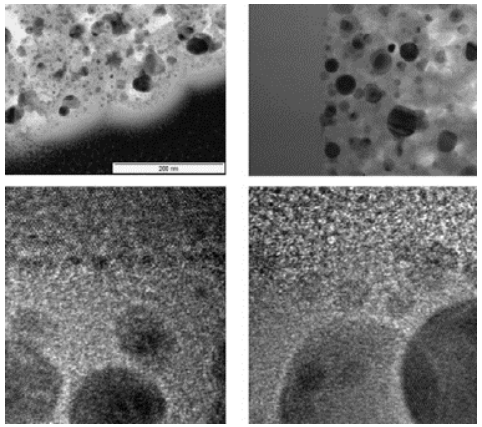
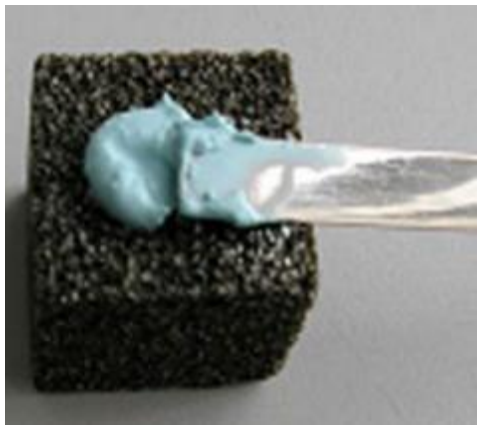
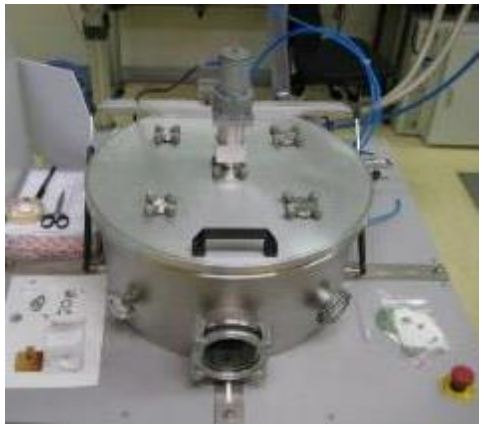
Activity on coatings at GLANCE

