INNOVATIVE COATING
SOLUTIONS

Innovative Coating Solutions S.A.

Headquarters: 11, Place Saint Pierre, B-5380 Forville, Belgium
Operations: 61, Rue de Bruxelles, B-5000 Namur, Belgium

www.incosol4u.com
linkedin.com/company/incosol4u

Marc J.M. VanWonterghem, MSc
mva@incosol4u.com
+32 473 622 021

Prof. Stéphane Lucas
slu@incosol4u.com
+32 498 975 282

ICS in short

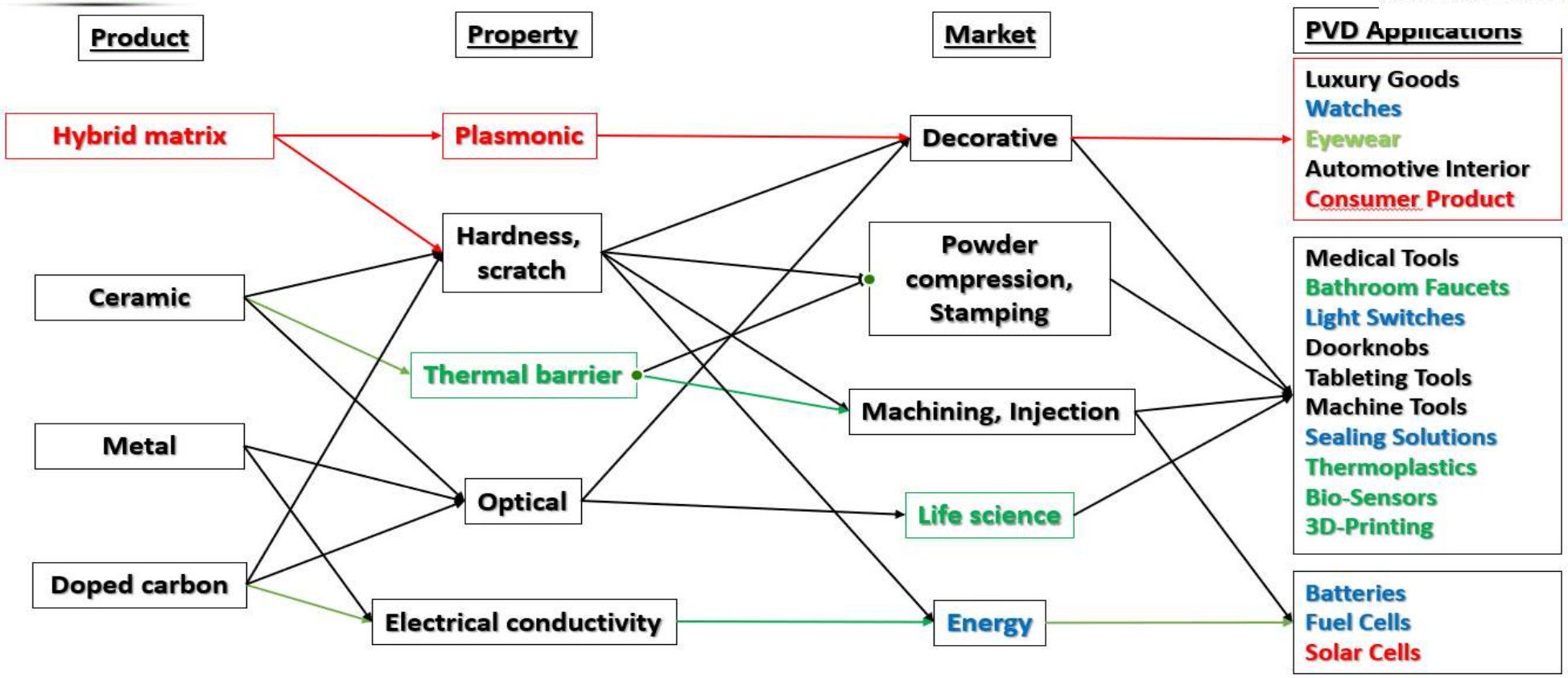
- Spin off of the University of Namur, Be
- Specialized in the deposition of **Thin Film**s by Physical Vapor Deposition (PVD), and film **Characterization**.
- ICS business is organized around 3 pillars:
  - ***Job Coater:*** parts are coated with one of ICS's recipes, based on the customers' needs.
  - ***R&D Consulting in Coating:*** ICS develops tailor-made coatings to answer the customers' requests.
  - ***Licensing:*** ICS sells licence processes in customers' machines or installs and integrates a dedicated machine in the customers' production facility.

ICS PVD Coating Capabilities
Markets & Applications

INNOVATIVE COATING SOLUTIONS

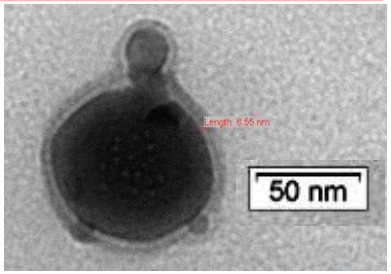
A SPIN-OFF FROM

Established / Starting customer
Currently working on
New



Carbon **Nitrides** **Metal**

Pure Li **Metal compound**



INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

ICS Coating propositions

Coatings (single/multilayers, tunable property)

