Development and Upscaling of Antisoiling Hybrid Sol-Gel Coatings

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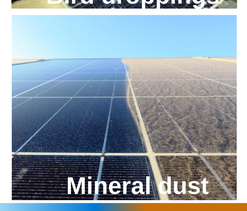
Introduction

Soiling of PV modules

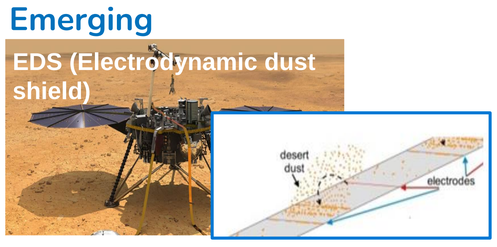


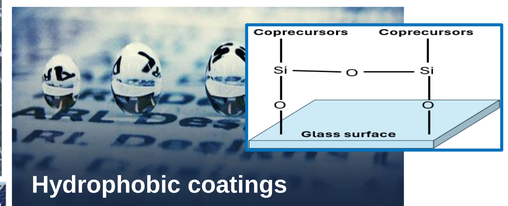
PV Efficiency decrease with Soiling increase

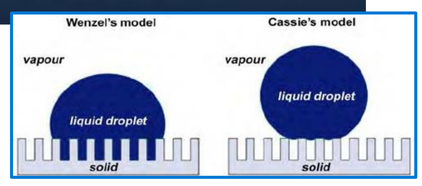
Anti-Soiling Solutions

Actual

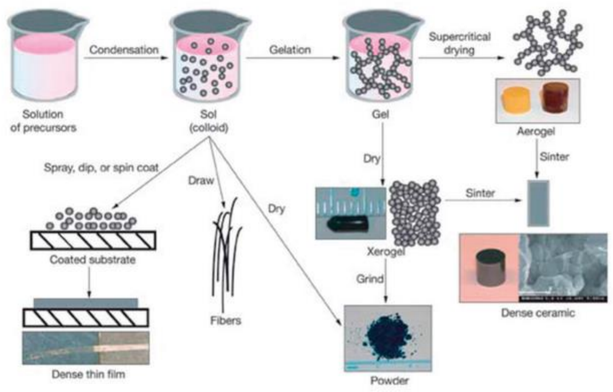
Emerging







Sol-Gel Technologies and Products



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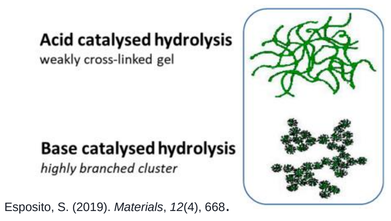

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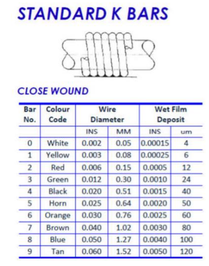
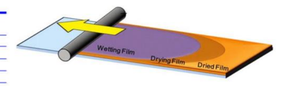
Coating Techniques

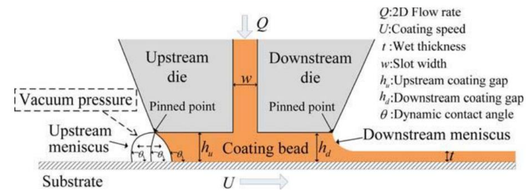
Bar Coating

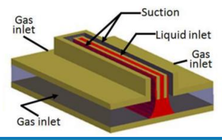


Bar No.	Colour Code	Wire Diameter INS	Wire Diameter MM	Wet Film Deposit INS	Wet Film Deposit um
		INS	MM	INS	um
0	White	0.002	0.05	0.00015	4
1	Yellow	0.003	0.08	0.00025	6
2	Red	0.006	0.15	0.0005	12
3	Green	0.012	0.30	0.0010	24
4	Black	0.020	0.51	0.0015	40
5	Horn	0.025	0.64	0.0020	50
6	Orange	0.030	0.76	0.0025	60
7	Brown	0.040	1.02	0.0030	80
8	Blue	0.050	1.27	0.0040	100
9	Tan	0.060	1.52	0.0050	120