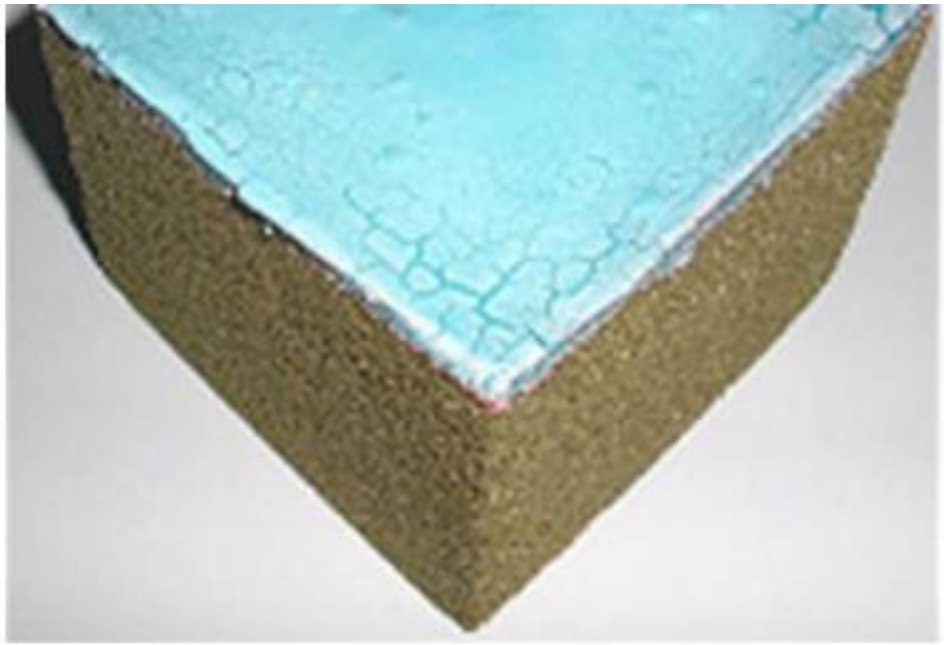
http://www.composites.polito.it/

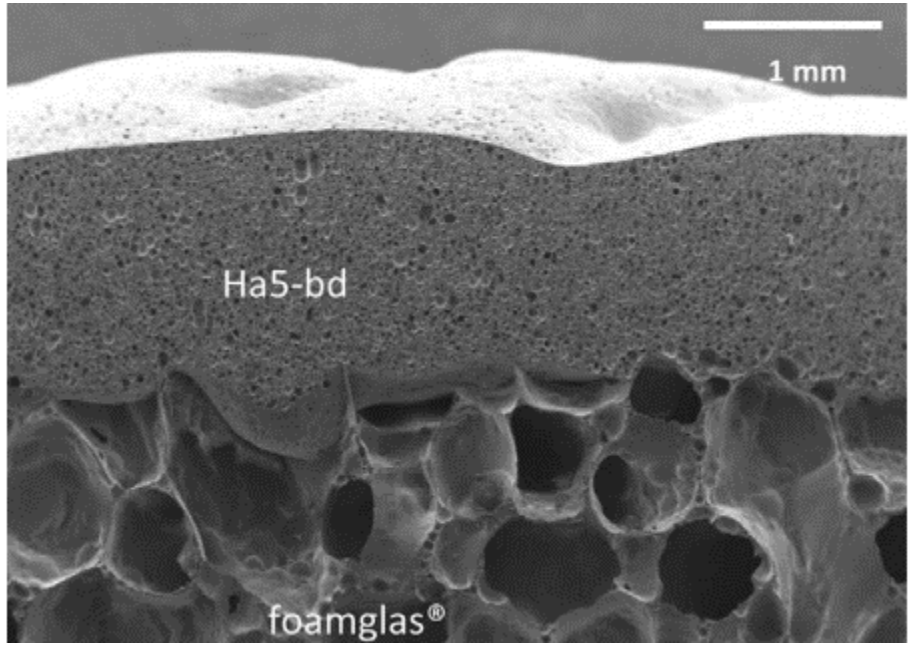
http://www.j-tech.polito.it/





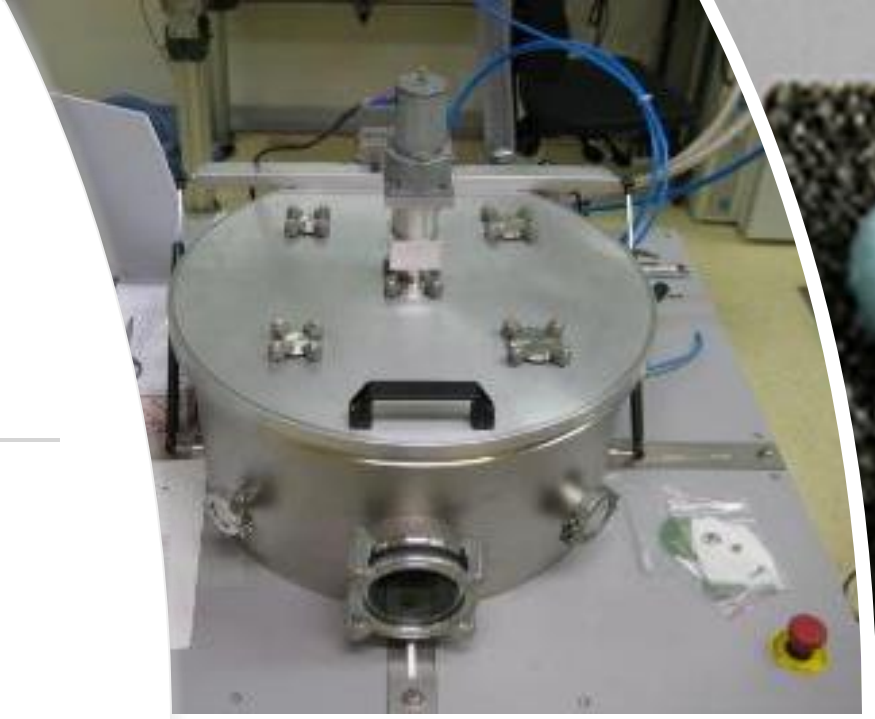


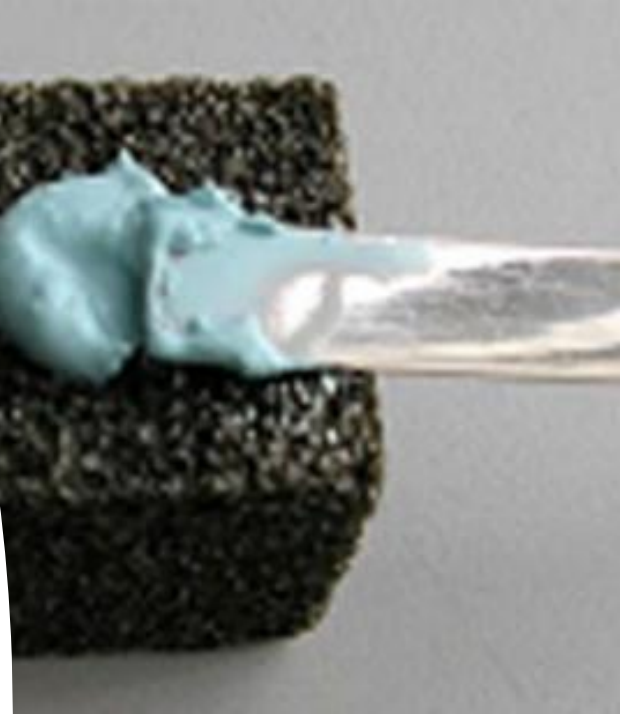


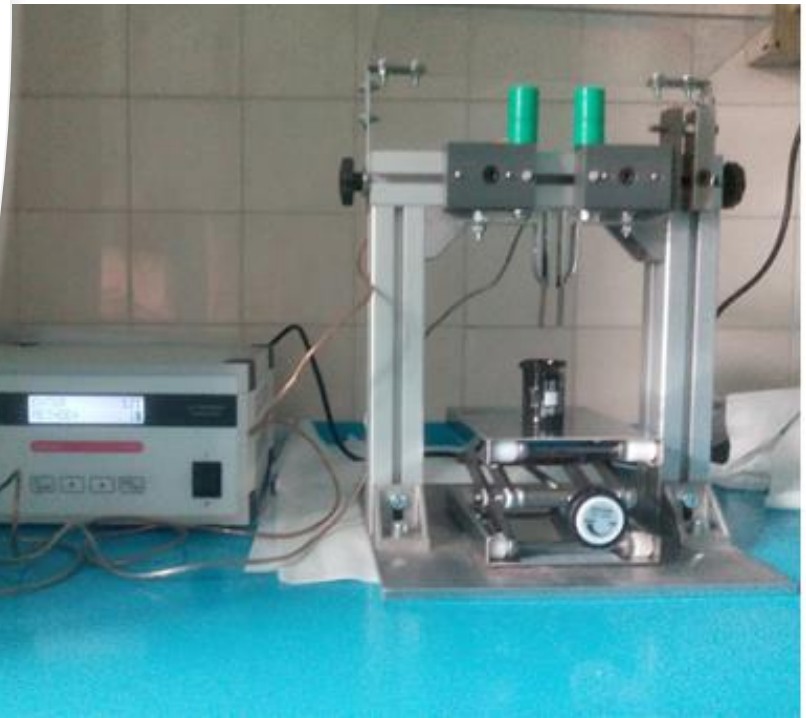


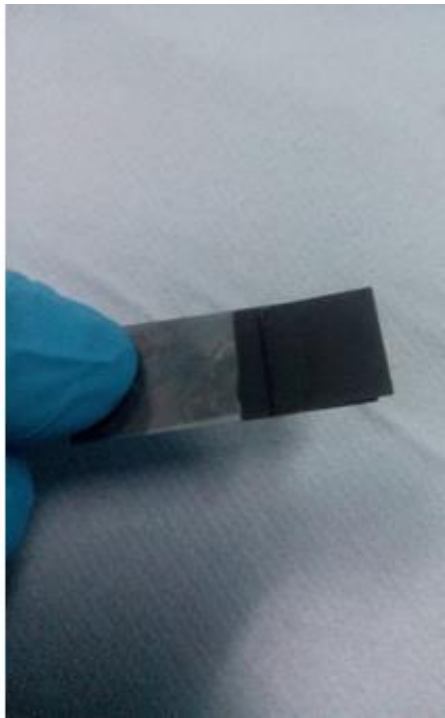
Available coating tecnologies

- *Slurry*
- *Sputtering*
- *ElectroPhoreticDeposition*
- *Sol-gel*
- *Polymeric and hybrid coatings*
- *Plasma*
- *Laser*
- *Dipping*
- *Heat treatment in molten salts*



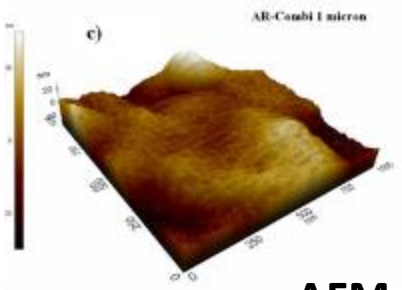


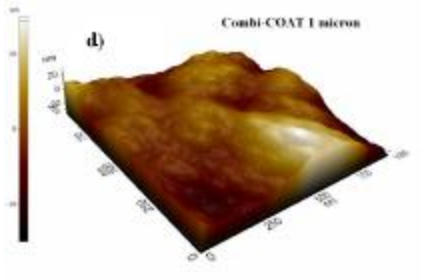




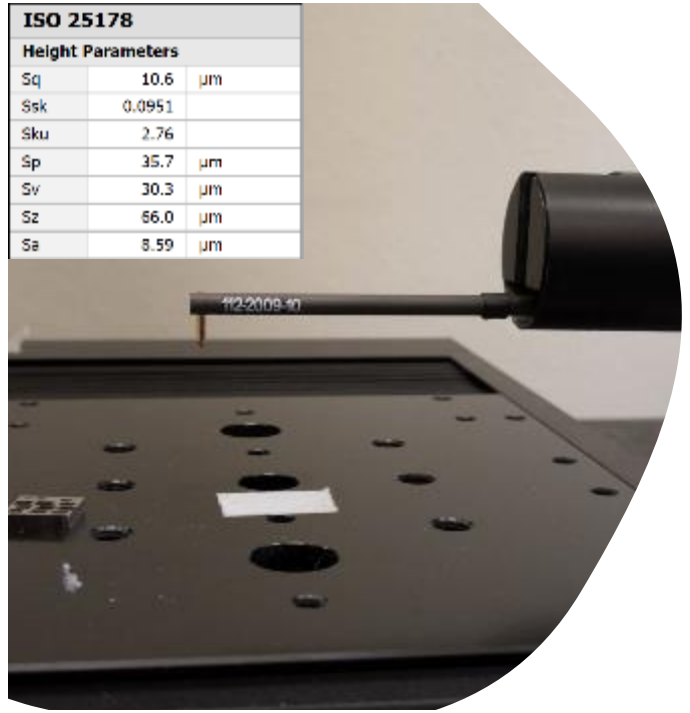
Available tests on coatings

- Oxidation tests
- Profilometry
- Tape test
- Hardness (HV, …)
- Z-potential
- FE-SEM/EDS/EBDS
- Optical microscopy
- Confocal microscopy (Ra, Sa, Sq….)
- Atomic Force Microscopy and KPFM
- ATR-FTIR analysis
- Wetting angle
- Thermal and thermal shock resistance tests
- Antibacterial test with non-pathogen bacteria and fungi
- Surface contamination test by means of bacterial aerosol generator