INNOVATIVE COATING SOLUTIONS

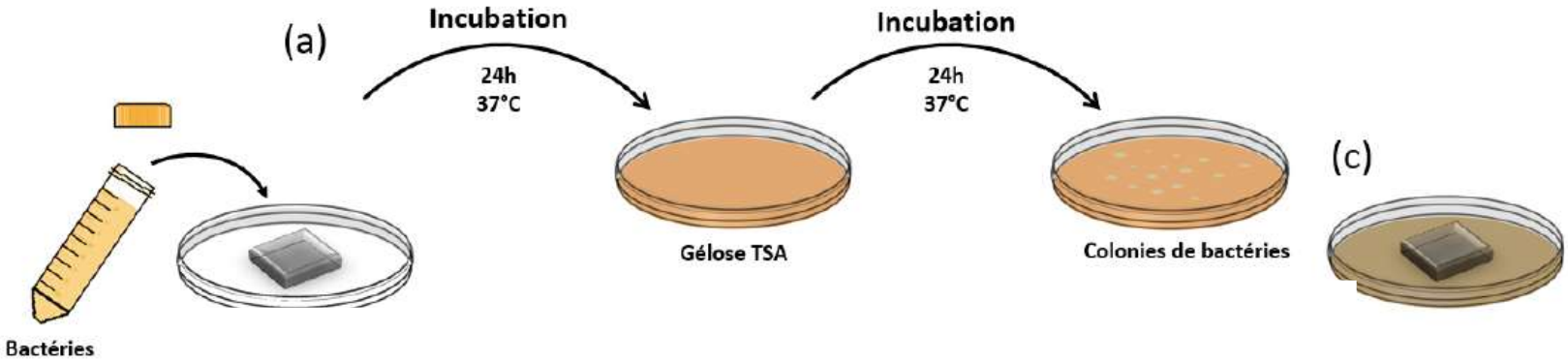
Coatings	Nitrides	Oxides	Soft DLC	Silicon Carbide	Functional groups	Gold	Li
Formula	TiN, ZrN, TaN, CrN, TiAlN, …	**Al2O3, CrOX, ZrOx, V2O5, …**	**a-C:H**	**SiC**	**NH2 or COOH**	**Gold**	**Li**
Hardness (HV)	Up to 3400	2300	200-1900	2000-5000	n.a.	n.a.	n.a.
Coef of friction (Dry, SS ball)	0.3	0.3	0.1		n.a.	n.a.	n.a.
Thickness (microns)	up to 7	up to 5	up to 15	10	Up to 1 micron	as low as 3 nm	50
Max usage temp	700° C	550° C	350°C	1300°C	200°C	n.a.	150
Substrate	Steel, Iron, Copper, plastics,	Steel, Iron, Copper, Alloys, plastics	Steel, Iron, Copper, Alloys, plastics, nanoparticles	Suitable up to 1300°C	Steel, Iron, Copper, Alloys	Glass,Mica, ...	Metal, polymer
Substrate geometry	**1D, 2D, 3D**	**1D, D, 3D**	**1D, 2D, 3D**	**1D, 2D, 3D**	**1D, 2D, 3D**	**1D, 2D, 3D**	**2D, 3D**
Application, property	**Protection: Cutting & molds, corrosion resistance, …**	**Protection: Machining, Medical, Heat Resistance Corrosion,**	**Tribology, Corrosion protection, Energy storage**	**Thermal Barrier Coating, Corrosion resistance**	**Corrosion resistance, polarity change, grafting, ….**	**Biosensors, Electrochem. Electrodes**	**Electrodes, energy storage**

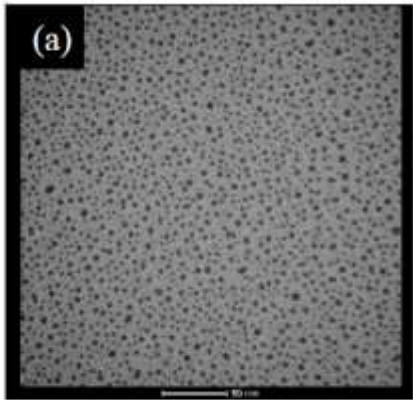
+ Others already developed or under developement. Call us

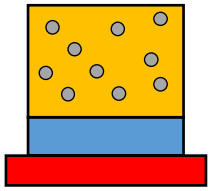
A bit of current research

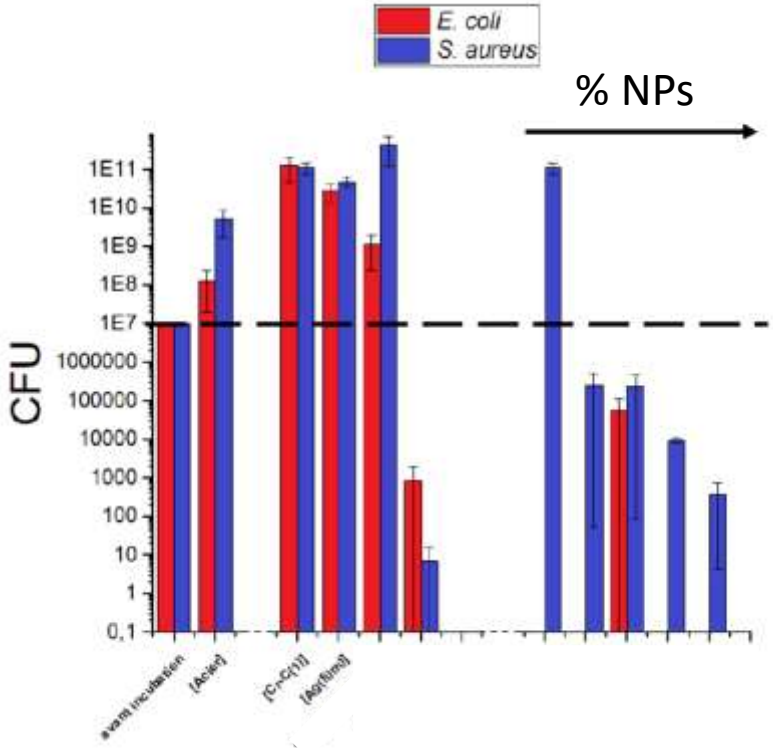
Black antibacterial (& antiviral) coatings

