

Le LCMCP

Groupe « COUPLAGE CHIMIE PROCÉDES »



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UPMC - Collège de France, Paris, France.



Le LCMCP

Sites: Collège de France et Jussieu, Paris centre.

Activité: Procédés sol-gel utilisés dans la synthèse de nanomatériaux originaux et d'organisations très variées, à base d'oxydes (métalliques, hybrides organiques-inorganiques, hybrides inorganiques-biologiques). Compréhension des processus impliqués dans la polymérisation inorganique afin de maîtriser l'ensemble de la filière synthèse-mise en forme-microstructure-propriétés.

Thèmes transversaux principaux

Matériaux pour l'énergie, l'environnement et les technologies de l'information.

Matériaux fonctionnels pour la biologie et la médecine.

Texturation et organisation multi-échelle de la matière.

Elaboration de nanostructures 2D et 3D inorganiques et hybrides.

Effectifs : \approx 100 personnes dont 32 (enseignants) chercheurs.



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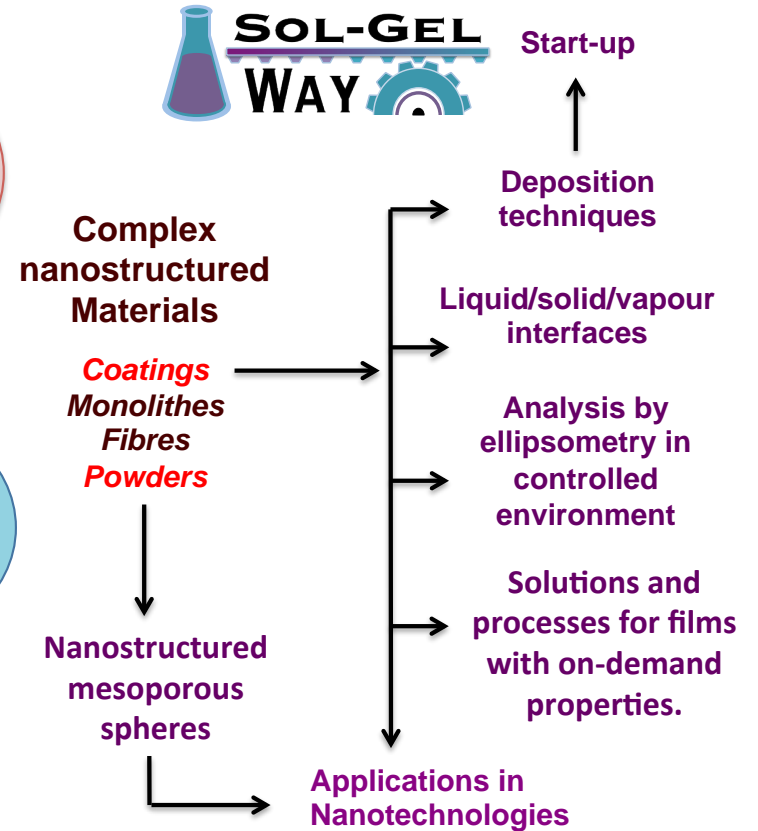
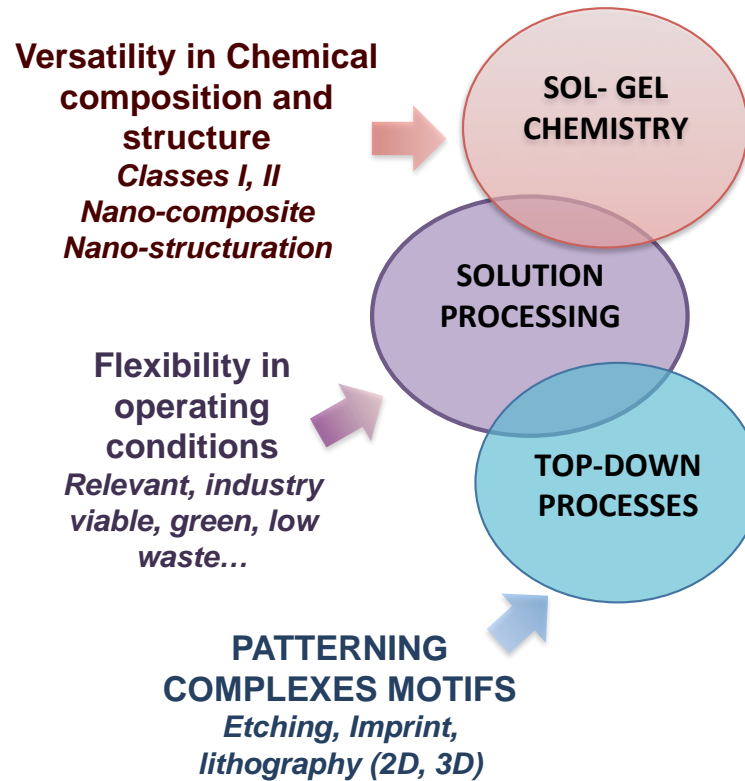
Sous groupe du groupe Hybrid Materials and Nano-materials (C. Sanchez)