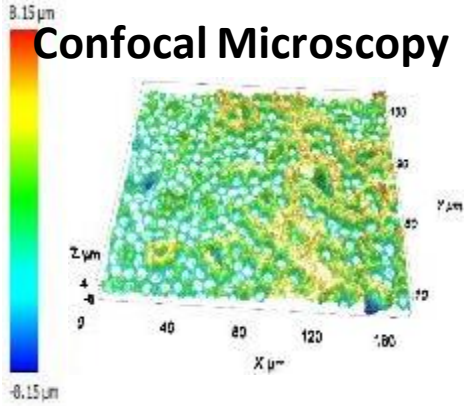


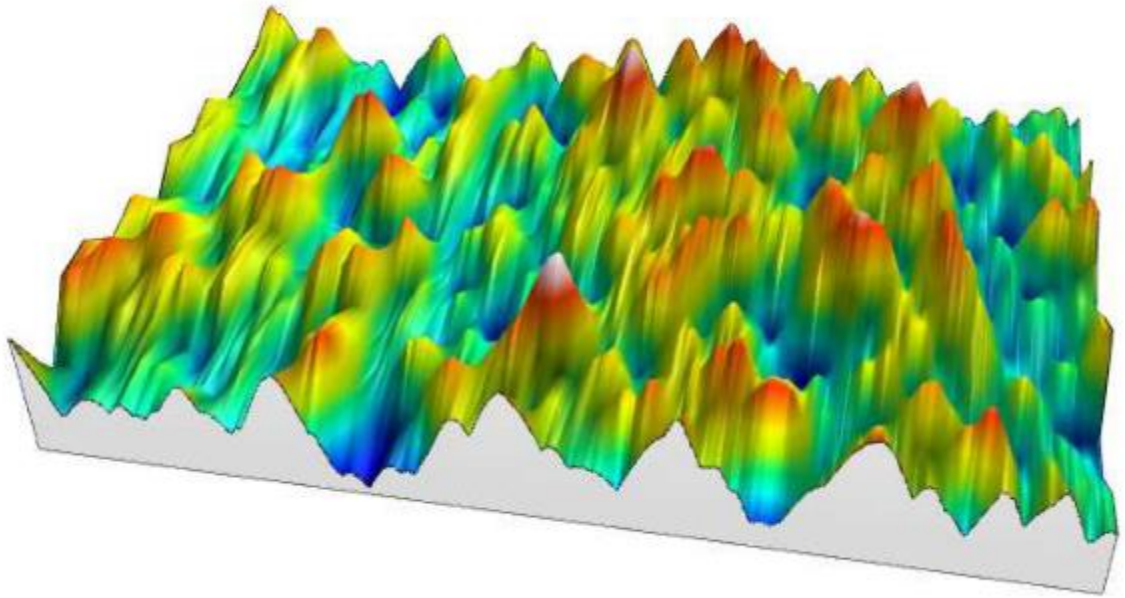


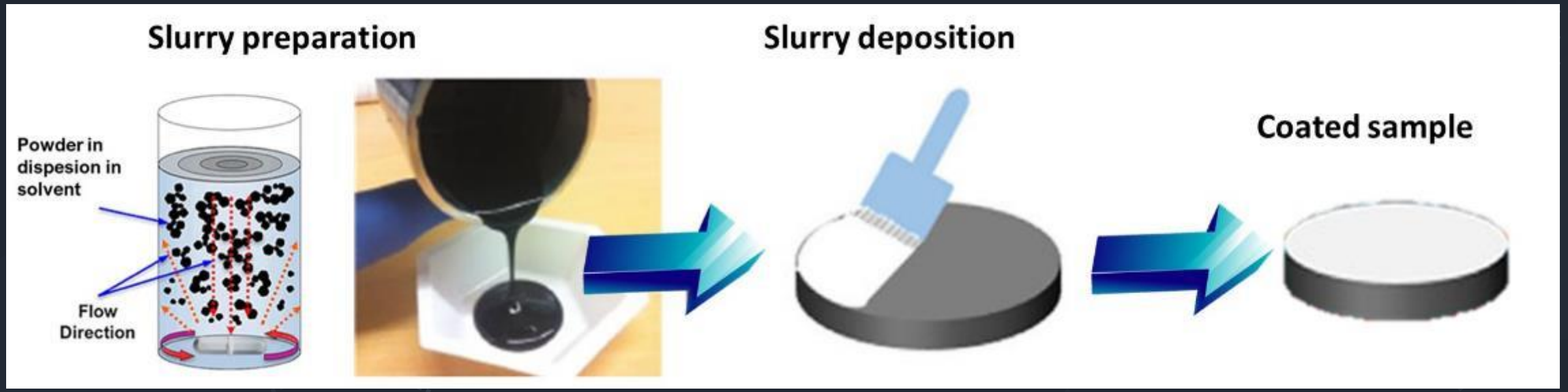
AFM



Confocal Microscopy







coatings by slurry

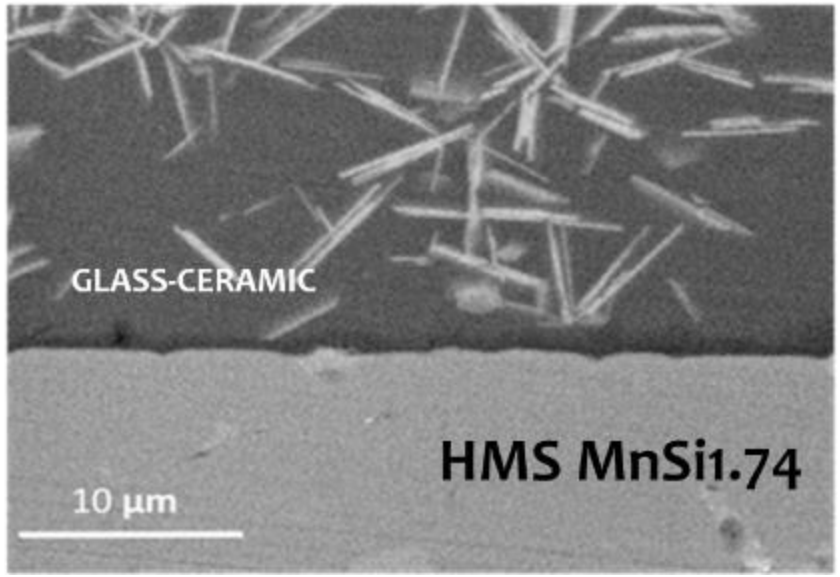
- Suitable for a wide range of materials:
  - Glasses, glass-ceramics, composites, polymers, metals, multilayers,...

- Powder selection
- Slurry preparation and deposition
- Thermal treatment

Oxidation protection coatings by slurry

- Development of oxidation protective coating for thermoelectrics

Oxidation protection up to 600°C



M. Salvo et al, Journal of the European Ceramic Society, 39 (2019) 66-71.

- Development of oxidation protective coating for carbon/carbon composites

Oxidation protection of C/C up to 1300°C, in air, 50 hours

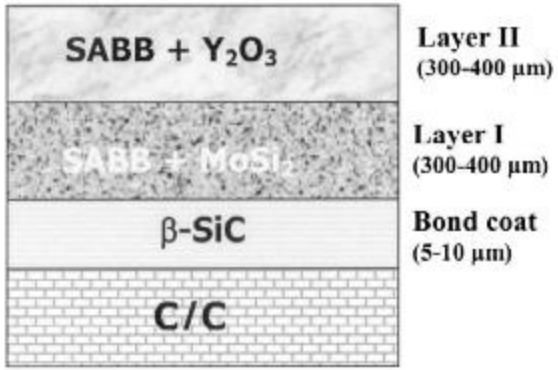


Fig. 1. Scheme of the multilayer coating system.

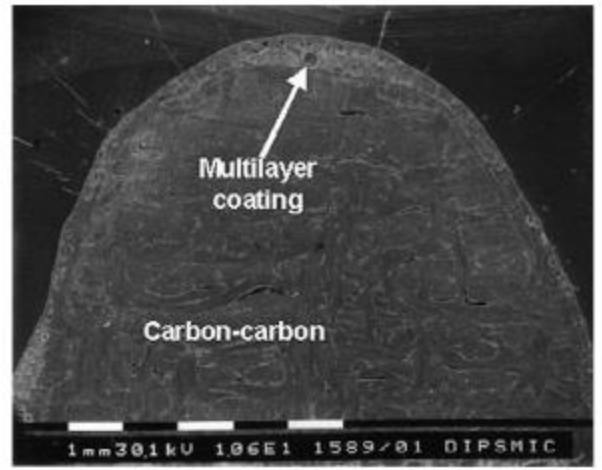


Fig. 8. SEM micrograph of the cross section of the sample TC after 50 h of thermal cycling tests at 1300 °C in air.

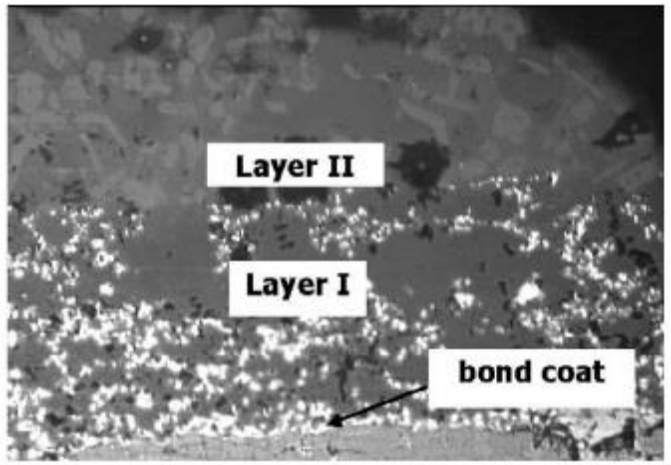
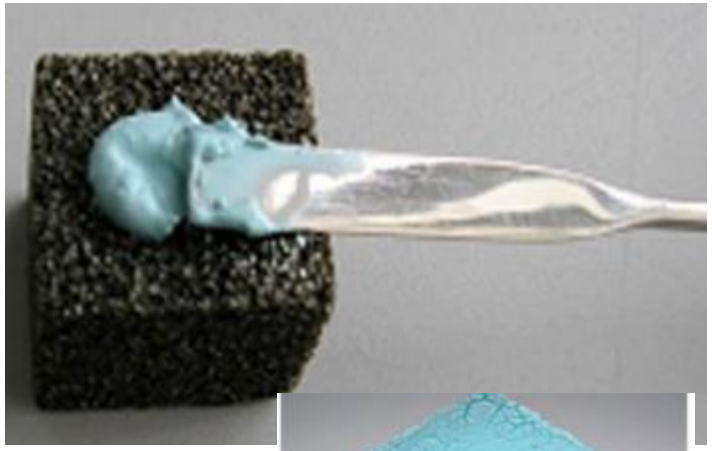


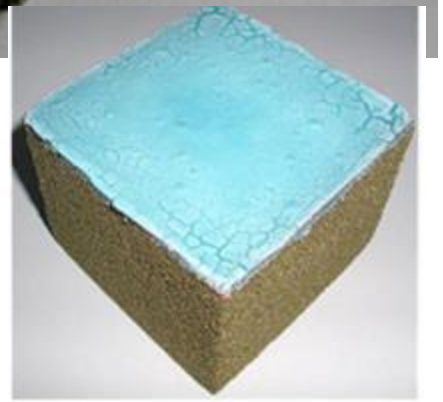
Fig. 2. Optical micrograph of a cross section of the multilayer coated C/C.