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

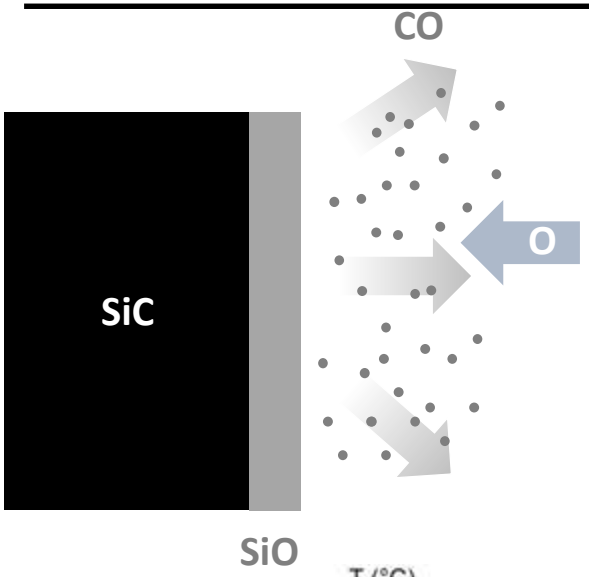


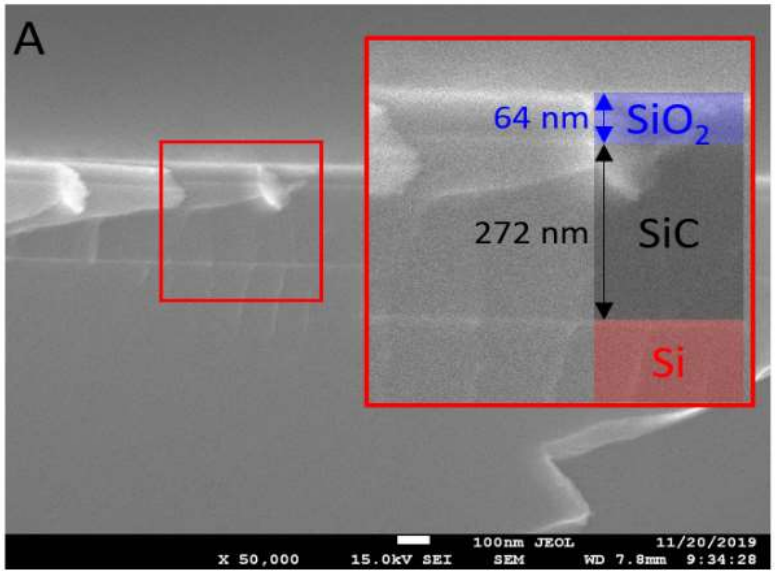


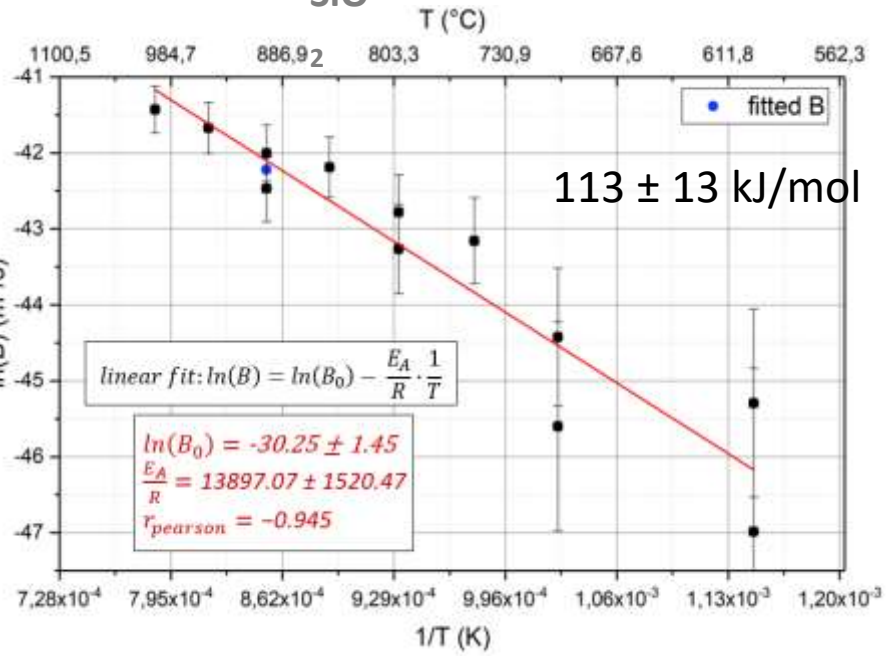


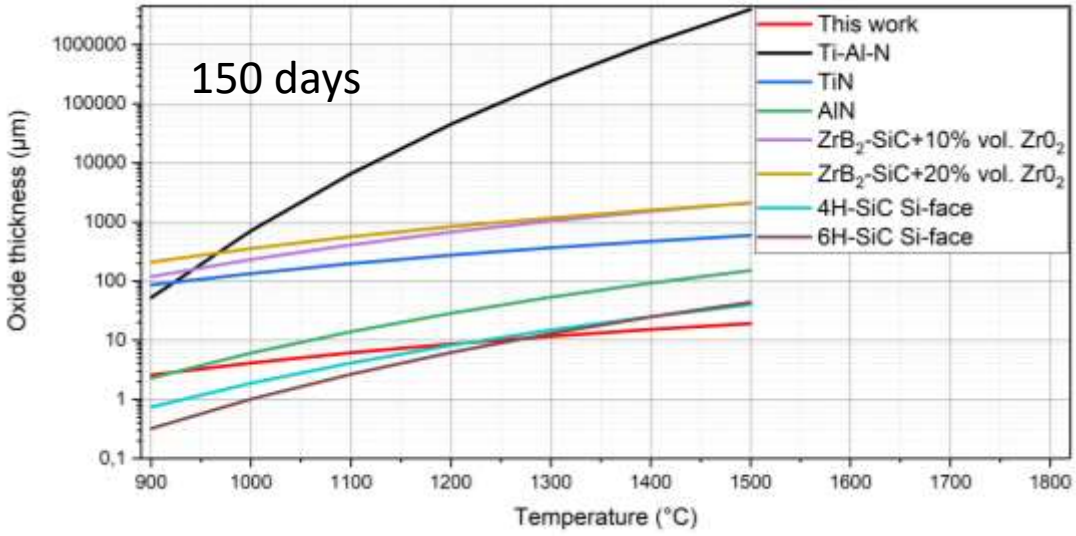


Thermal barrier (oxidation resistance)









INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Team

ICS Founders

INNOVATIVE COATING SOLUTIONS

sol4u.com

Stéphane Lucas

PhD in Physics, MBA

2003 - Now:	Professor at **Unamur – Director of LARN,** Mechanical workshop, SIAM
1998 - 2003	**Ion Beam Application** Louvain-La-Neuve, Belgium. Project manager, CEO of IBA-RI
1997 - 1998	**Glaverbel Research Center (AGC),** Jumet, Belgium Senior Scientist: industrial plasmas
1991 - 1997	**Cockerill Sambre (Steel Industry)**, Liège, Belgium Senior scientist: industrial plasmas
1990 - 1991	**University of Aarhus**, Aarhus, Denmark Post-Doctoral fellow, ion implantation and thin film mechanical property

40 publications and 10 patents on plasma and coatings

UNIVERSITÉ DE NAMUR

Marketing, R&D, Production, Finance & Administration

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Marc J.M. Van Wonterghem
MS in Electronics Design
Business Development

Eng. Rémy Wauters
Engineer in Electromechanics
Production

Prof. Dr. Stéphane Lucas
PhD Physics, MBA
CTO

Finance & Admin
Administration Officer

R&D and production

Dr. Emile Haye,
PhD in Material Science
Product Development

More than 12 researchers at UNamur:
Postdocs, PhD, Masters, Engineers

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Industrial Track Record

Selection of 3D substrates

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Metallization Deposition of Metal on any Surface for any functional Properties

Ag on SiO2

Jewelry

Al, Ti on carbon

Industrial

Cr on Zr ceramic

Industrial

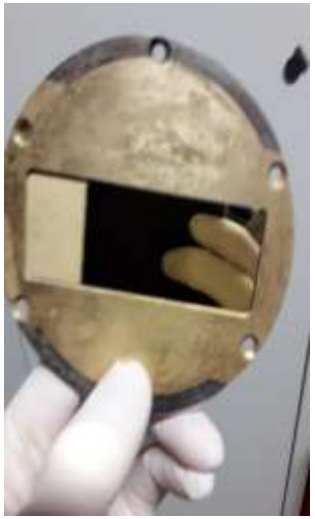
Cr on vials

Decoration

Au on buckle

Jewelry

Au for bio-applications



Biotech

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Metallization Deposition of metal on any surface for any functional properties

Harmless Cr
on brass

Outdoor decoration

Harmless Cr on
PP, HDPE, ABS/PC, HIPS, ABS, PA

Industry

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Decoration Deposition of decorative layers on any surface

Black, gold and blue on SS

Nickel like on brass

Dark grey on 3D printed polymer

Black on SS

Nuances of gold like on brass

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Decoration *Black and rainbow coatings on high quality bike hubs*

Before After

Detail

Industrial track record

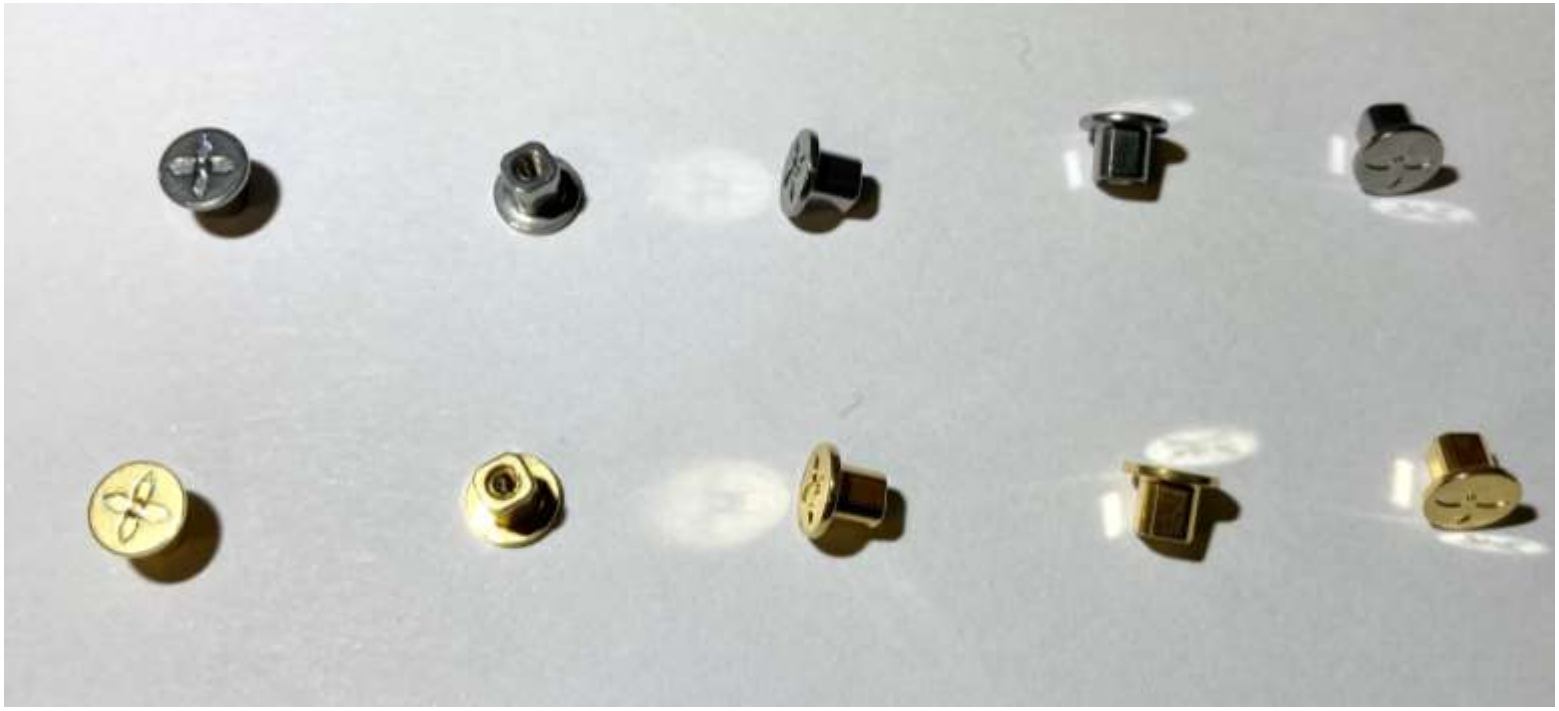
INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Decoration Deposition on High End leather goods accessories