Prof. C1 D. Grosso
CR 1 C. Boissière
MdC 1 L. Nicole
MdC 2 M. Faustini

\approx 10 PD + PhD + Master



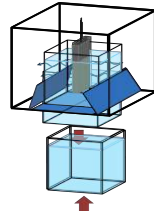
Stratégies du groupe Couplage Chimie Procédés



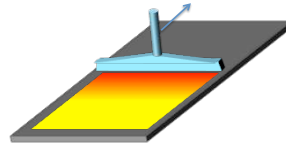
Mettre au point les outils de synthèses (combinaison chimie / procédés)



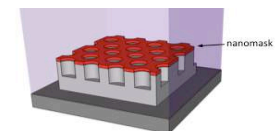
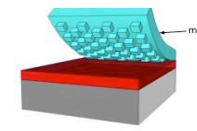
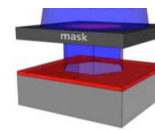
Dip Coating
- Patented -



Spray Coating
- Patented -



Top-down
Optical Lithography / Nano Imprint / Reactive Etching (dry / wet)



| Ultra thin nanopattern | Porous (open/close, meso/macro, thin 20nm/thick 2000nm, amorphous/crystalline, ordered/disordered) | | | | Epitaxial (MESOPOROUS α -quartz) | | | | | | | | | | | |
|------------------------|--|------------------|---|---------------------------|---|------------------------------|-------------------------|-------------------------|--------------|--------------|----------------|----------------|---------------|--|---------------|-------------------|
| | | | | | | | | | | | | | | | | |
| SiO_2 | $\gamma\text{-Al}_2\text{O}_3$ | CoTiO_3 | SrTiO_3 | MgTa_2O_6 | TiO_2 | $\text{TiO}_{2-x}\text{N}_x$ | Nb_2O_5 | Eu_2O_3 | ZnO | ITO | MgF_2 | SnO_2 | WO_3 | $\text{Ln}_{0.1}\text{Ce}_{0.9}\text{O}_2$ | Hybrid silica | alpha-Quartz etc. |
| Multilayers | Pillared Planar Nanochannels (PPN) | | Honey combs, 1D/2D photonic hierarchical porosity, pillars, nanowires | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

Domains of application

- | | | | |
|--------------------------------|----------------------|---------------------------------|-----------------|
| - Analysis and sensing | - Tribology | - Micro and nano fluidics | - Separation |
| - Catalysis and photocatalysis | - (Opto)electronics | - Energy production and storage | - Protection |
| - Wetting / Unwetting | - Optics (S.Windows) | - Decoration, ergonomy | - Biomedical... |

Applications : optics, catalysis, environment, sensing, analysis, protection, energy, electronic, ergonomy, biomedical, construction,

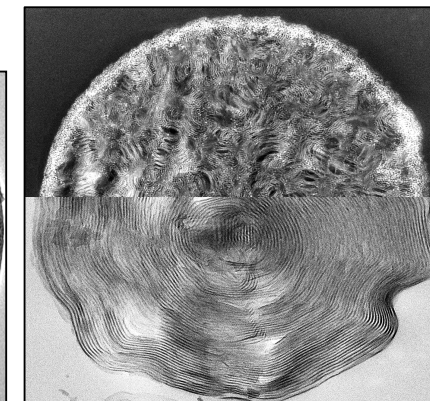
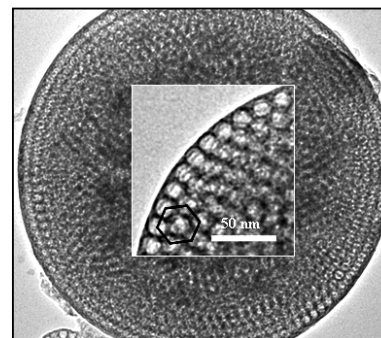
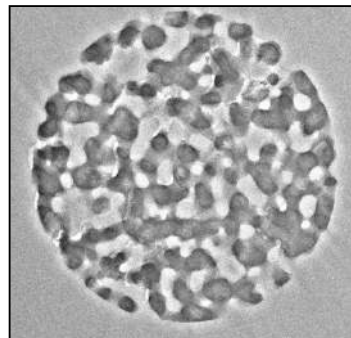
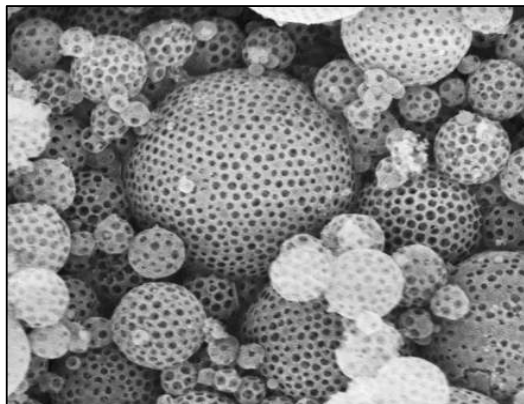
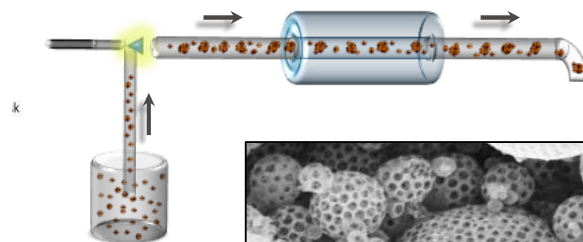
Collaboration : IFPEN, AREVA, St Gobain, DSM, Photowatt, Polyrise, EADS, IFTH, CEA, CILAS, Crystal Laser, PSA, Renault, Pilot, SILSEF.

