov/media/NewsRel/NR2000/images/jpg/ocm.jpg

VOCs

Desorption from:
- glues
- Epoxies
- Contaminated surfaces

Dispensable getters: SAES solutions

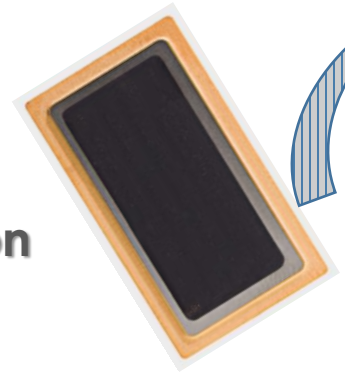
ZeDry™ Family

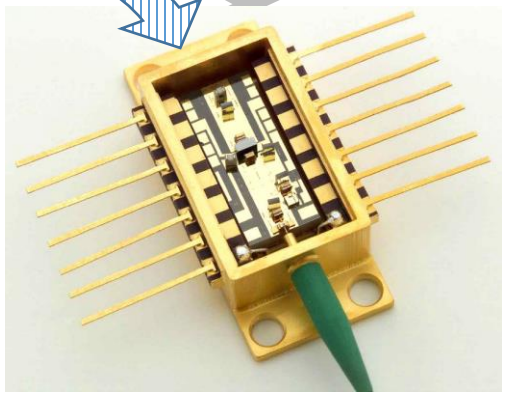
ZeDry-M
High level of moisture

ZeDry-H_2
Hydrogen & Moisture

ZeDry-VOC
VOCs & Moisture

ZeDry Getter Film on metallic Lid





https://www.sandia.gov/media/NewsRel/NR2000/images/jpg/ocm.jpg

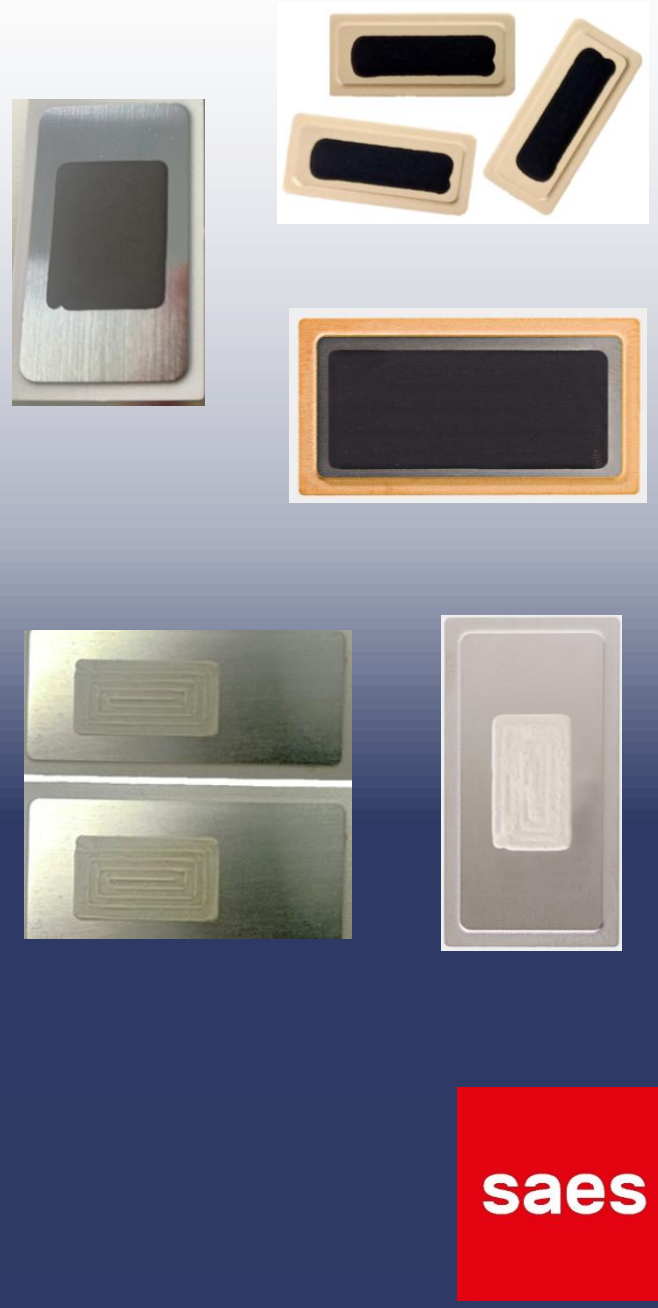
ZeDry™ Family Getters: general features

Formulations:

- ✓ Solventless formulations: no outgassing issues
- ✓ Formulations can be handled in ambient air
- ✓ High decomposition temperatures: > 300 °C
- ✓ Compatible with laser/seam welding sealing processes

Process integration:

