

WEBINAR:

Nuevas soluciones **PFAS FREE** en recubrimientos funcionales para aplicación multisectorial

30 junio 2026
→ 10:00 a 11:00

“Alternativas sol-gel libres de PFAS”

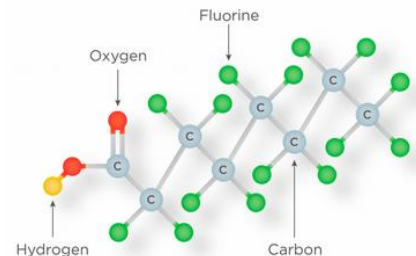


Usoa Izagirre
Investigadora Senior
TECNALIA

Introducción

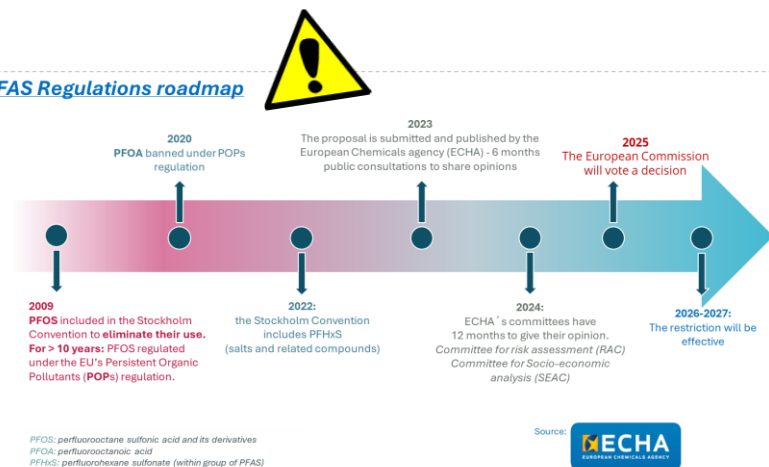
PFAS: Sustancias Perfluoroalquiladas y Polifluoroalquiladas

- Representan una clase versátil de **compuestos químicos sintéticos** que se utilizan ampliamente en diversas **aplicaciones industriales** y de **consumo**.
- Sus atributos distintivos -como la **repelencia** al agua y al aceite, la **resistencia al calor** y la robustez **química**- las hacen muy atractivas para una amplia gama de productos, desde utensilios de cocina antiadherentes, envases de alimentos, textiles, componentes industriales y hasta en espumas para extinción de incendios.
- Sin embargo, las propiedades únicas derivadas de sus fuertes enlaces químicos también provocan **efectos adversos en la salud humana** y el **medio ambiente**. Su uso está siendo prohibido en distintos sectores y se necesitan urgentemente **alternativas más sostenibles**.



En la imagen pueden verse algunos usos comunes de los PFAS. Imagen cortesía para Tecna:ia de Carollo Engineers; en particular, Cayla Cook y Eva Steinle-Darling.

PFAS Regulations roadmap



Usos de los recubrimientos PFAS

A nivel de productos industriales y de consumo, los **PFAS** se utilizan en infinidad de **aplicaciones** y **sectores** donde se requiere el uso de **recubrimientos anti-adherentes** y **resistentes** tanto a **agentes químicos** como a la **temperatura**.



Propiedades clave de los recubrimientos base PFAS

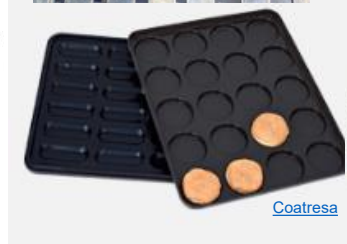
- Antiadherencia
- Bajo coeficiente de fricción
- Anticorrosión
- Alta resistencia térmica
- Alta resistencia química



Reepack



[Tecil SRL](#)



[Coatresa](#)



Soluciones sol-gel de TECNALIA libres de PFAS

- **TECNALIA ha desarrollado sistemas de recubrimiento de metaloxanos híbridos** con las propiedades requeridas para diversas aplicaciones (antiadherentes, anticorrosivos, autolubricantes y resistentes al calor).
- El recubrimiento se sintetiza mediante la técnica **sol-gel**, un método versátil para la obtención de materiales **inorgánicos** o **híbridos orgánico-inorgánicos**: la fase inorgánica garantiza la adhesión al sustrato metálico analizado, mientras que en la red orgánica pueden integrarse grupos funcionales y/u otros para dotar a la superficie de diferentes propiedades.
- **Ventaja competitiva:** Durabilidad de los recubrimientos (mantenimiento de las propiedades frente al uso).



Recubrimientos técnicos multicapa: Recubrimientos en base a metaloxanos híbridos con propiedades anti-adherentes, anticorrosión, resistentes a la temperatura y al desgaste.

- ❑ **Aplicación:** utensilios de cocina, menaje, máquinas de procesamiento de comida, u otras superficies metálicas que requieran propiedades anti-adherentes, protectoras, resistencia a la temperatura y al desgaste.

REEPACK
COMMITTED TO PACK

PROPLANET



Alluflon S.P.A.

TORNAD



Especificaciones técnicas

Cookware: hydrophobicity (Targeted: > 100° Achieved: 99°), SFE (Targeted: ≤ 20 mN/m (teflon); Achieved: 26 mN/m), Durability /Thermal resistance (SFE unchanged before and after extensive use)

Recubrimientos de capa delgada : Recubrimientos transparentes de metaloxanos híbridos con propiedades hidrofóbicas, oleofóbicas y anti-reflectantes.