Mettre au point les outils de synthèses (combinaison chimie / procédés)



Aerosol generation

- Patented -



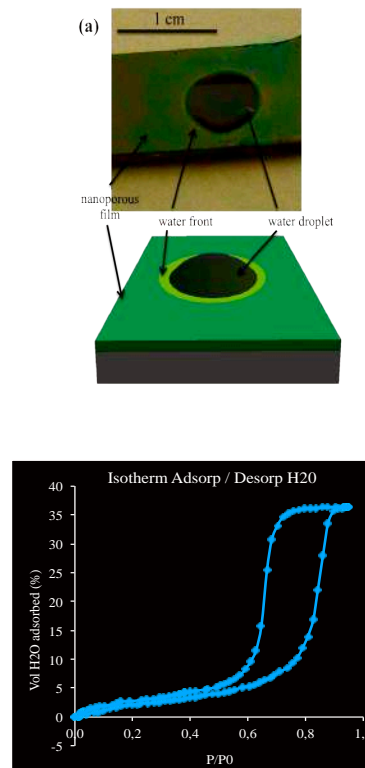
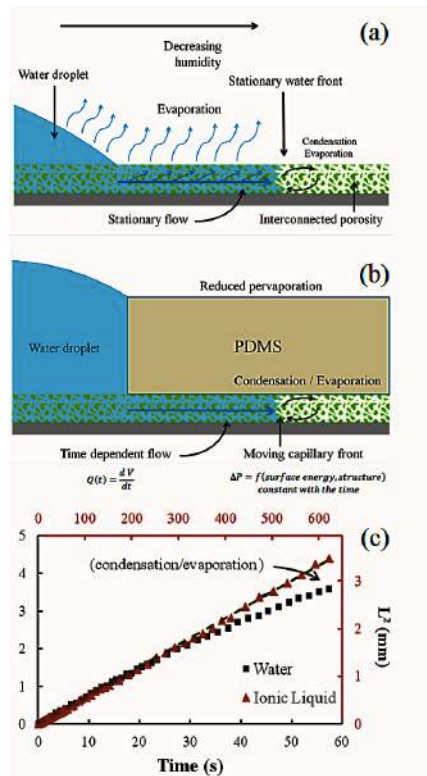
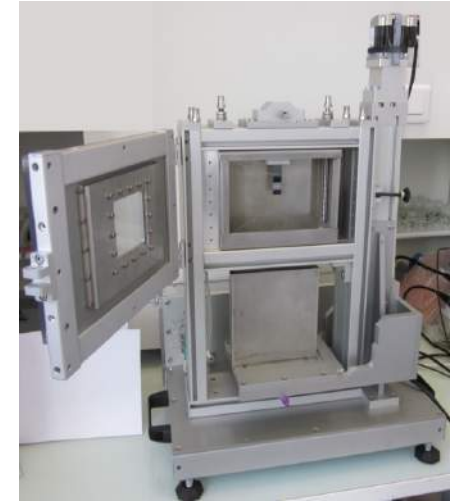
Nanostructured aerosol
spheres - catalysis, vectoring

SiO_2 , TiO_2 , ZrO_2 , CeO_2 , SiOC , Al_2O_3 ,
(Mo, Co, W, Ni) SiAlO_xS_y , hybrids,
composites (Au, Fe_2O_3 , CeO_2 ,
MOFs, Qdot, TiO_2), etc.

