Nanostine

The scalable way to do nanocoatings

Commercial Dossier

Executive summary

Nanostine industrializes nanostructured coatings, combining lab-grade purity with industrial throughput and low cost. The company has validated its technology **with 11 industrial and institutional customers**, including **ESA, SENER, Graphenea, Acciona, Nano4Energy and B5Tec**, delivering **more than 25 projects**.

Higher reactivity
thanks to a much larger surface area.

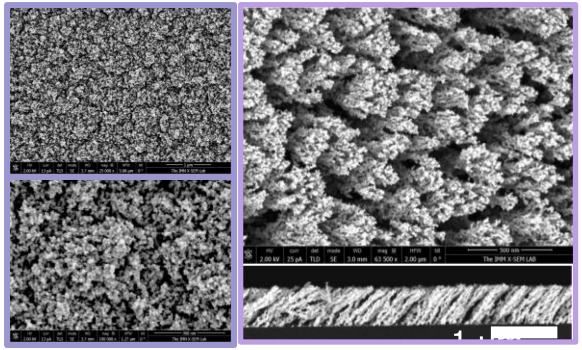
New properties (optical, electrical, catalytic)
driven by size effects and quantum effects.

Application-tailored performance,
making materials lighter, harder, more durable and non-stick.

Nanostine has worked with 28 materials to provide a unique combination:

Cost + Quality + Scale + Sustainability

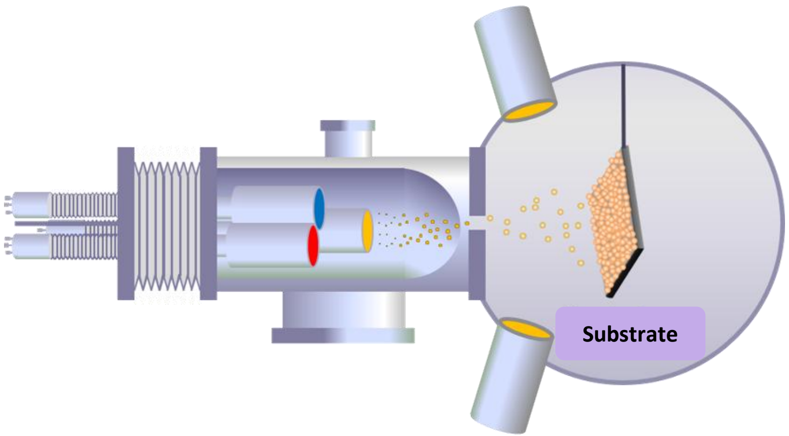
- ✓ **28+ materials** processed (metals, oxides, polymers, …).
- ✓ Designed for **high-throughput, low-cost production.**
- ✓ Processes compatible with **industrial scale** and **sustainability targets.**



Surface treated with nanoparticles, increasing interaction area without impurities.

Technology: Industrial precision and scalability

Our **proprietary** MICS (Multiple Ion Cluster Source) technology enables the manufacturing of **complex nanoparticles** with **atomic-level precision** and **industrial stability**.



Full control

Generation of alloys and complex nanostructures in a single step using **three independent magnetrons**.

Industrial scalability (the “race track” issue solved)

We have solved the typical instability of conventional sputtering by using our proprietary **Full-Face Erosion (FFE) magnetrons**.

Stability data

Validated continuous operation for more than 12 hours without replacing the feedstock, achieving 20 % target utilization (vs. 5-10 % standard), significantly reducing OPEX and maintenance downtime.

Nanostine: High-performance coatings at scalable cost

Precision and purity

Ultra-thin conformal layers (from single-particle-thick coatings to films of several µm) with thickness control of ±2–10 nm.

Very low impurities, resulting in higher performance and reliability.

Cost and scalability

Lower cost per m^2 than traditional methods**: up to 33% lower than CVD and 50% lower than laser**, with better quality.

High productivity compatible with volume manufacturing. Cycle times per part can be **just a few seconds**.