Gold coating on blind rivets

Before

After



Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Friction/wear

Deposition for the purpose of friction reduction

Pinion gear (oil pump)

All-gear-differential

Tested on Audi A4

Noise reduction

Planet gear (noise reduction)

Piston (pump)

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Decoration Black coating with unique properties

Coating compatible with sterilisation process

Developed for SIBEL:

SIBEL
THE ONLY BELGIAN MANUFACTURER OF SURGICAL INSTRUMENTS

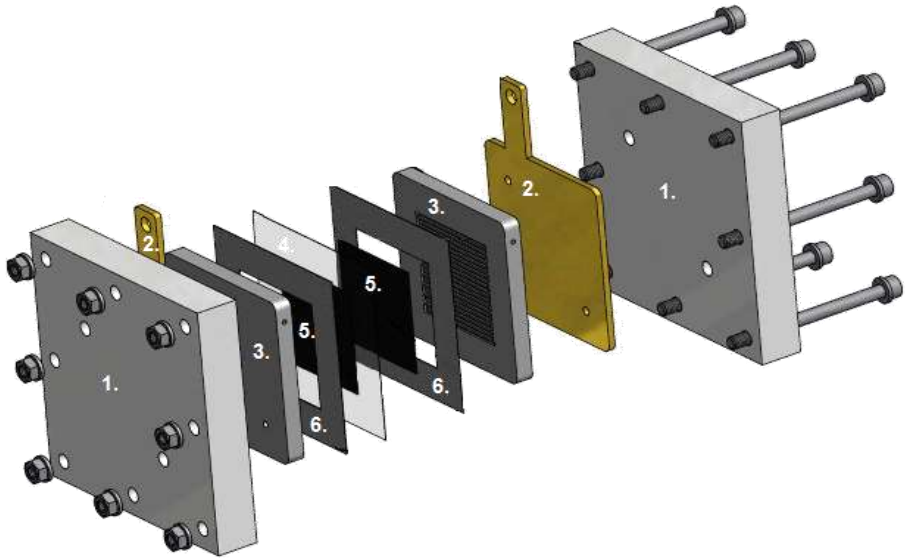
info@sibel.be

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Bipolar plate

*ICS black layer **electrical conductivity can be tuned** by metal doping making it excellent for **deformable electrodes** (e.g. fuel cell bipolar plates) with low interfacial contact resistance and high corrosion resistance*

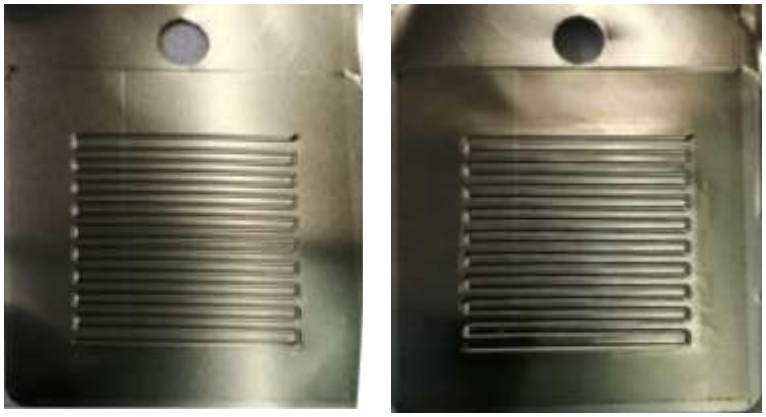


1. Campling system
2. Current collector
3. **Bipolar plate**
4. Membrane
5. Catalytic layer
6. Seal

Best coatings better than DoE 2020 target
ICR= 3-7 mΩ.cm² at 150 N/cm
I_{corr}*= 0.01-0.05 µA/cm²

Coating validated after real test in PEMFC during 200h

Before test *after test*



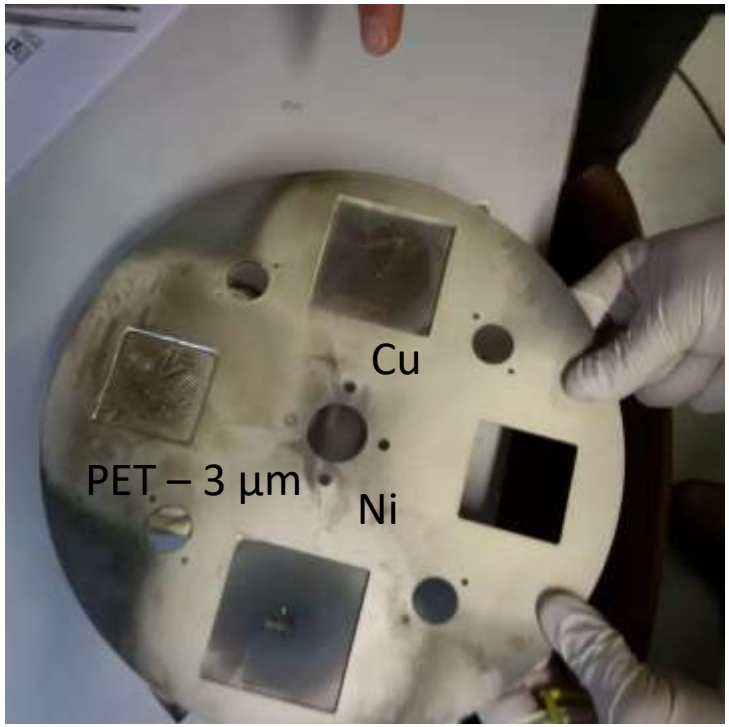
**Corrosion tests:*
H_2SO_4 0.6M, pH 0.5, 60°C, 0.48V, 16h