Slot-die Coating



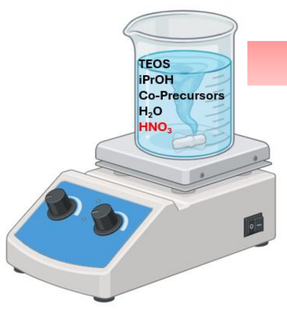


Dynamic Liquid Drop Meniscus (DLM) Technology

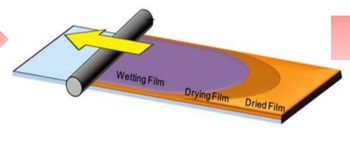
Methodology

Sol-Gel Synthesis for Thin Film Production and Application

Acidic Environment



Stirring solution for 2h at R.T.

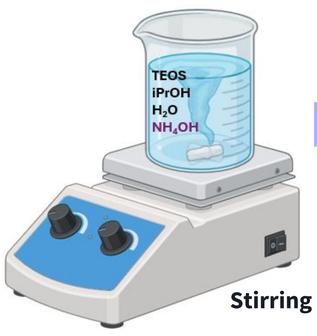


Bar coating Application on glass substrate

Thermal treatment for 120 sec. at 30°C.

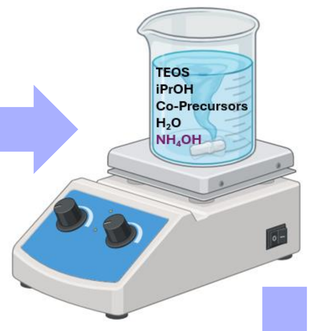
	Hydrocarbon chain	Fluorurate chain
Co-Precursors	P1, P2, P3, P4, P5	PF2

Basic Environment

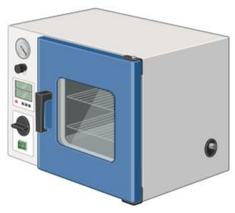


Stirring solution for 2h at R.T.

Co-Precursors Addition



Stirring solution for 2h at R.T.



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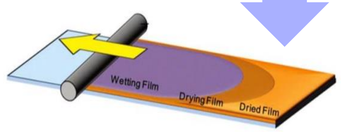
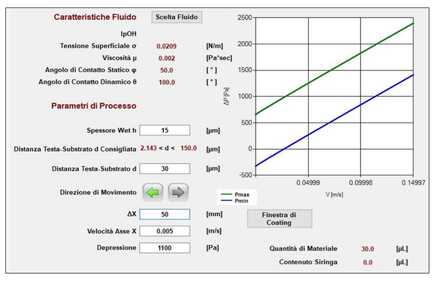


Bar coating Application on glass substrate

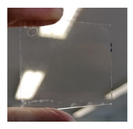
	Hydrocarbon chain	Fluorurate chain
Co-Precursors	P1, P2, P3, P4, P5	PF2