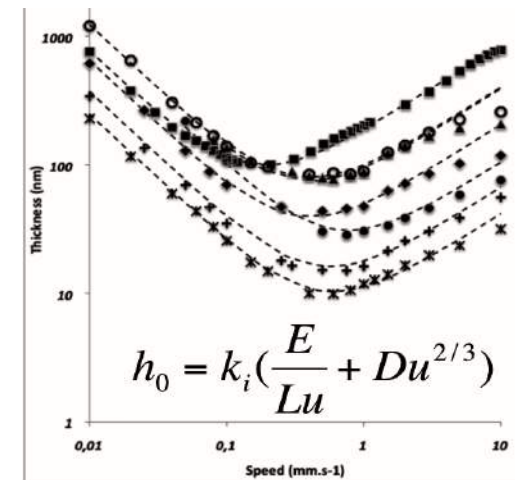
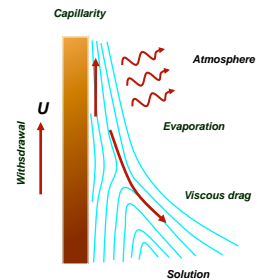
Applications : optics, catalysis, environment, sensing, analysis, protection, energy, electronic, ergonomics, biomedical, construction,

Collaboration : IFPEN, AREVA, St Gobain, DSM, Photowatt, Polyrise, EADS, IFTH, CEA, CILAS, Crystal Laser, PSA, Renault, Pilot, SILSEF.

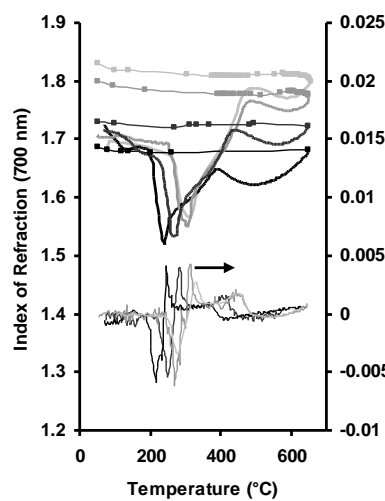
Comprendre les aspects fondamentaux (chimie sol-gel, dynamique des interfaces solide/liquide/vapeur).



Processing, Characterisation, Properties, Fundamental



Développer des techniques d'analyse appropriées (ellipsométrie)



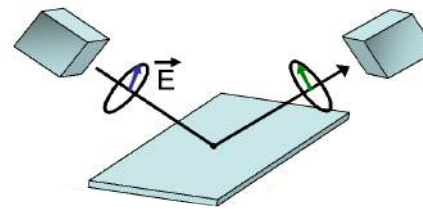
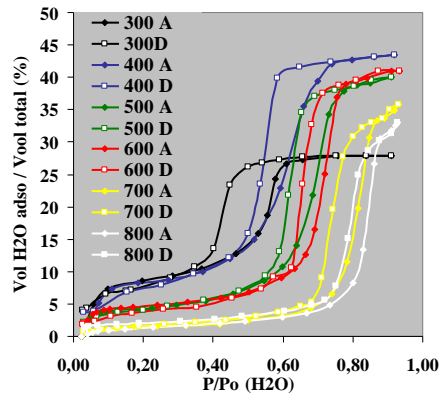
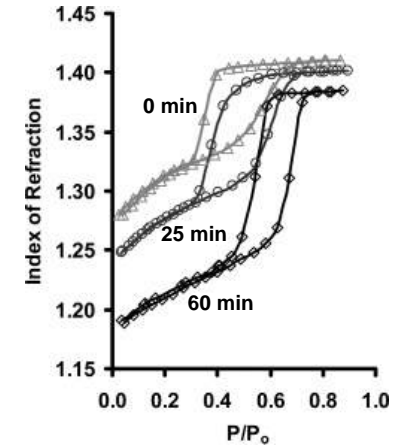
Thermal stability
(TGA, DSC)

Stability (Liq. Or
Vapour)

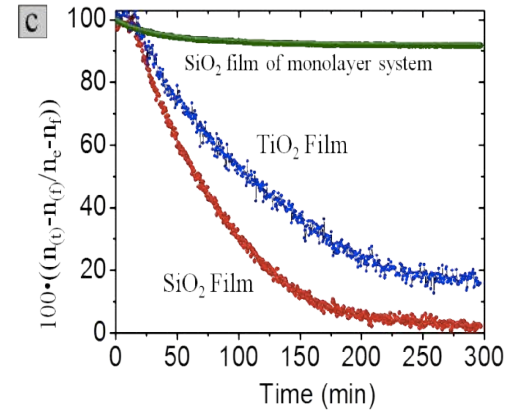
POROSITY (V%,
PSD, inter.)