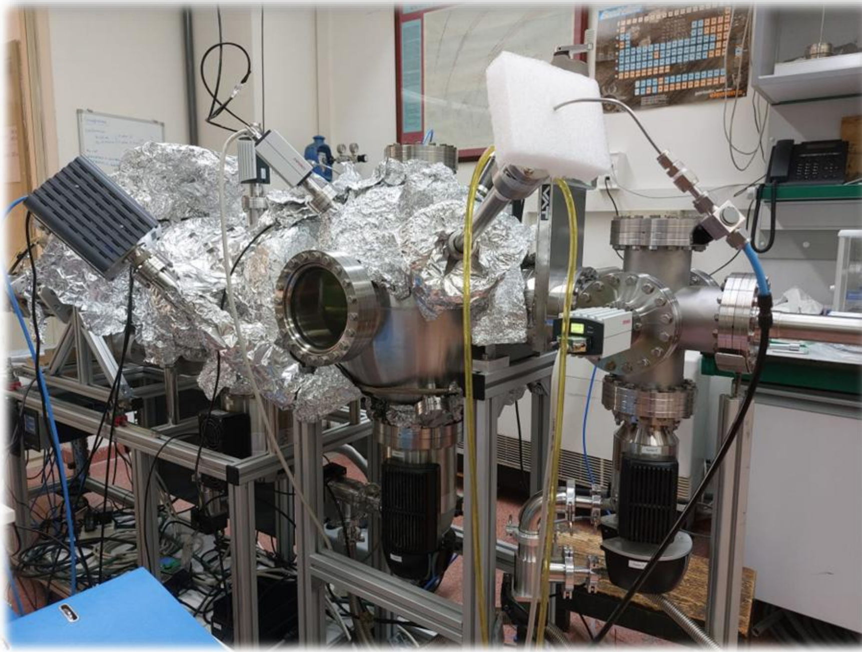
Sustainability

Dry process, with no solvents or hazardous reagents (vs. chemical alternatives).

Reusable raw material, reducing cost.

CSIC
Consejo Superior de Investigaciones Científicas

Nanostine is a CSIC spin-off with patented technology*



CSIC: Spain's largest public research organization and #3 in Europe.

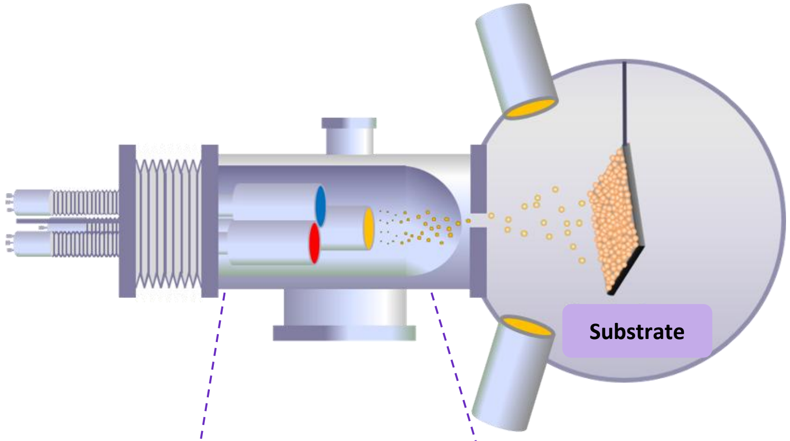
Patents: Strong intellectual property protection

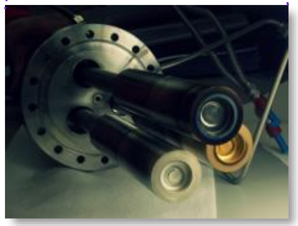
1 **EP3605583B1 DEVICE FOR THE STABLE MANUFACTURE OF NANOCLUSTERS**

- Stable nanoparticle production using FFE magnetrons.
- Enables continuous industrial operation.
- European patent granted and validated in ES, DE, UK, FR, IT, SWZ.
- Co-developed with CSIC. Exclusivity for Nanostine.

2 **EP25382706.7 ANTI-MULTIPACTOR COATING, METHOD OF PRODUCTION AND USES THEREOF**

- Protects the family of anti-multipactor coatings for RF components in space applications.
- European patent in the validation process.
- Filed on 8 July 2025.
- Developed jointly with CSIC. Exclusivity for Nanostine.





Proprietary know-how

1. **Equipment design and tuning**

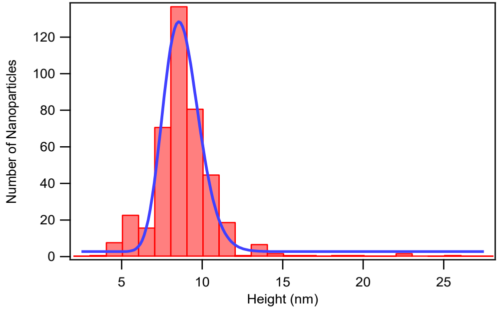
   Maintaining UHV and plasma stability during continuous nanoparticle growth.

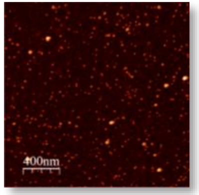
2. **Synthesis route optimization**

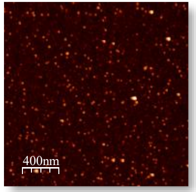
   Empirical calibration protocols for each substrate and coating family, ensuring reproducibility and performance.