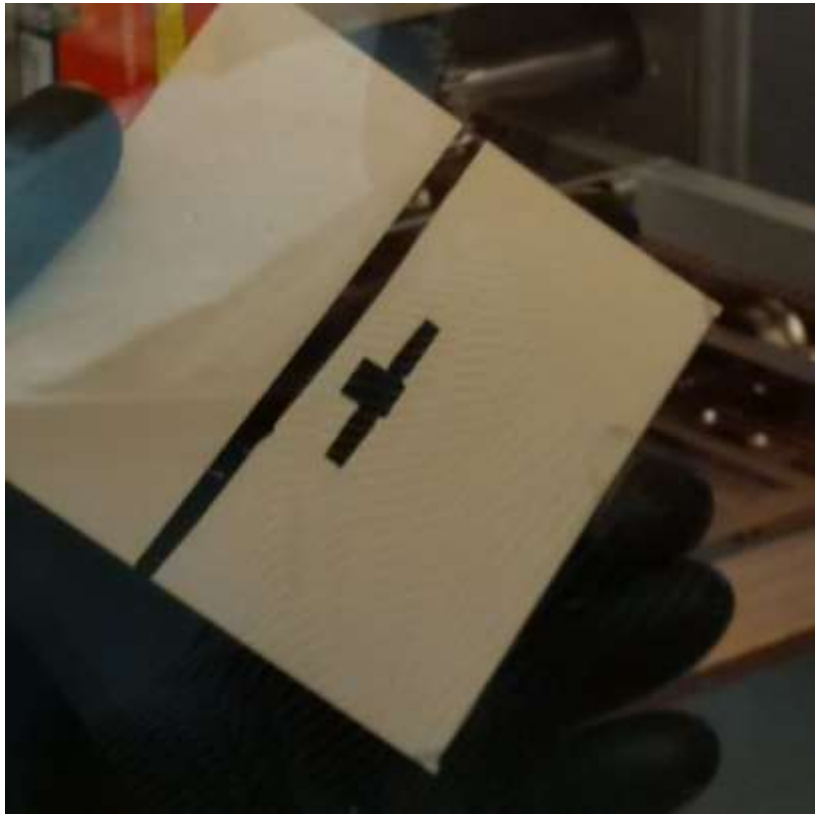
Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Metallic Li coatings

ICS has developed a PVD process to deposit Thin or Thick metallic Li coatings on 2D or 3D substrates at high rate





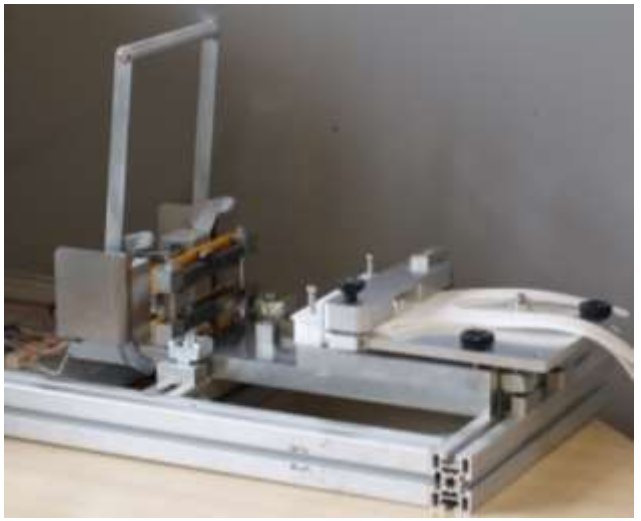
About 2 µm metallic Li in 40 sec

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Anti-sticking

Black coating deposited on heated jaw (RT-200 °C, cycling) to weld polymer



Developed in 2 days during Covid-19 crisis: mask welding

In collaboration with MALCOURANT MECANIQUE

ppowis@malcourant-mecanique.be

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Anti-sticking

*ICS black layer has **anti-sticking properties** making it suitable for treatment of **powder compression** tools*

Powder compression & tabletting tools

Significant **reduction** of **powder adhesion** on tool

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Industrial Track Record *Powder*

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

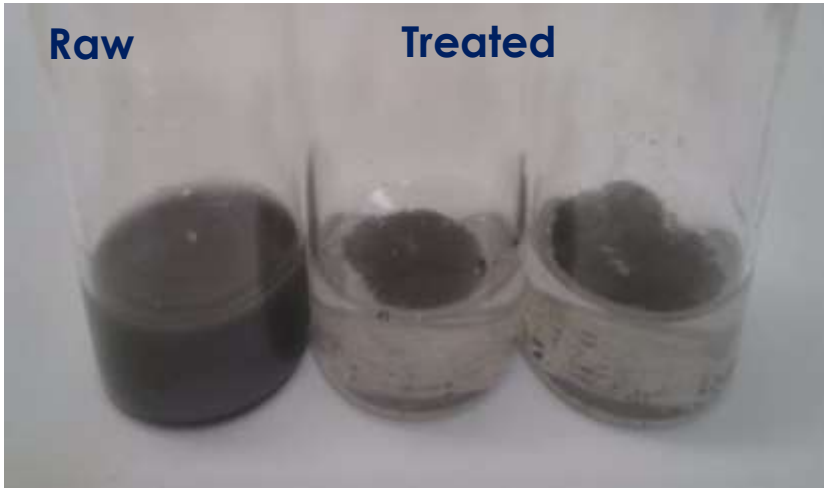
Powder treatment

Treat nanometer or micrometer powder of any material to modify their surface reactivity