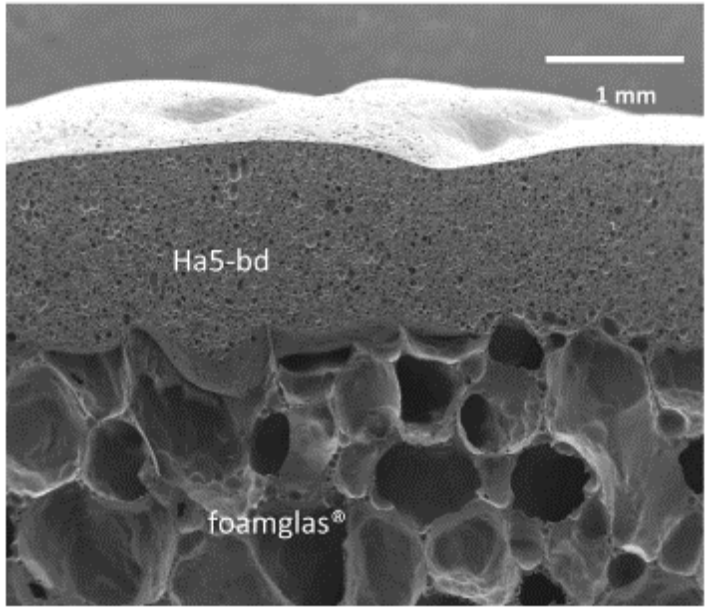
F. Smeacetto et al. / Carbon 41 (2003) 2105–2111

Oxidation protection coatings by slurry

- Development of Durable Glass-Ceramic Coatings for Foam Glass





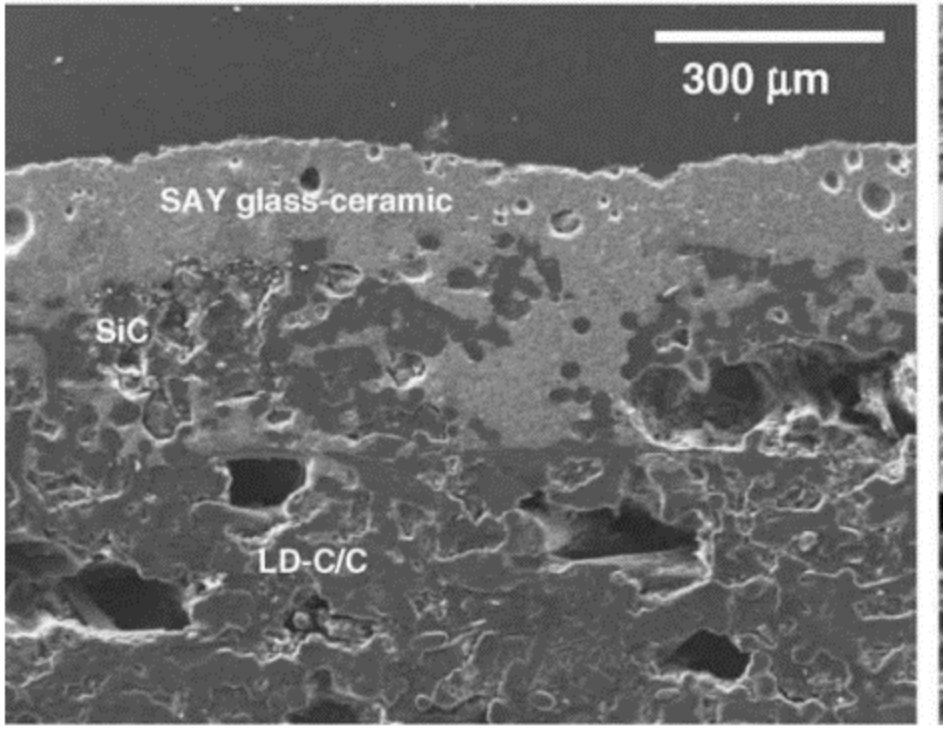


JMEPEG (2012) 21:2380–2388 ASM International DOI: 10.1007/s11665-012-0164-9

International Journal of Applied Glass Science 3 [1] 69–74 (2012) DOI:10.1111/j.2041-1294.2011.00071.x

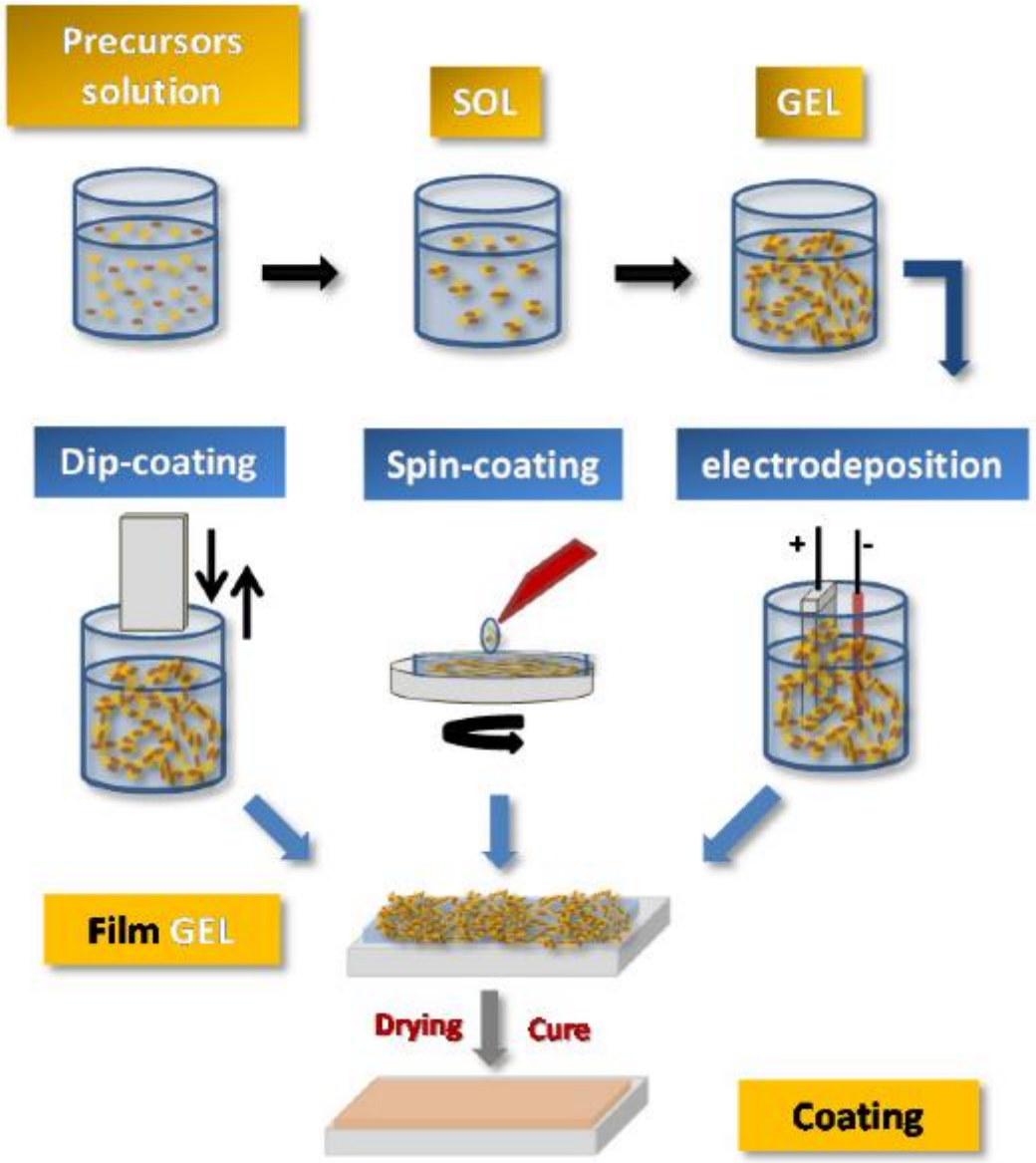
: Smeacetto F, et al. New glass-based coatings coloured with red pigments for Foamglas® panels. J Eur Ceram Soc (2012), http://dx.doi.org/10.1016/j.jeurceramsoc.2012.12.00

- Development of glass-ceramic erosion protective coating for carbon/carbon composites