SURFACE
REACTIVITY

Epaisseur
(n, k)



Optical quality
Thickness (5nm < 5000 nm)
Rapidity



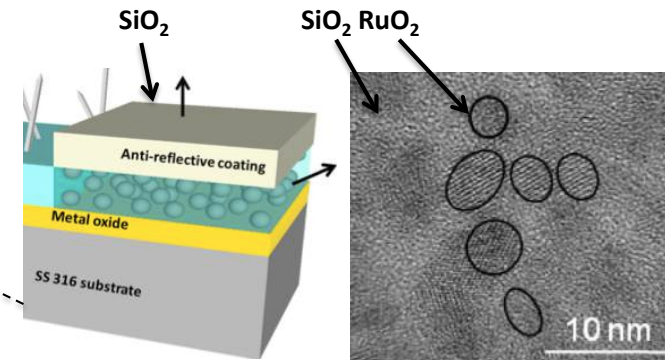
HIGHLIGHTS

Thermally stable sol-gel coatings for solar energy conversion.

High solar selectivity ($\alpha > 0.94$, and $\epsilon_{@873K} < 0.28$); stable in air at 873K (patented by UPMC/AREVA).

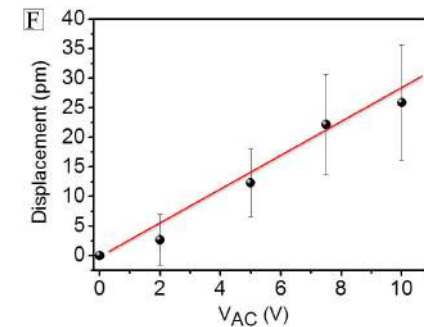
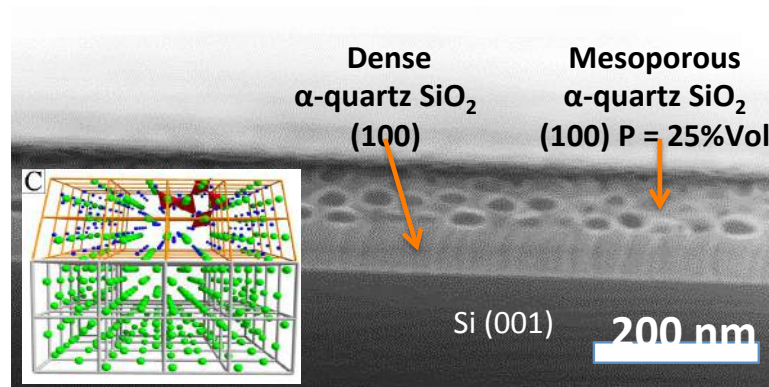


LINEAR CSP COLLECTOR



Sol-gel routes to Epitaxial alpha-Quartz Thin Films

Epitaxial growth of nanostructured polycrystalline piezoelectric quartz films on Si (100) substrates (Published in Science, Patented by UPMC).