In H_2O

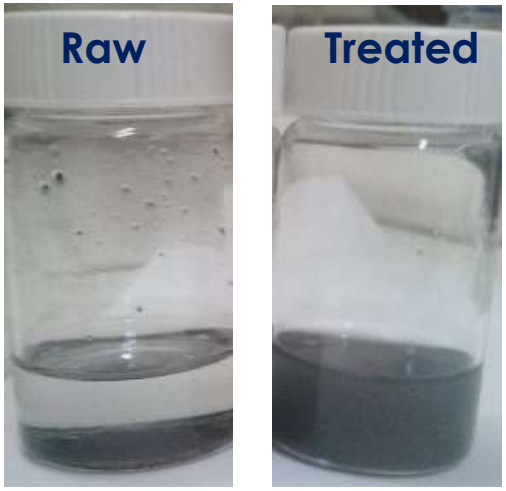
ZrO_2

Al



In organic solvent

Al



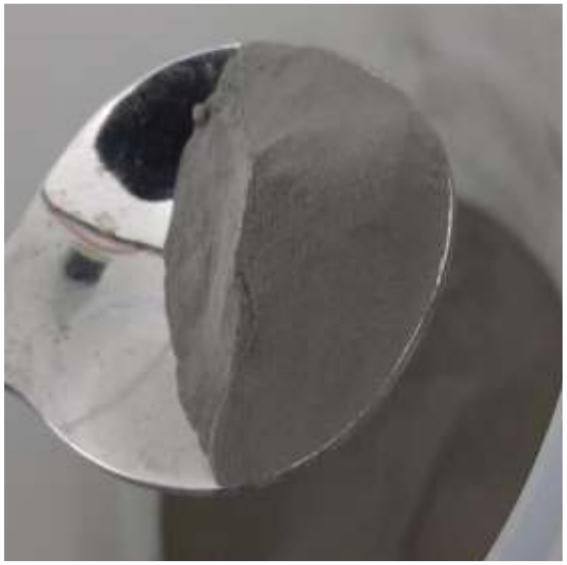
- Improved dispersion and stability in various matrices
- Hydrophobic/hydrophilic properties on demand
- Long term stability
- Applications in batteries, paint durability, additive manufacturing, …

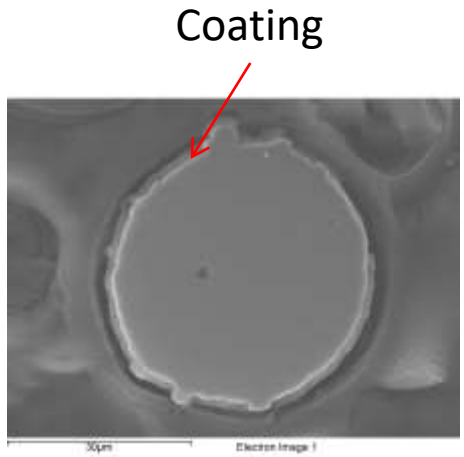
Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Powder treatment

Low cost treatment of your raw powder for 3D metal printing.





Significant improvement of **powder flowability**
No detrimental effect on printability

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Process transfer ICS proprietary process sold with inline coater