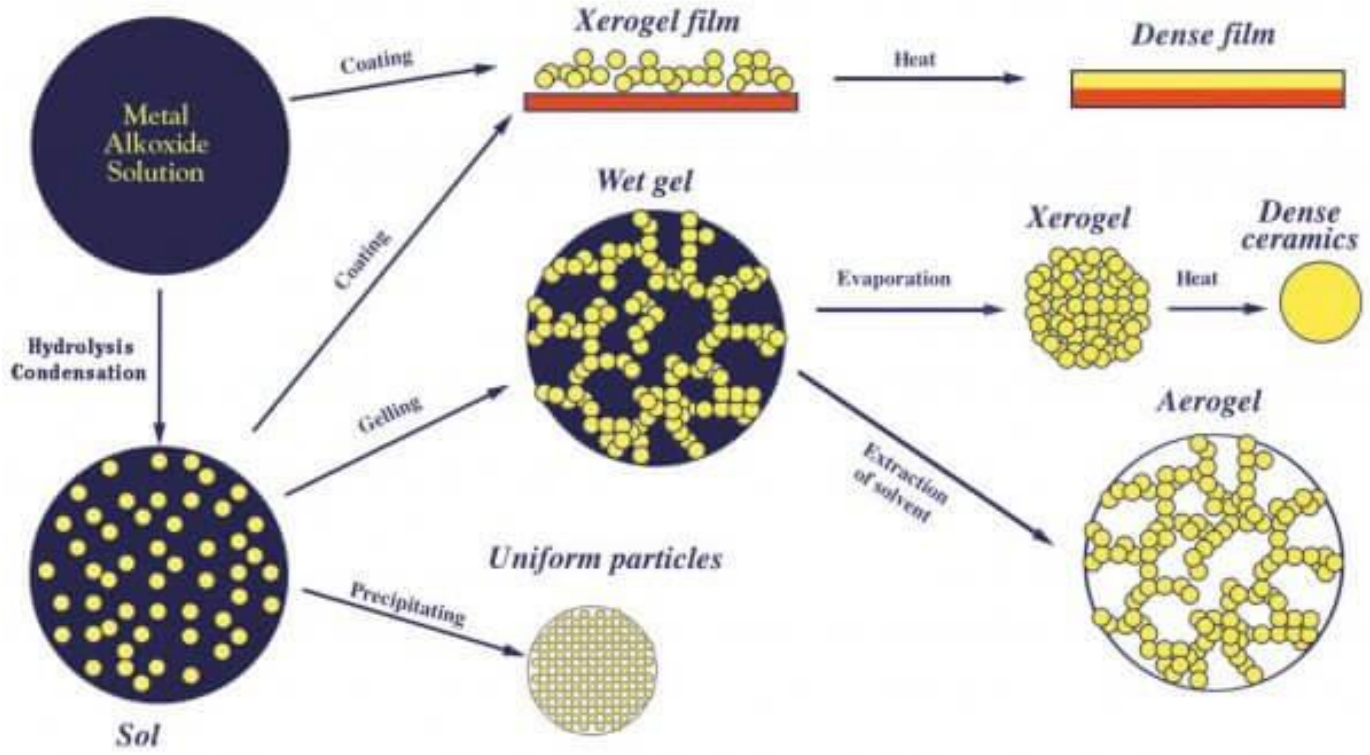


CARBON 47 (2009) 1511 – 1519

coatings by sol-gel

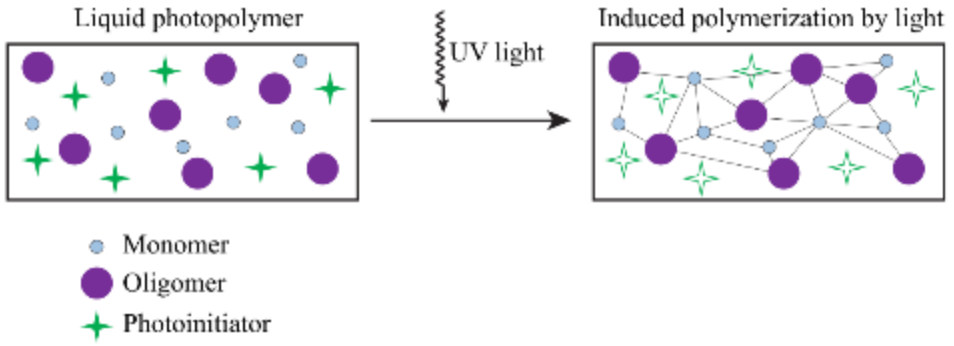


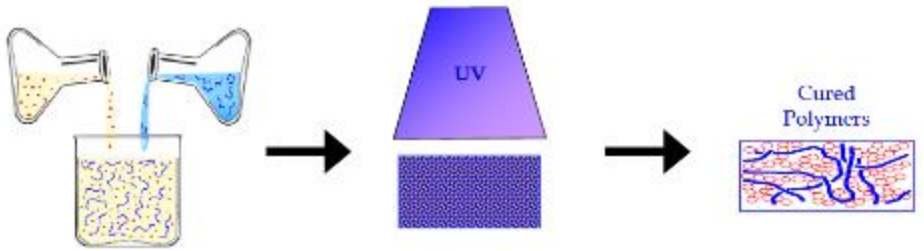
Hybrid coatings by sol-gel



UV-cured polymeric coatings

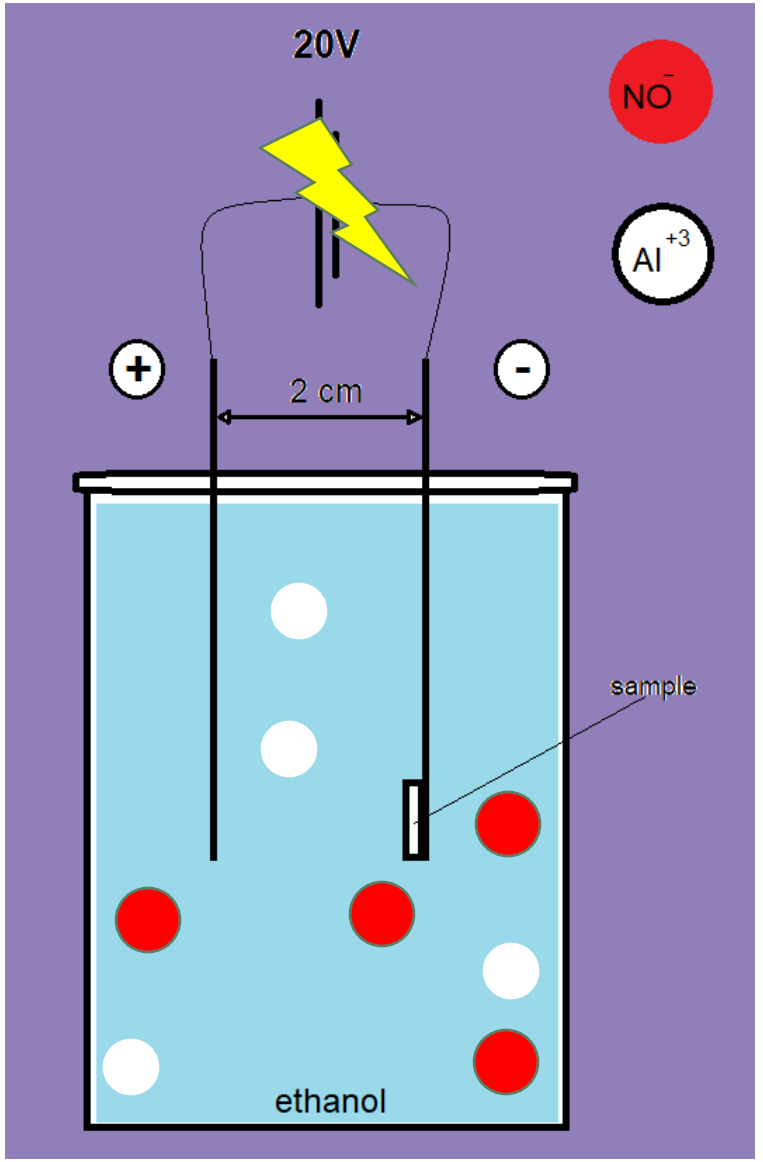
- **<u>Advantages:</u>**
- High cure rate
- Process at room temperature
- Environmental friendly technique
- **<u>Disadvantages</u>:**
- Limited curable thickness
- Difficult cure in the presence of fillers





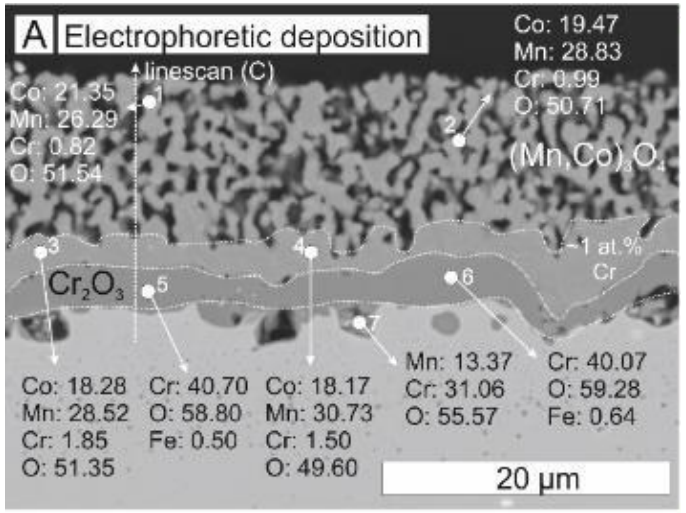
Coating by Electrophoretic Deposition (EPD)