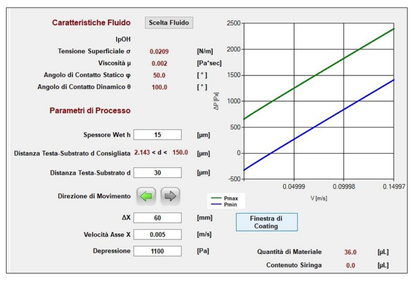
Application by Slot-die Coating

mONE prototype, built by Rise Technology s.r.l



Coating Window and P5-based coating



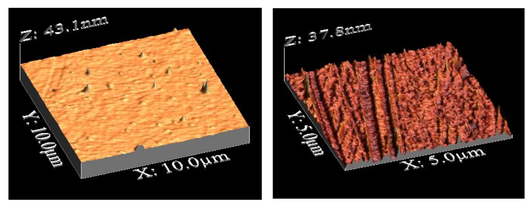


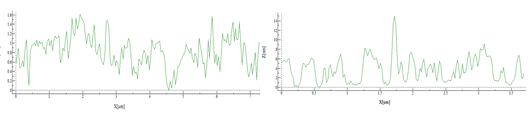
Coating Window and P2-based coating

Results

Bar Coated Substrates

P2 Acidic Environment | **P2 Basic Environment**

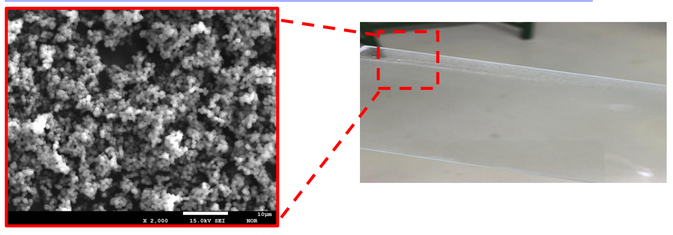




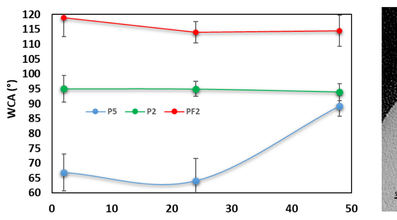
Morphological analysis by AFM

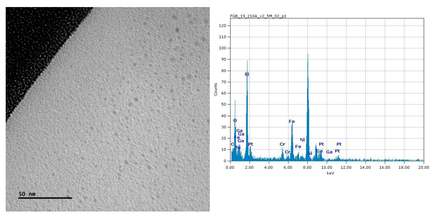
WCA Acidic [°]	Co-Precursor	WCA Basic [°]
98	P2	87
90	P5	80
106	PF2	101

Glass coated by Sol-Gel solution in basic environment

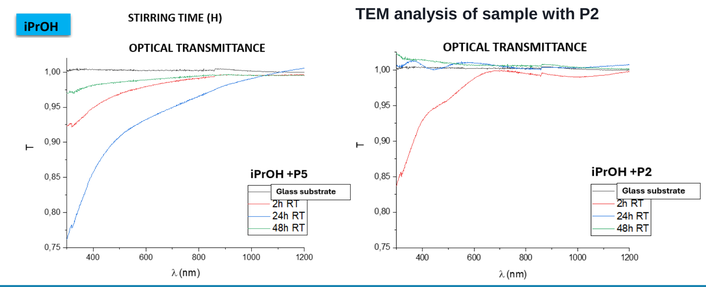


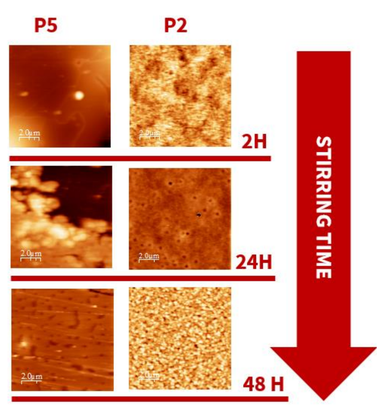
Slot-die Coated Substrates





TEM analysis of sample with P2





Morphological analysis by AFM

Conclusions

- Twelve formulations in acidic and basic environment were developed and applied on glass substrates;
- All coatings are tack-free within 120 seconds at 30°C;
- The best WCA values were obtained with P2, P5 and PF2, both in acidic and basic environments. The highest values was obtained with PF2 in acidic environment (119°);
- Hydrophobicity is due only to the chemical effect and not to roughness;
- The morphological analysis obtained by AFM demonstrated that the homogeneity increases as a function of the stirring time and the nature of functional groups. In general, the surfaces are quite planar and smooth;
- Slot-die coating allows to produce thin films more homogeneous than bar coating, making it the best choice for industrial applications. On the other hand, bar coating technique is better for in-field restoration.

Acknowledgements

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POR Calabria 2014-2020 Fesr-Fse il futuro è un lavoro quotidiano