3. **Process software and control logic**

   Unique deposition algorithms to scale from lab to industrial platforms.

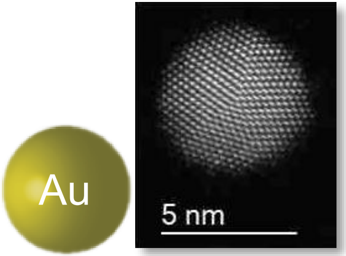




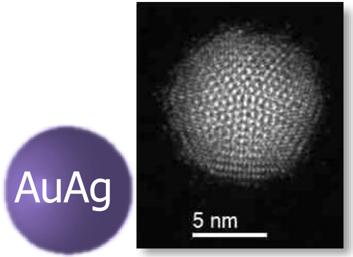


Homogeneous nanoparticle distribution.
No agglomerate formation.
Deposits <1 monolayer.
Controlling the number of nanoparticles per μm^2.

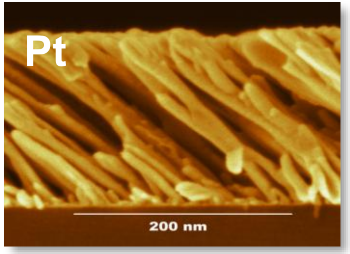
Examples of broad product portfolio



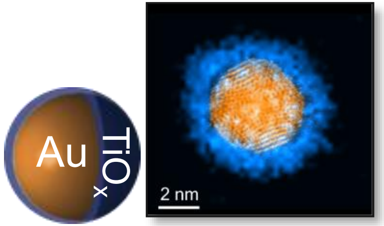
Single element



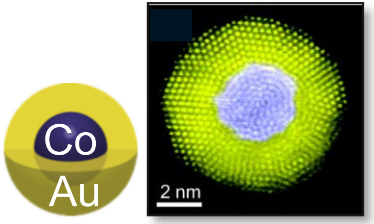
Alloys



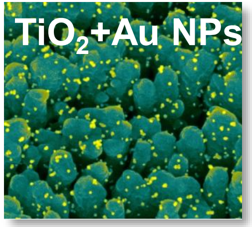
Nanocolumns



Oxidized nanoparticles



Core-shell



Nanocolumns + nanoparticles

Wide range of options

Elements **used by Nanostine** in nanoparticle synthesis

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											**5 B 10.811**	**6 C 12.0107**	7 N 14.0067	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989769	**12 Mg 24.3050**											**13 Al 26.9815386**	**14 Si 28.0855**	15 P 30.973762	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955912	**22 Ti 47.867**	**23 V 50.9415**	**24 Cr 51.9961**	**25 Mn 54.938045**	**26 Fe 55.845**	**27 Co 58.933195**	**28 Ni 58.6934**	**29 Cu 63.546**	**30 Zn 65.38**	31 Ga 69.723	32 Ge 72.64	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	**40 Zr 91.224**	**41 Nb 92.90638**	**42 Mo 95.96**	**43 Tc [98]**	**44 Ru 101.07**	45 Rh 102.90550	**46 Pd 106.42**	**47 Ag 107.8682**	48 Cd 112.411	In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.293
55 Cs 132.9054519	56 Ba 137.327	57-71 Lanthanides	**72 Hf 178.49**	**73 Ta 180.94788**	**74 W 183.84**	**75 Re 186.207**	76 Os 190.23	**77 Ir 192.217**	**78 Pt 195.084**	**79 Au 196.966569**	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98040	84 Po [209]	85 At [210]	86 Rn [222]

Validated results across 4 strategic industries

Aerospace & Defense	**Multipactor mitigation** x 2–7 on satellite RF components **Hydrophobic/self-cleaning** lenses, x 2 faster contamination removal **Materials outgassing** reduced up to x 100 with higher reliability in orbit
Energy	**Electrodes coating:** 30 % less **catalyst** with increased durability & performance **Improved lifetime & efficiency** for fuel cells and electrolysers
Sensors	**Sensitivity improved** x 2-3 Enhanced microorganism detection (biosensing)
Healthcare	**Antibacterial** nanoparticle **implant coatings** **Adhesion & biofilm** proliferation reduced by up to 95 %

SpaceTech success story #1: Radiofrequency

Problem

Multipactor effect, a phenomenon in which electrons bounce between metallic surfaces inside RF devices, creating a cascade that overheats or destroys components. Existing coatings (Alodine, SurTec) mitigate it only partially:

1. **Alodine** uses hexavalent chromium (Cr VI), a carcinogen restricted under the European REACH regulation (Registration, Evaluation, Authorization and Restriction of Chemicals).