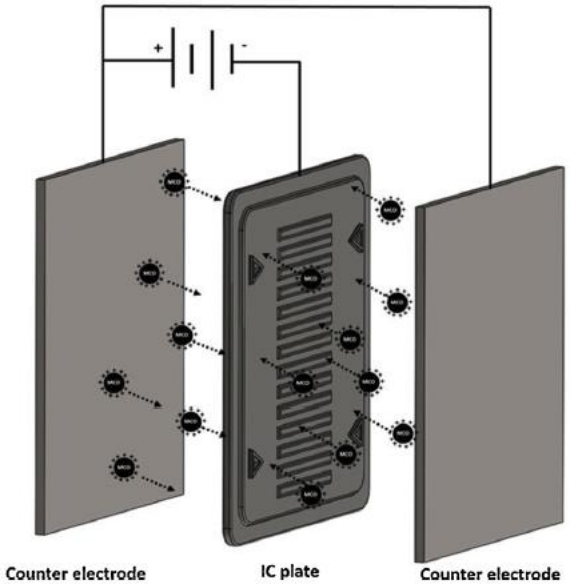
- Solution based electrochemical process
- Cathode(+):migration of anions
- Anode(-): migration and deposition of cathions on a substrate
- Example: solution 10% $Al(NO)_3$ /ethanol
- a potential difference (20V, 1 min) to separate Al^{+3} and $3NO^-$ ions.
- Cathode(+):migration of $3NO^-$ anions
- Anode(-): migration and deposition of Al^{+3} cathions and coating of samples



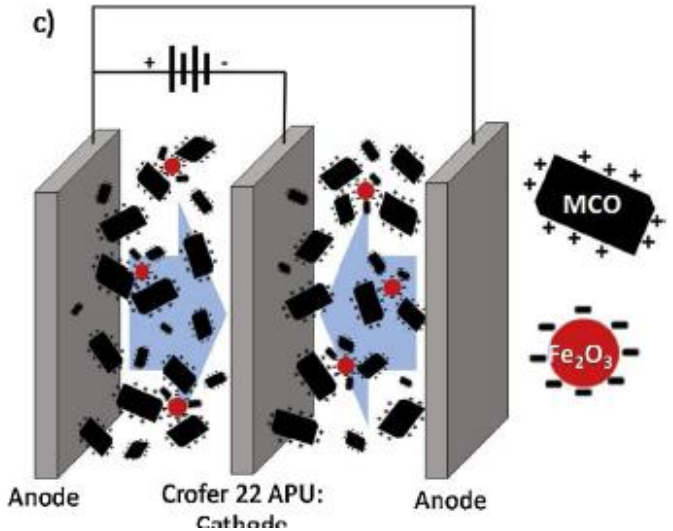
Courtesy of Gabriele Sanfratello S278151 Politecnico di Torino

Ceramic coatings on metallic interconnects for *Solid Oxide Cells* applications by Electrophoretic Deposition (EPD)

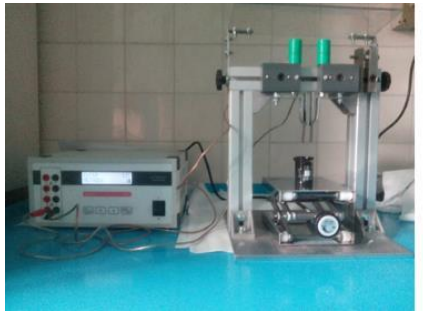


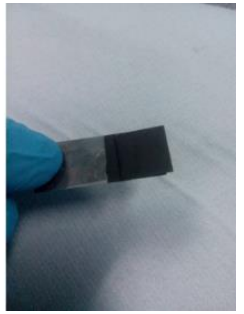


EPD co-deposition approach



3 electrodes configuration set up for real size IC plates



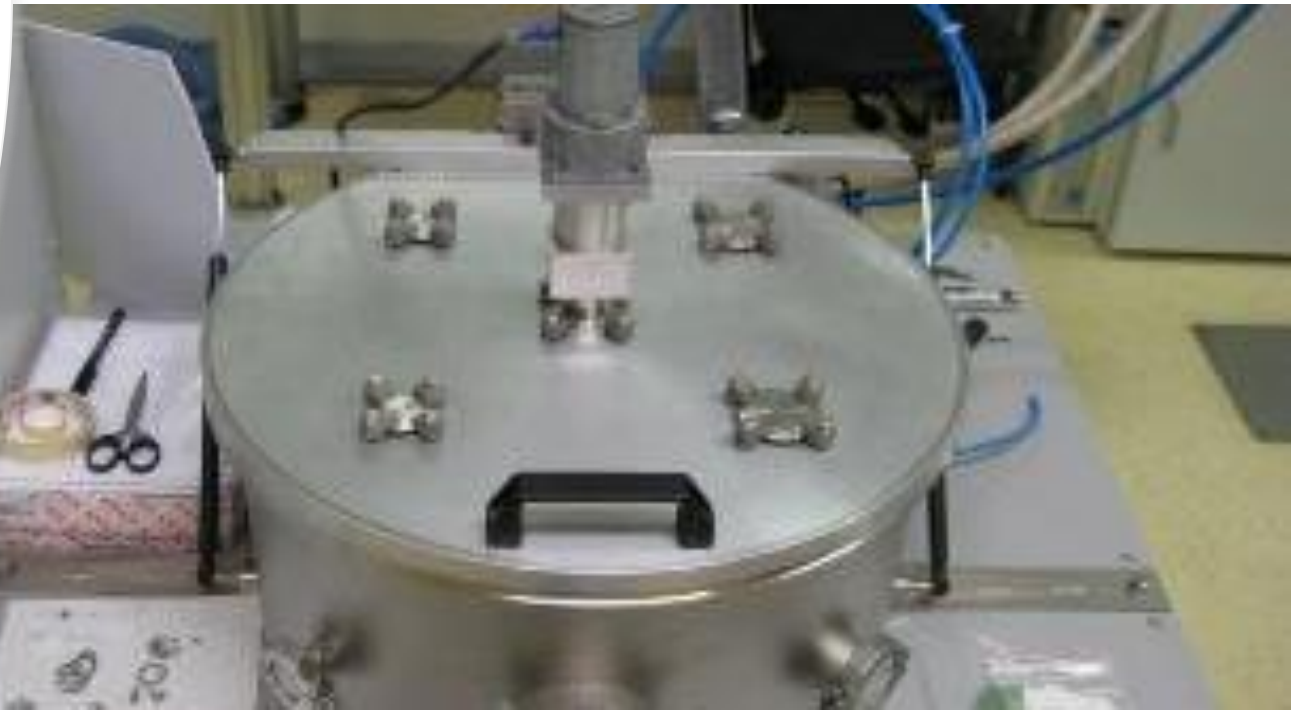


E. Zanchi et al, Journal of the European Ceramic Society 39 (2019) 3768–3777

A. G. Sabato et al, Journal of the European Ceramic Society 41 (2021) 4496–4504

coating by sputtering

- Magnetron (RF, DC, pulsed DC) confocal three target (3 inches) co-sputtering with: atmosphere control (three gasses mixture) plasma etching reactive deposition substrate heating and cooling substrate biasing.
  - Two target magnetron (RF, DC, pulsed DC) co–sputtering (6 inches and 1 inches) with atmosphere control (three gasses mixture)