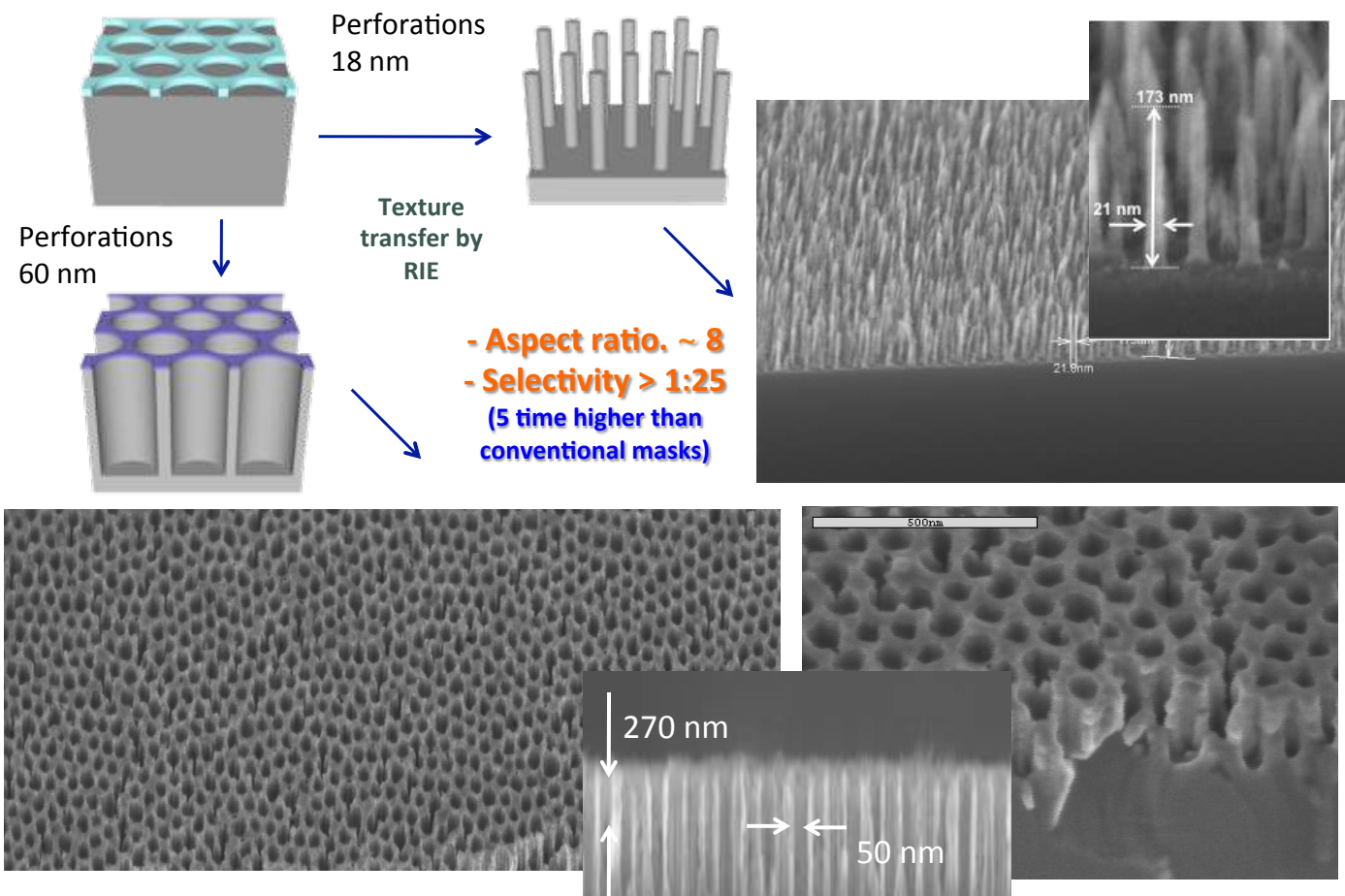


linear dependence between the applied voltage and the mean deflection (2.5 ± 1 pm/V)

HIGHLIGHTS

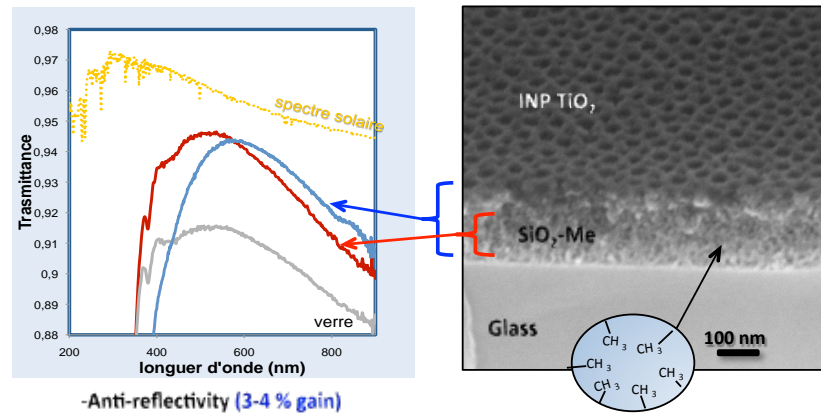
Self-assembled inorganic nanopatterns as reactive nanomasks for dry etching lithographic transfer with high selectivity.

Lithographic pattern transfer on Si wafer through a novel self-assembled CaTiO₃ inorganic Reactive NanoMask (RNM) (Patented UPMC/UTT).



HIGHLIGHTS

Hydrophobic, Antireflective, Self-Cleaning, and Antifogging Sol-Gel Coatings for Photovoltaic Cells.

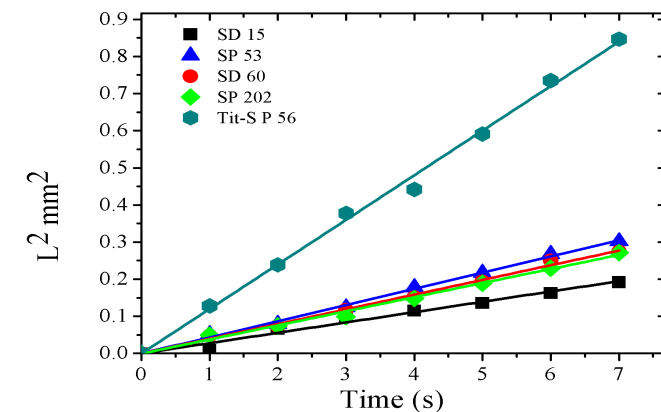
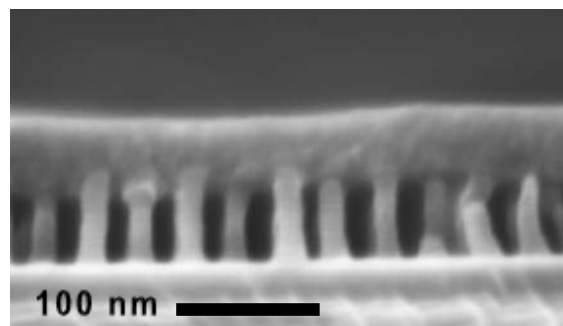