2. **SurTec** is REACH-compliant but provides weak multipactor suppression, forcing operation at lower RF power levels or requiring device redesign.

Solución de Nanostine

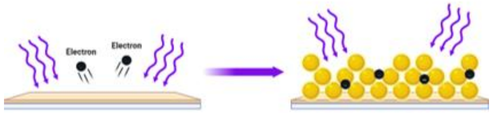
REACH-compliant nanostructured coatings that drastically reduce secondary electron emission while maintaining electrical conductivity and mechanical stability (-150 °C to +150 °C).

Validation to date

ESA BIC Madrid and ESA IDEAS-OSIP projects with **ESA** and **SENER**.

Performance improvement of x 3–7 (first crossover energy (E1) = 130 eV vs. 41 eV (Alodine) and 18 eV (SurTec); discharge threshold (ΔP): 7–9 dB vs. 3.3–7.7 dB for Alodine 1200).

esa



Comparison between a flat surface (left) and a nanoparticle-textured surface (right) to mitigate the multipactor effect. Electrons escape more easily from less rough surfaces (without nanoparticles).

SpaceTech success story #2: Self-cleaning lenses

Problem

Fingerprints, organic stains and fogging on external glass surfaces **degrade image quality**.

Nanostine solution

Self-cleaning photocatalytic coatings based on titanium dioxide nanocolumns (TiO_2 NC).

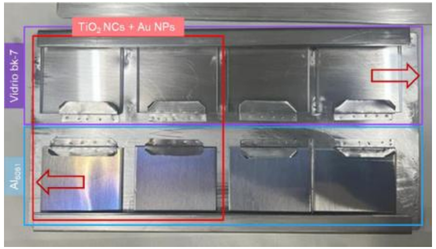
Validation to date

Pilot project with **Lidax Ingeniería**.

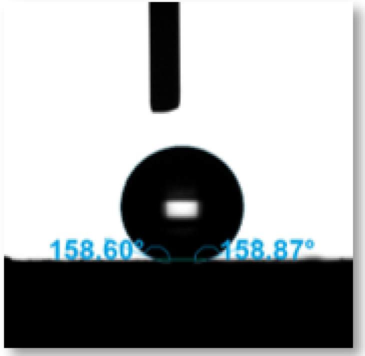
Samples intentionally contaminated with hydrocarbons and esters following ECSS-Q-ST-70-05C.

Two cleaning protocols: conventional bake-out (72 h, 80 °C, 10^{-6} mbar) and UV-assisted cleaning.

UV cleaning removed up to twice as much organic residue as bake-out, confirming photocatalytic self-cleaning capability.



Nanostructured coatings deposited on metal substrates (bottom) and optical glass (BK7) (top).



Superhydrophobic coatings.

Sensor success story: High-sensitivity sensors for IoT

Problem

Increase signal-to-noise ratio and sensitivity in miniaturized IoT sensors without damaging the base material of the devices.

Nanostine solution

Ultra-pure metal nanoparticles (Ag, Au) deposited directly onto active graphene or silicon substrates.

Commercial product in collaboration with Graphenea

Nanostine's MICS process deposits precision nanoparticles on Graphenea's graphene sensors.

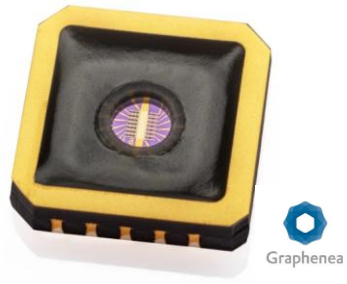
This functionalization **improves sensor sensitivity** to specific biological or chemical analytes without the contamination risks of wet chemistry.

Technology advantage (tailored functionalization)

Independent control: We can tune particle density (NPs/µm²) and particle size independently.

Benefit: This lets us maximize active surface area (increasing signal) without increasing individual particle size (maintaining resolution).

Press release link



Ultra-sensitive sensors.

Energy success story: Electrode optimisation

Problem

Electrodes in fuel cells, electrolysers and batteries suffer from **low catalyst utilization, limited durability and high catalyst cost**.

Nanostine solution

Nanoparticle coatings engineered at the nanoscale to maximize catalytic surface area, improve charge transfer and **reduce precious-metal loading by ~ 30 %**.

Solvent-free process, uniform coverage even on porous electrodes.