Industrial track record

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Machine design

2D, 3D parts

Powder

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

ICS Process and Coating simulation capabilities

You'll belong to a large community

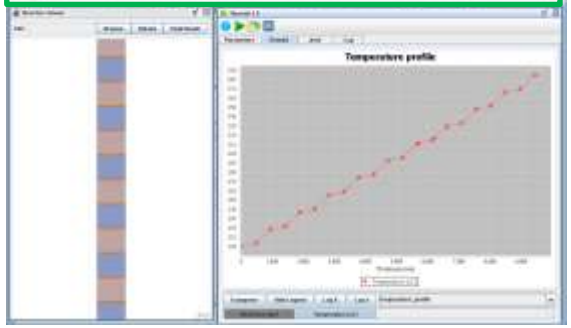
INNOVATIVE COATING SOLUTIONS

www.incosol4u.com

The properties you are interested in

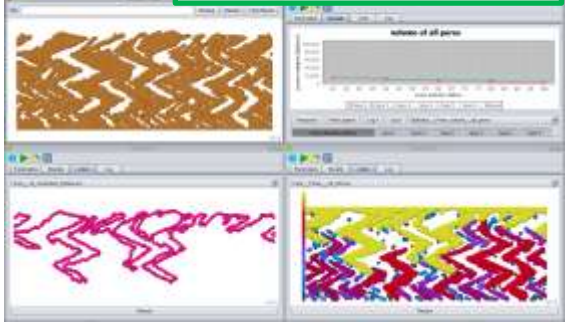
Thermal properties

Temperature profile across the coating



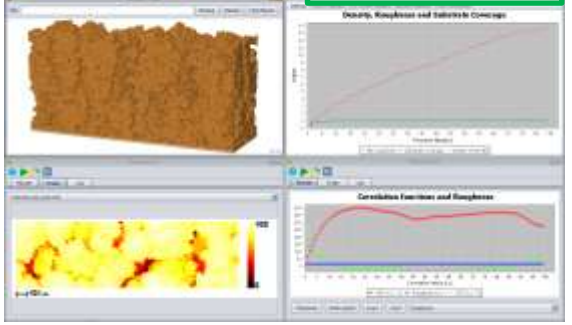
Porosity

Glancing angle deposition



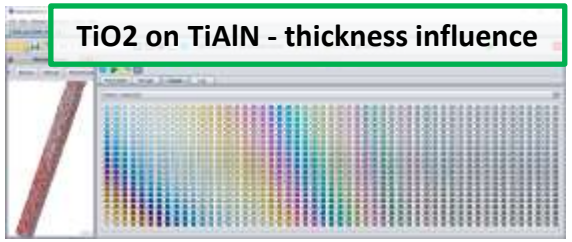
Roughness

Chemical sensor



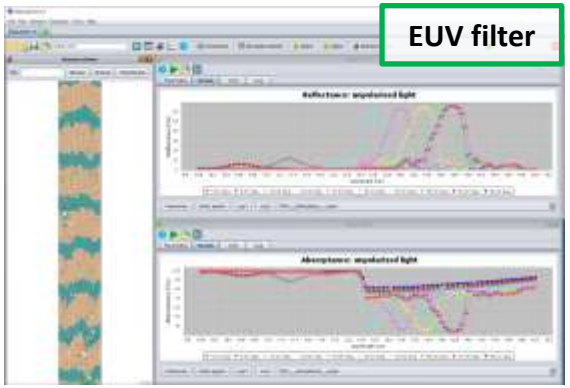
Colour

TiO2 on TiAlN - thickness influence



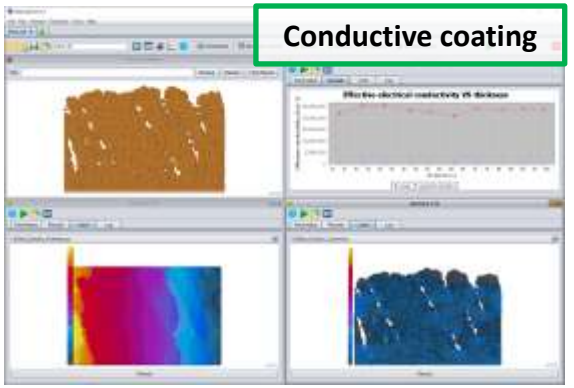
Optical properties

EUV filter



Electrical properties

Conductive coating



Prof. Stéphane Lucas
slu@incosol4u.com
+32 498 975 282

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Partnerships

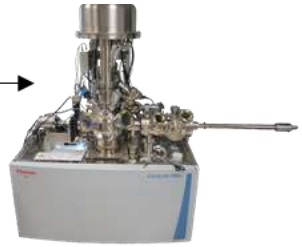
Partnership with University of Namur

As a spin-off, ICS has access to state of the art analytical & simulation tools of University of Namur, needed for product qualifications & developments

Characterisation for product development and problem solving

ToF-SIMS

XPS

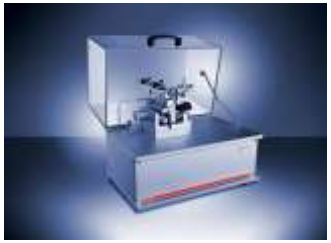


HRSEM with EDS

TEM (HRTEM soon)

Nano-indentation

Pin-On-Disk



Partnership with D&M Vacuumsystems B.V.

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

ICS has a unique partnership D&M Vacuumsystems B.V.
Together we offer turn-key solutions
for (high-quality & complex) vacuum systems.

D&M has received confidence and credits from various prestigious companies and institutes that are active in the following industries: Lighting, Semiconductors, Space, Research applications, Solar systems, Thin film deposition, Analytical, Medical and Cryogenics.

ICS and D&M have now teamed up to offer the best hardware in thin film deposition.

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Scientific credentials

Innovation all along the line

Some scientific references (S. Lucas)

- Vandenabeele, C & Lucas, S 2020, 'Technological challenges and progress in nanomaterials plasma surface modification – A review', Materials Science and Engineering R: Reports, vol. 139, 100521.
- Haye, E, Colaux, JL, Moskovkin, P, Pireaux, JJ & Lucas, S 2018, 'Wide range investigation of duty cycle and frequency effects on bipolar magnetron sputtering of chromium nitride', Surface and Coatings Technology, vol.
- Mathioudaki, S, Barthélémy, B, Detriche, S, Vandenabeele, C, Delhalle, J, Mekhalif, Z & Lucas, S 2018, 'Plasma Treatment of Metal Oxide Nanoparticles: Development of Core–Shell Structures for a Better and Similar Dispersibility', ACS Applied Nano Materials, vol. 1, no. 7, pp. 3464-3473.
- Tonneau, R, Moskovkin, P, Pflug, A & Lucas, S 2018, 'TiOx deposited by magnetron sputtering: a joint modelling and experimental study', Journal of Physics D: Applied Physics, vol. 51, no. 19, 195202.
- Godinho, V, Moskovkin, P, Álvarez, R, Caballero-Hernández, J, Schierholz, R, Bera, B, Demarche, J, Palmero, A, Fernández, A & Lucas, S 2014, 'On the formation of the porous structure in nanostructured a-Si coatings deposited by dc magnetron sputtering at oblique angles', Nanotechnology, vol. 25, no. 35, 355705.
- Lopez-Santos, C, Colaux, J, Laloy, J, Fransolet, M, Mullier, F, Michiels, C, Dogné, J-M & Lucas, S 2013, 'Bioactivity and hemocompatibility study of amorphous hydrogenated carbon coatings produced by pulsed magnetron discharge', Journal of Biomedical Materials Research - Part A, vol. 101 A, no. 6, pp. 1800-1812.
- Godinho, V, Rojas, TC, Philippon, D, Jimenez De Haro, MC, Fernandez, A, Lopez Santos, MC & Lucas, S 2012, 'Microstructural characterization of hydrophobic TiAlN coatings with moth-eye-like surface morphology', Journal of alloys and Compounds, vol. 536, no. SUPPL.1.
- De Vriendt, V, Felten, A, Blondeau, J-P, Pireaux, J-J, Maseri, F & Lucas, S 2011, 'Deposition of superhydrophobic structures by magnetron discharge', Surface and Coatings Technology, vol. 205, no. SUPPL. 2.
- Limage, H, Tichelaar, FD, Closset, R, Delvaux, S, Cloots, R & Lucas, S 2011, 'Study of the effect of a silver nanoparticle seeding layer on the crystallisation temperature, photoinduced hydrophylic and catalytic properties of TiO2 thin films deposited on glass by magnetron sputtering', Surface and Coatings Technology, vol. 205, no. 13-14, pp. 3774-3778.
- Rigaux, C, Bodart, F, Lafort, A, Jongen, Y, Cambriani, A & Lucas, S 2009, 'Analyses of thick lithium coatings deposited by sputter-evaporation and exposed to air', Plasma Processes and Polymers , vol. 6, no. SUPPL. 1.

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Summary

INNOVATIVE COATING
SOLUTIONS

ICS offers **30 years of experience** in surface **PVD** (Physical Vapor Deposition) treatment in industrial & academic environment.

We bring diversity of various skills gathered under one roof.
As such we support Customers from **Concept & Development** of the **Custom PVD Product** into **Mass Production**.

Opposite to standard Chemical Depositions Techniques, PVD is a **Environmental-Friendly Zero-Waste and Low-Energy** use technology.

3 Service Pillars

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

- **Job Coater:** we **coat your par**ts with one of our recipes based on your needs at our production facility.

- **R&D Consulting in Coating:** we develop a **taylor made coating** to answer your very specific Surface Optimisation needs.

- **Licensing:** we **licence our process in your machine** or we install & integrate a dedicated machine in your production facility to allow you to integrate our technology in your production cycle.

INNOVATIVE COATING SOLUTIONS
www.incosol4u.com

Thank you