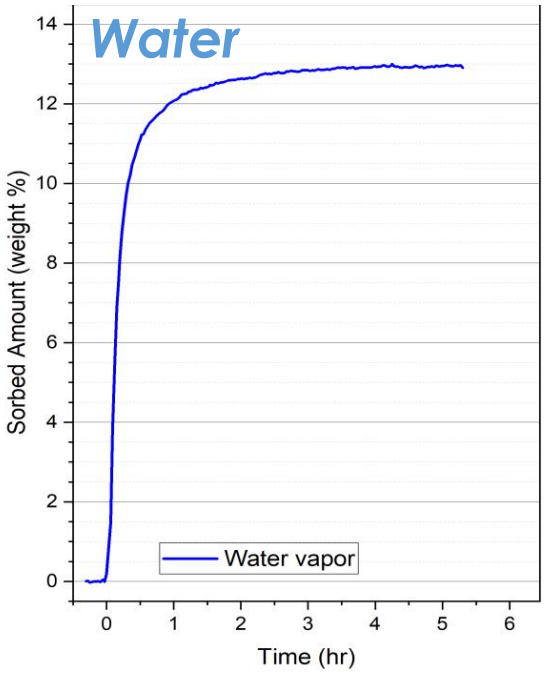
- ✓ Dispensable pastes by needle dispensing
- ✓ Thermally curable formulations
- ✓ Substrates: kovar lids, ceramic, glass
- ✓ Getter activation conditions prior sealing:
  - ✓ Vacuum – nitrogen – dry air
  - ✓ Temperatures: 100 °C – 200 °C
  - ✓ Time: few hours
- ✓ Water absorption properties up to 80 °C - 100 °C

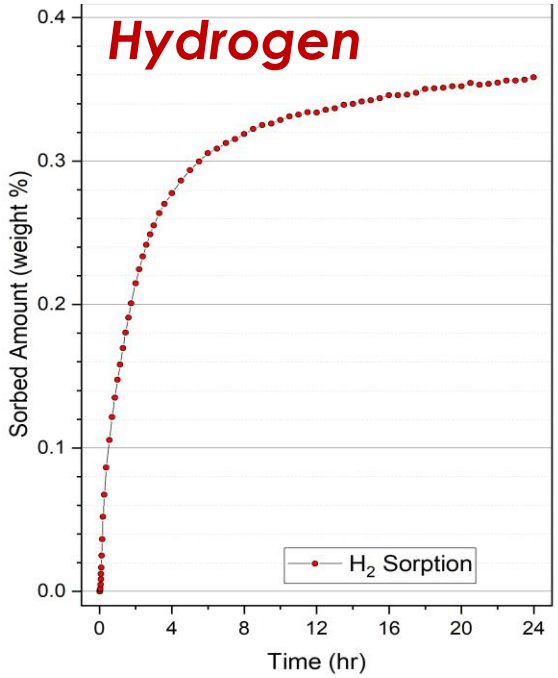


ZeDry/H_2: Getter solution for H_2 and H_2O

Main characteristics:

- ✓ Nominal Moisture Capacity: 13%wt
- ✓ Nominal Hydrogen Capacity: 40 Ncm^3/g
- ✓ Hydrogen and moisture adsorptions are not competitive processes