A multifunctional optical films was prepared by applying a ultra thin perforated TiO₂ layer on top of a mesoporous methylated thicker layer.

Sol-gel prepared Titanosilicate Mesoporous Pillared Planar Nanochannels for Nanofluidic Applications.

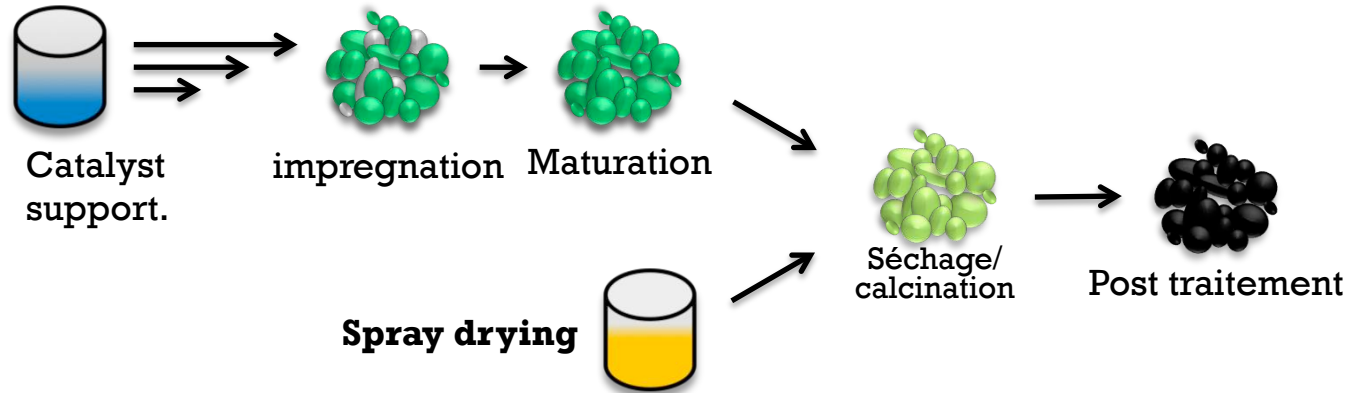


10 nm nano pillars arrays supporting a sealing roof, ideal for natural capillary filling (UPMC patent)

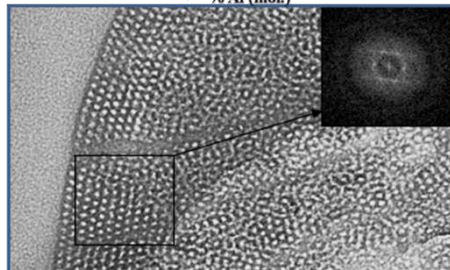


HIGHLIGHTS

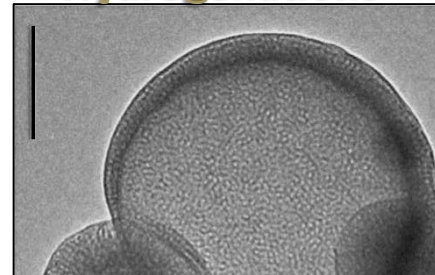
Spray Drying for direct mass production of high performance heterogeneous catalysts