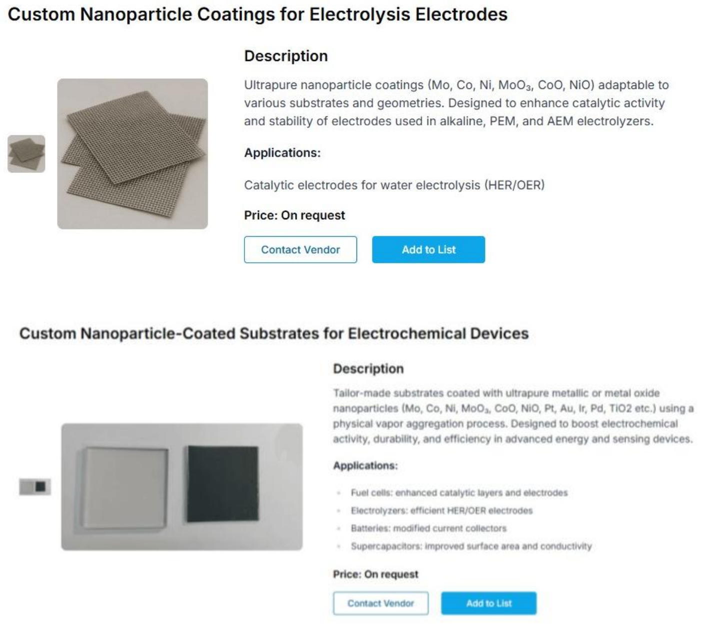
Validation to date

Products commercialized on **ElectroSeek**.

B5Tec project: same performance with ~ 30 % less platinum (a very expensive material). Strong adhesion under methanol flow (high robustness).

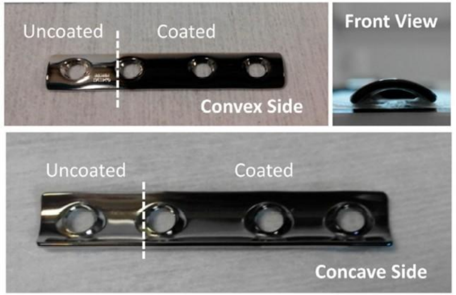
Nano4Energy project: electrolyser electrodes for green hydrogen.

Natrion and UAM: solid-state battery interfaces and nanoparticles for H_2 storage.



Products on ElectroSeek (marketplace).

New developments: Healthcare and prosthetics



Problem

Existing coatings (TiN, antibiotic films) to **prevent post-implant infections lack antibacterial activity** or promote resistance.

Nanostine solution

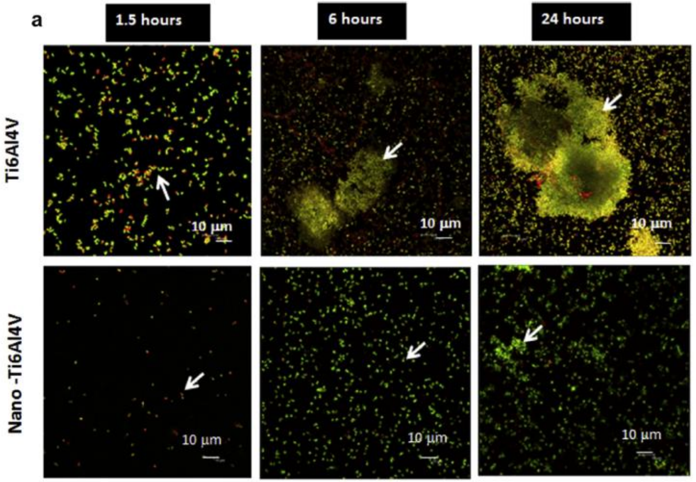
Antibacterial and **biocompatible** nanostructured **coatings** that inhibit bacterial adhesion and biofilm formation without antibiotics, while maintaining mechanical stability for years.

Development status

95% in-vitro bacterial reduction on real implants tested with academic partners.

Excellent adhesion and surface finish.

Selected for HealthStart 2025 (Community of Madrid) to define the industrial pathway (TRL 4 → 5 during the project).



Top image: Implant example.
Bottom image: Coating real implants and prostheses to prevent bacterial and biofilm growth. Comparison of bacterial growth without nanoparticles (top) vs. with nanoparticles (bottom).

Nanostine is a platform with multiple applications

Beyond the showcased use cases, we **develop nanoparticles and coatings** to solve specific industrial requirements.

Tailored

Designs **adapted** to specific requirements and materials.

Scalable

From lab to industrial production with **repeatability**.

High-ROI

Measurable improvements in total cost and performance.

Nanostine

The scalable way to do nanocoatings

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