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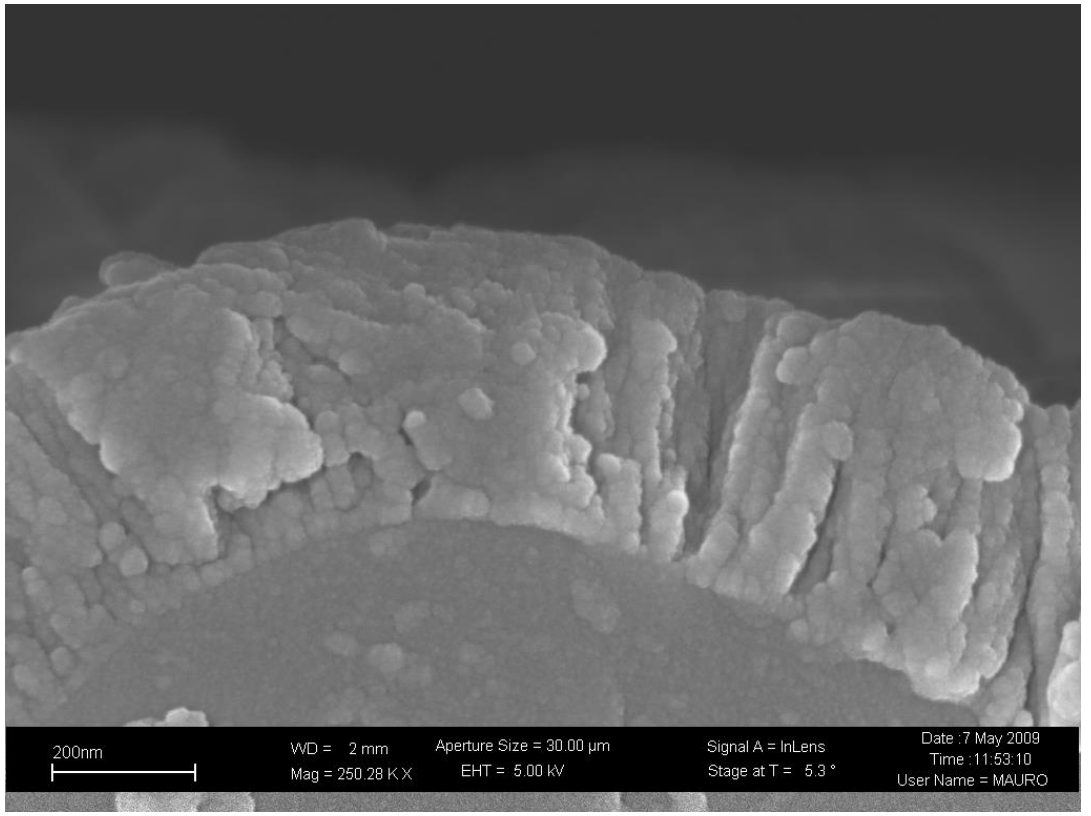
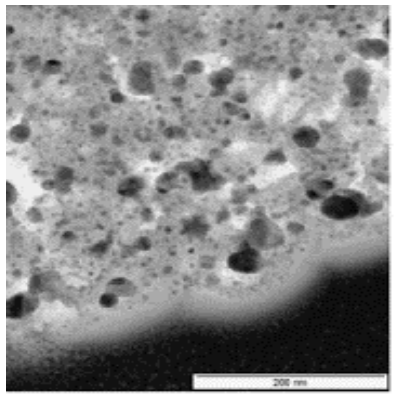
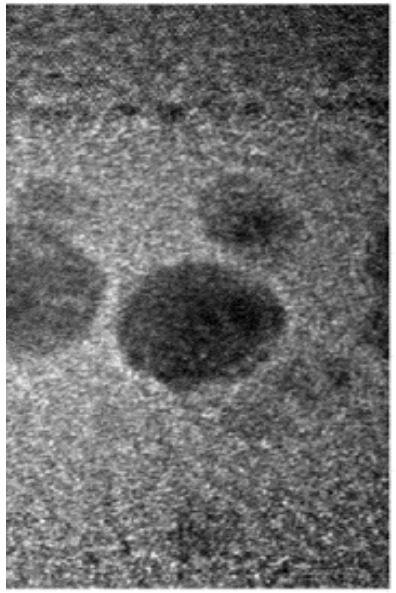


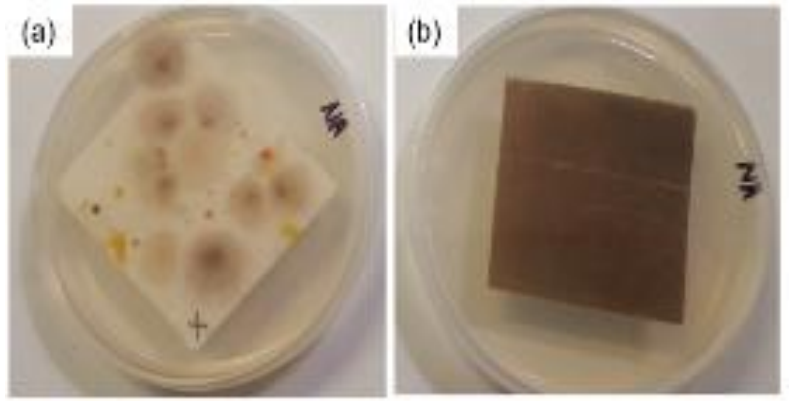
Antibacterial, antifungal, virucidal coating by sputtering

- POLITO developed an antibacterial/virucidal coating demonstrated to be effective against bacteria, fungi and some respiratory viruses, SARS-CoV-2 included

- The antibacterial/virucidal coating can be applied by sputtering on every substrate: polymers, glasses, metals, textiles, air filters







Glass Fiber Air filters used for 30 days in an air conditioner in lab: (a) bacterial proliferation on filter; (b) no bacterial proliferation on filters with POLITO coating

Inhibition halo test of POLITO coating on cotton

Antibacterial, antifungal, virucidal coating by sputtering

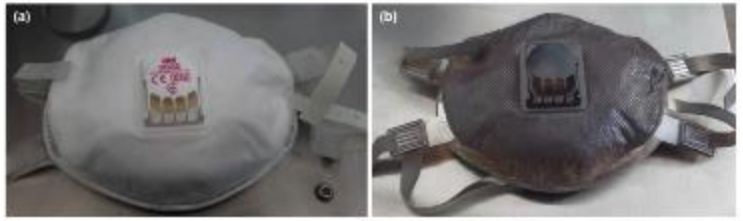
- POLITO developed an antibacterial/virucidal coating demonstrated to be effective against bacteria, fungi and some respiratory viruses, SARS-CoV-2 included

- The antibacterial/virucidal coating can be applied by sputtering on every substrate: polymers, glasses, metals, textiles, air filters

Table 1
Virus infectivity tests on coated and uncoated facial mask versus virus used as control for both experiments.

Sample	$TCID_{50}$/ml		
	Experiment 1[a]	Experiment 2	
	Ag3W	Ag3W	Ag5W
Coated mask	$(4.5 \pm 4.9) \times 10^{3}$	$(1.7 \pm 0.6) \times 10^{3}$	0.0 ± 0.0
Uncoated mask	$(1.6 \pm 0.0) \times 10^{4}$	$(1.8 \pm 0.9) \times 10^{4}$	$(1.4 \pm 0.3) \times 10^{4}$
Virus control	$(2.4 \pm 1.1) \times 10^{4}$	$(2.1 \pm 0.9) \times 10^{4}$	$(2.9 \pm 0.7) \times 10^{4}$

[a] done on Ag3W only.



Open Ceramics

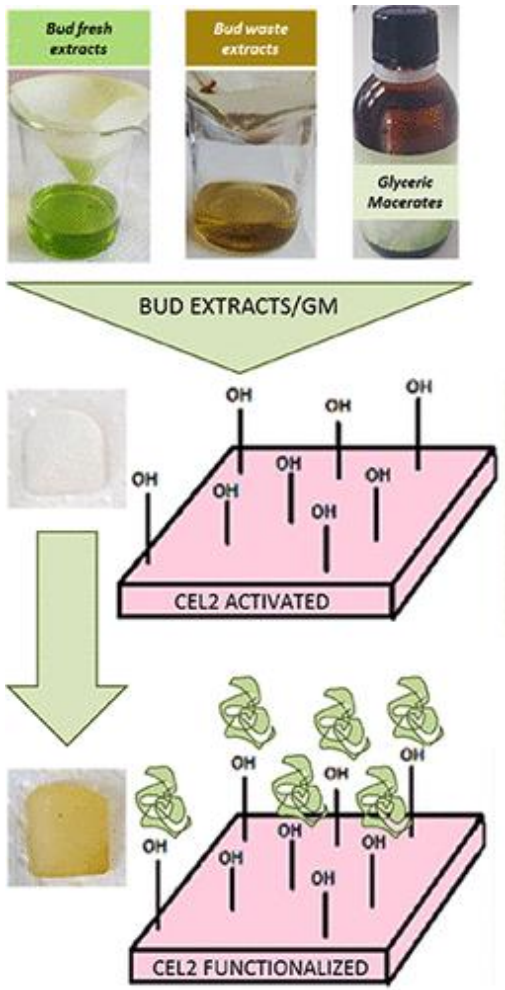
Virucidal effect against coronavirus SARS-CoV-2 of a silver nanocluster/silica composite sputtered coating

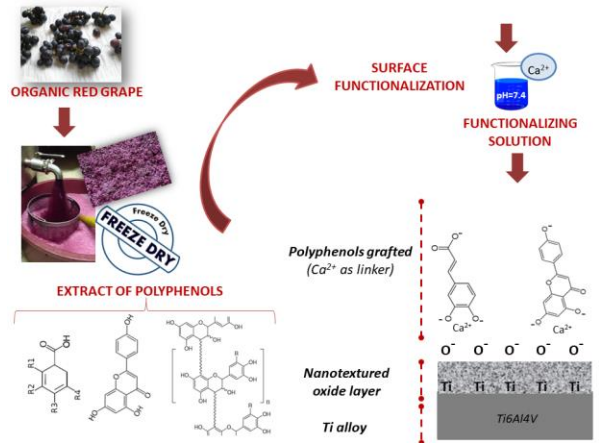
Cristina Balagna, Sergio Perero, Elena Percivalle, Edoardo Vecchio Nepita, Monica Ferraris