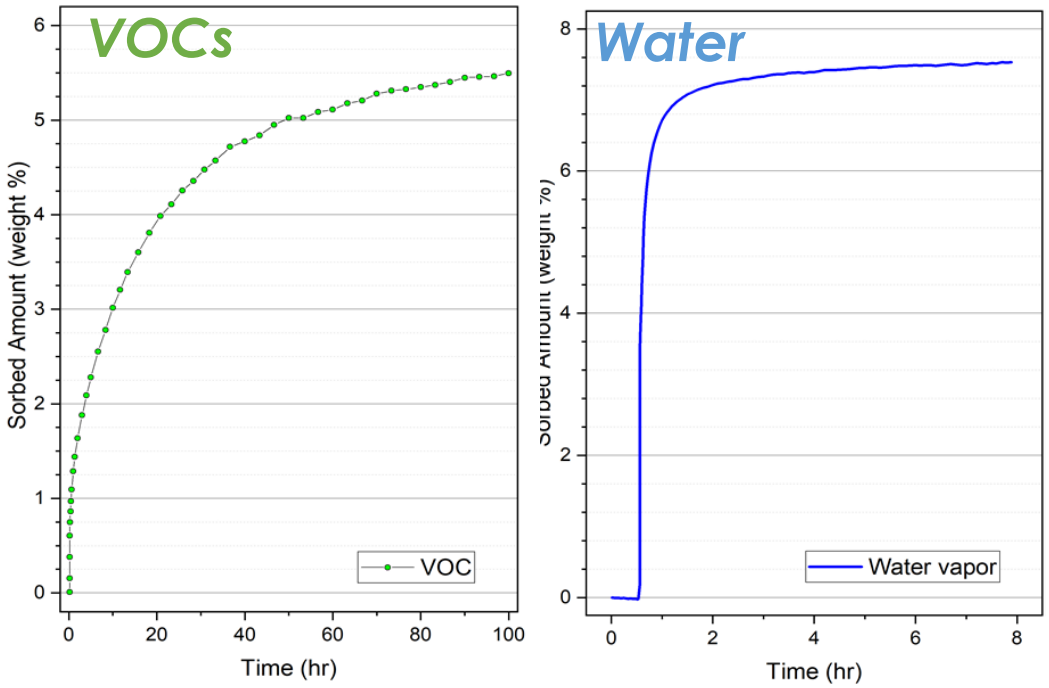


- ✓ Reversible getter adsorption for H_2O, irreversible getter for H_2
- ✓ Sorption measurements @ RT
- ✓ Water vapor pressure: 15 mbar
- ✓ Hydrogen pressure: 8 Torr

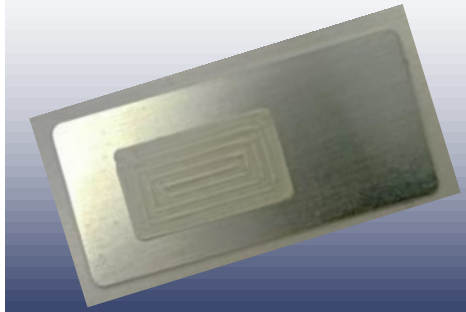
ZeDry/VOC: Getter solution for VOCs and H_2O

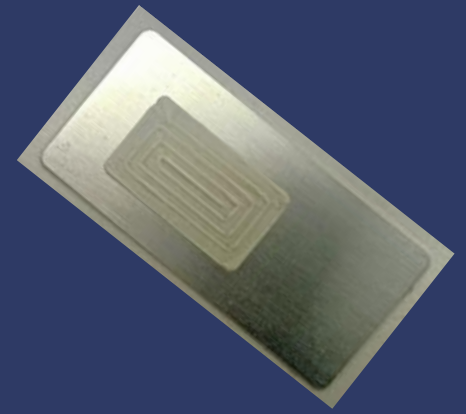
Main characteristics:

- ✓ Nominal Moisture Capacity: 8%wt
- ✓ Nominal Capacity for VOCs: 5%wt
- ✓ VOCs and moisture adsorptions are not competitive processes



- ✓ Reversible getter adsorption for VOCs and H_2O
- ✓ Sorption measurements @ RT
- ✓ Water vapor pressure: 15 mbar
- ✓ VOC pressure: 55 mbar

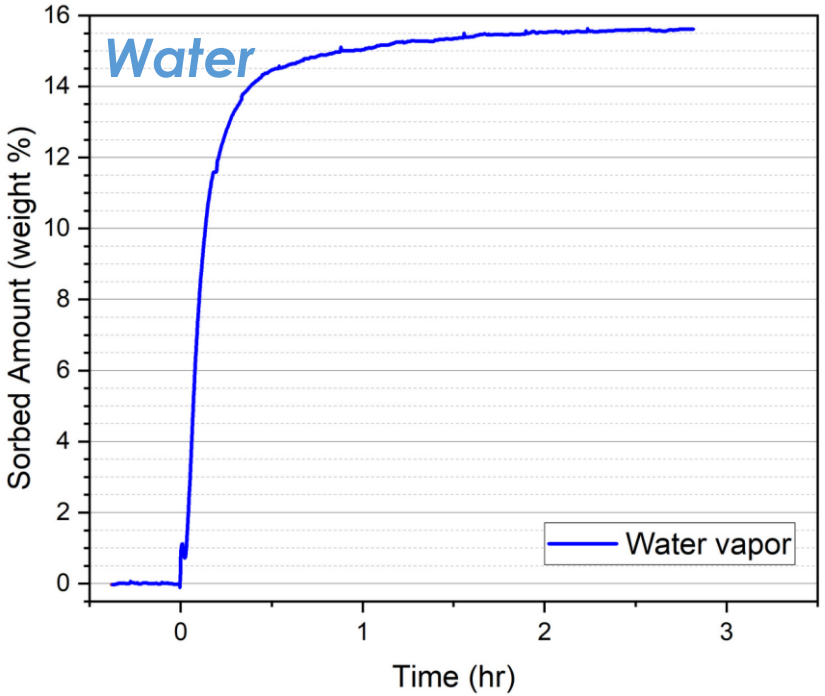




ZeDry/M: Getter solution for H_2O

Main characteristics:

- ✓ High Capacity getter
- ✓ Nominal Moisture Capacity: 15%wt



- ✓ Reversible getter adsorption for H_2O
- ✓ Sorption measurements @ RT
- ✓ Water vapor pressure: 15 mbar

TAKEAWAYS

- ✓ Photonic Devices may suffer issues from gaseous contaminants, inside the package, like H_2O-H_2-VOCs
- ✓ Issues can cause performance degradation, signal shift and attenuation, shortage
- ✓ Tailored getter materials can be integrated inside the device in order to absorb gases and assuring proper device functionality over lifetime.

Thank you

for your attention

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