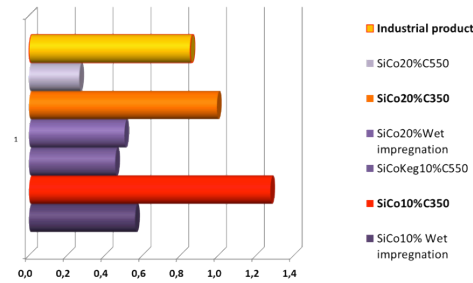
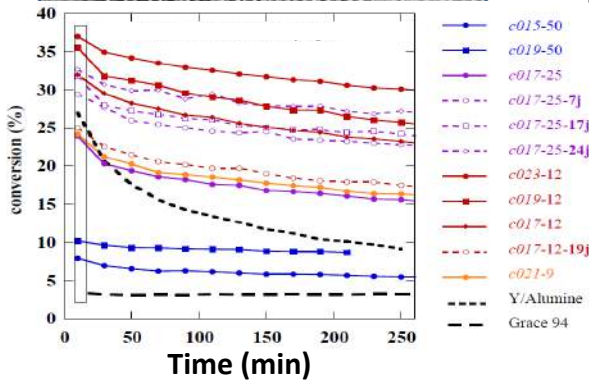
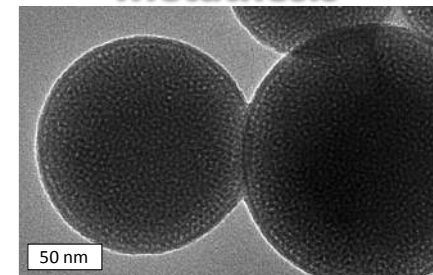
Isomerizations



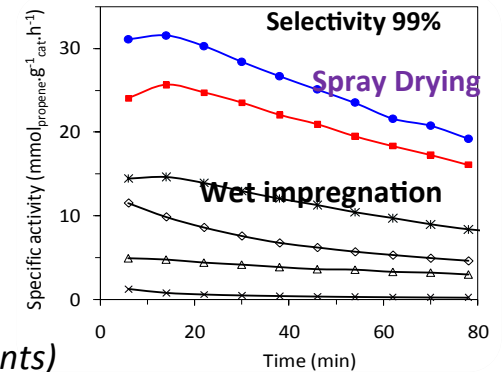
Hydrogenations



Metathesis



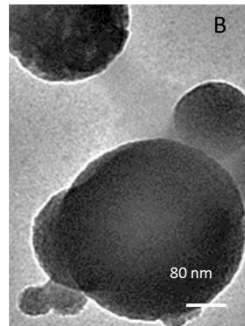
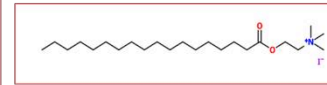
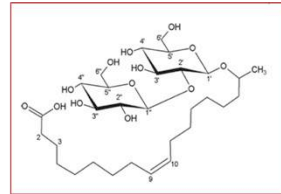
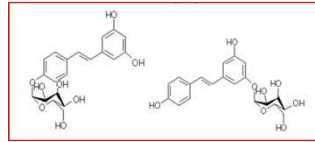
(17 patents)



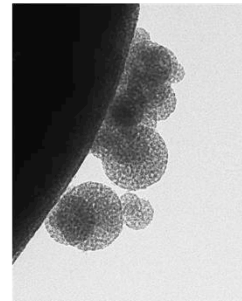
HIGHLIGHTS

Spray drying for Synthesis of therapeutic vectors

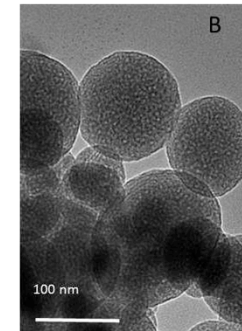
- One-pot encapsulation of amphiphilic drugs



Loading: 50 wt %

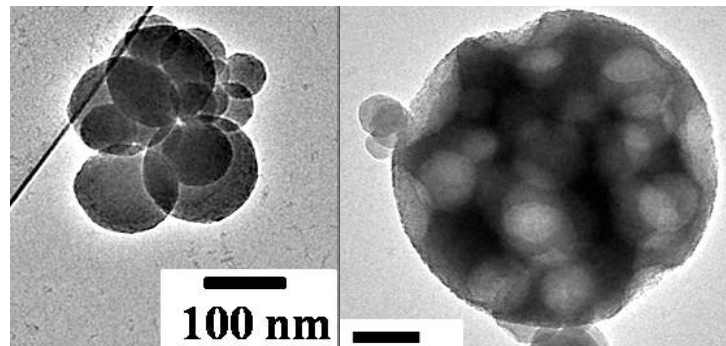
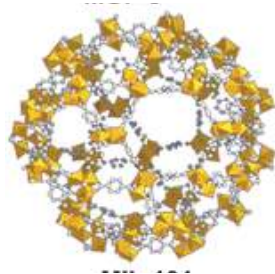


Loading: 51 wt %



Loading: 60 wt %

- Spray synthesis of Fe(BTC) MOFs nanoparticles.



La piste de développement la plus prometteuse et pourquoi?



COUPLAGE CHIMIE DOUCE / PROCÉDES PAR EVAPORATION

Excellente flexibilité contrôle thermodynamique / cinétique
Compatibilité avec les contraintes d'industrialisation et de production
Diminuer les coûts de mise en œuvre
Faible impacte environnemental



Ex.

PROCÉDES SOL-GEL / MICROFABRICATION