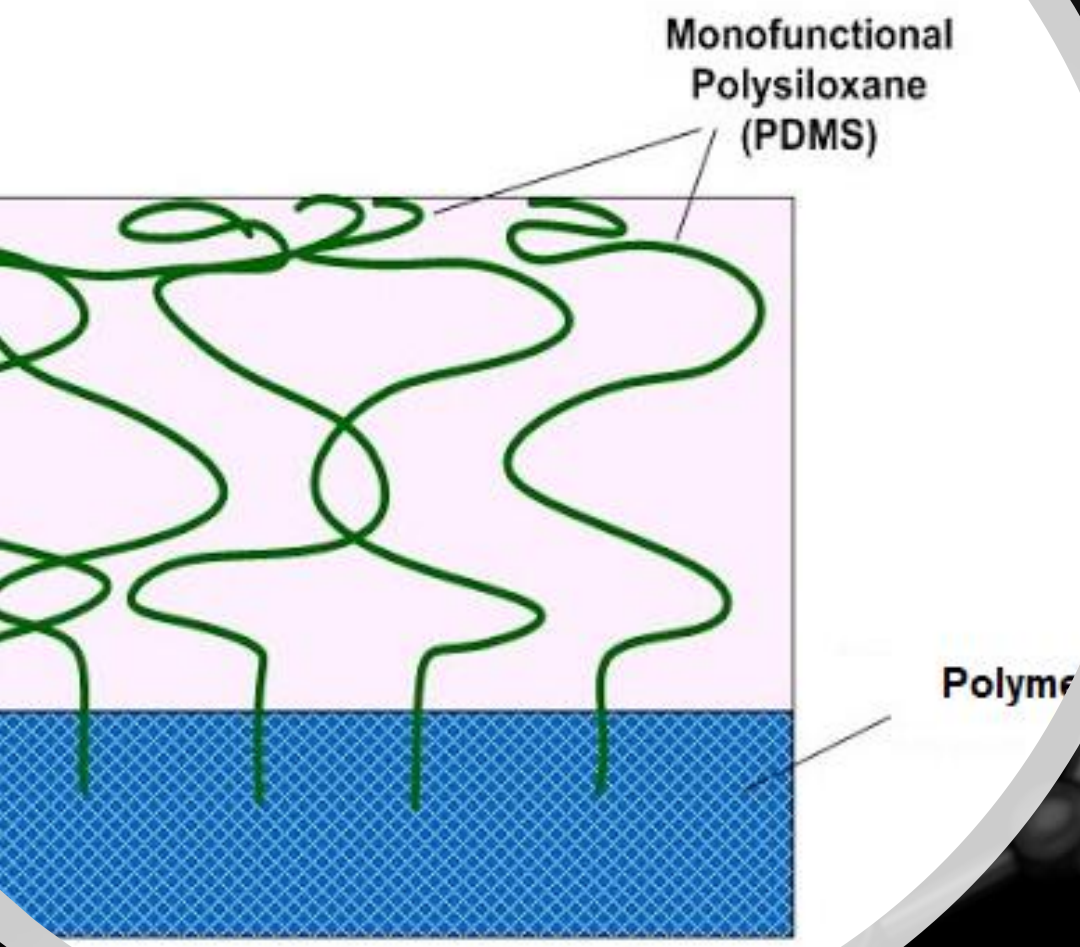
Functionalized coatings by dipping

- Surface functionalization or thin coating deposition on metal or glass substrates can be achieved through dipping in organic solutions.
- Different natural biomolecules have been tested for anti-bacterial, -cell adhesion, -cancer, -inflammatory puposes:

- Polyphenols
- Vitamin E
- Essential oils
- Bud extracts
- Polypeptides







Functionalized coatings

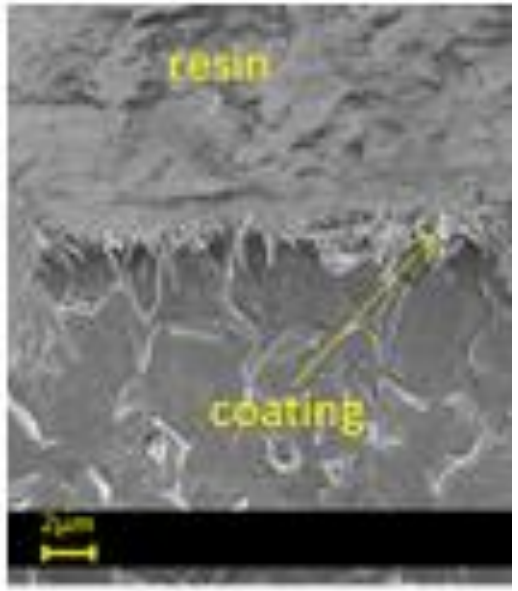
- Thermal and electrical conductive coatings
- Fluorescent coatings
- Silicone/Fluoride based antifouling coatings

Fretting and wear resistant boride coating on titanium alloys

- Surface ceramization of Ti alloys can be achieved through heat treatment in a boron rich environment (molten salts)
- Remarkable increase in surface hardness and wear resistance is obtained

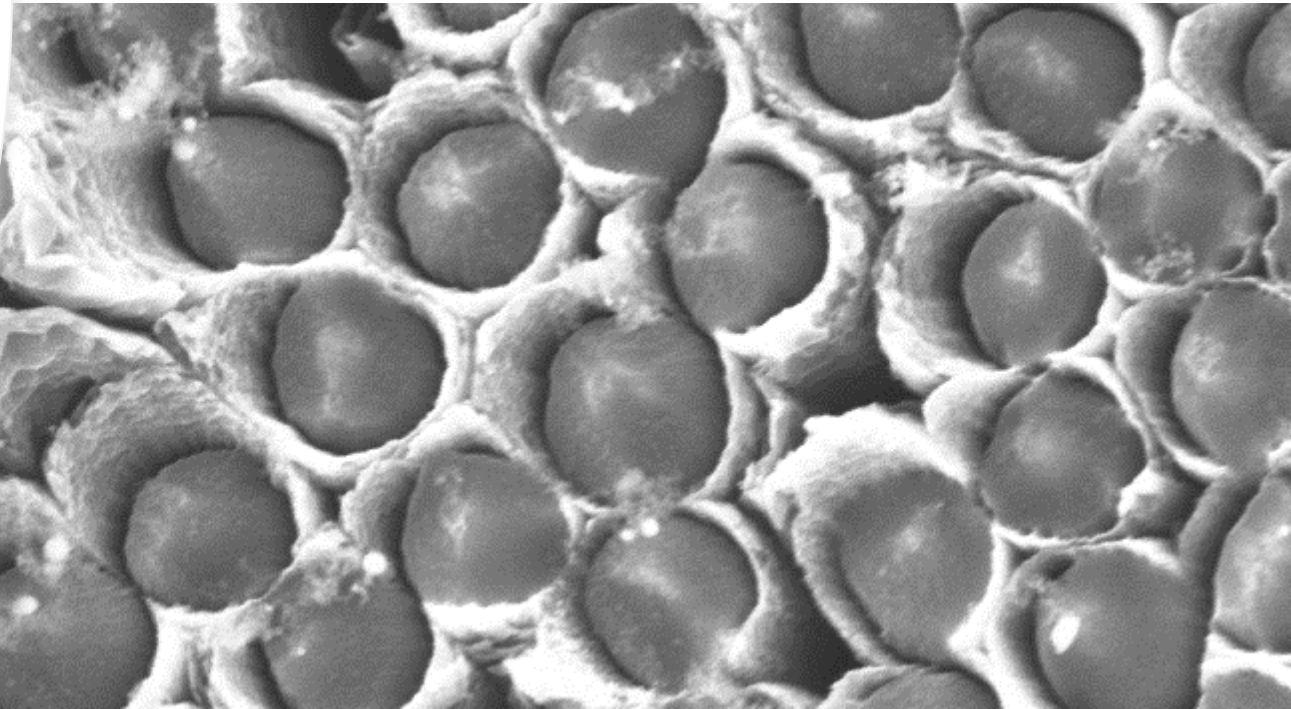
Material	Hardness
Ti_6Al_4V	4.1±0.3GPa
TiB coating	45±10GPa (~ 4000 KH)

Heat treatment on a mix of salts (B source, activator and filler)



Surface treatments to decrease/increase wettability, increase surface area, adhesion, etc…

- Atmospheric Plasma (PlasmaTEC-X TANTEC)
- Vacuum Etching Plasma (TUCANO)
- Corona Plasma (HF-SpotTEC TANTEC)
- Laser



Activity on coatings at GLANCE

http://www.composites.polito.it/

- http://www.j-tech.polito.it/