- ❑ **Aplicación:** desarrollado para **vidrio**, diferentes aplicaciones (mamparas de ducha, ventanas de coche, arquitectónico, etc.) pero extendible a otros productos y sustratos, incluso flexibles.

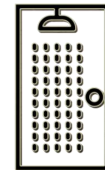
PILKINGTON

NSG
GROUP

PROPLANET



Automotive
window glasses



Shower doors

Especificaciones técnicas

Glass: hydrophobicity (Targeted: ≥ 100° Achieved: 100°), Transmittance (Targeted: ≥ 70 % ; Achieved: > 90 %) Durability (transmittance unchanged before and after ageing)

Recubrimientos híbridos sol-gel libres de PFAS

1

Síntesis del sol

Ruta de hidrólisis-condensación de alcóxidos metálicos



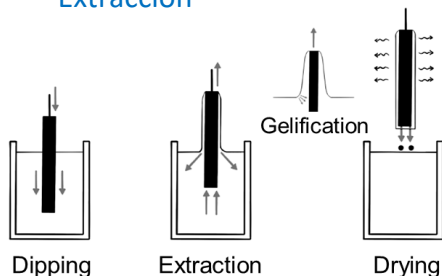
- ✓ **Técnica versátil** para obtener materiales cerámicos o híbridos orgánico-inorgánicos a T amb.
- ✓ **Ventajas.** Añadir grupos funcionales orgánicos y/o partículas/aditivos/resinas en la red para aportar las propiedades deseadas.

2

Aplicación

- ✓ Flexibilidad en el método de aplicación: inmersión, spray, roll etc.

Inmersión-Extracción



Esprayado



3

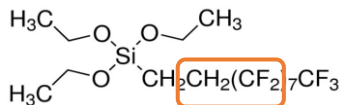
Curado



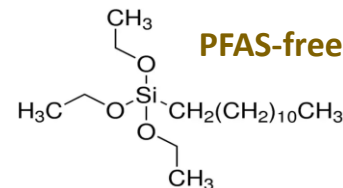
- Tratamiento térmico (150-180°C) (20 min-2h)
- Curado UV o IR/Laser modificando la formulación

Principios para lograr la **antiadherencia** del agua y otras sustancias: reducir la **SFE** → modificación química de los precursores utilizados

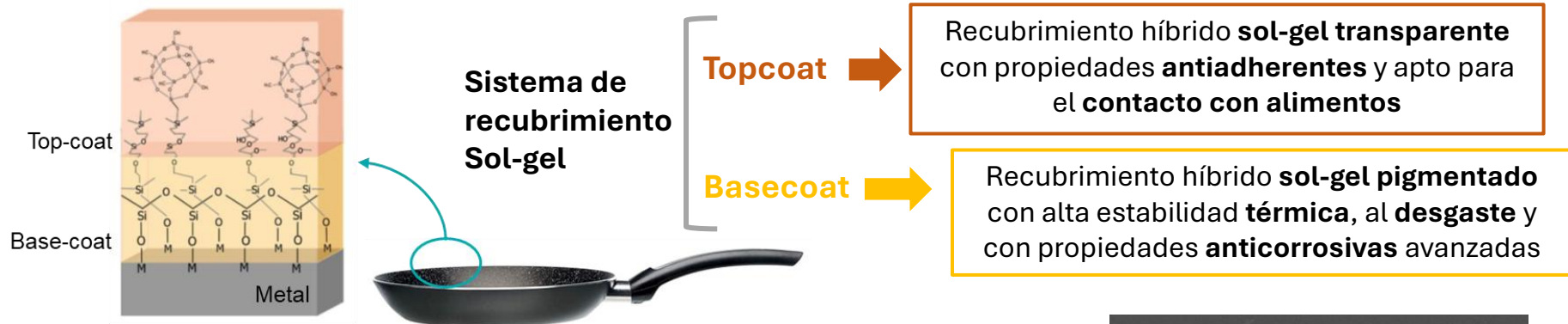
PolyFluoroAlkyl chain



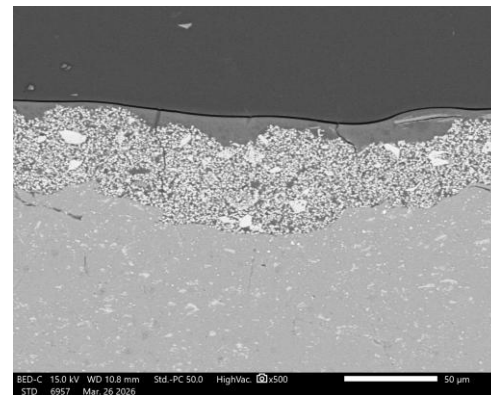
Ejemplo:



Recubrimientos técnicos sol-gel multicapa libres de PFAS



- ☐ Buena adherencia al metal
- ☐ Durabilidad:
 - Ensayo de abrasion por vibrado
 - Ensayo de la leche quemada
 - Ensayo del huevo
- ☐ Anti-adherencia:
 - WCA > 95°
 - HCA > 30°
 - SFE < 30 mN/m
- ☐ Apto para uso alimentario



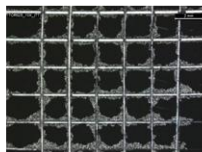
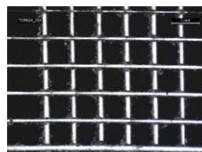


Adherencia antes y después de TT

BASECOAT BLACK



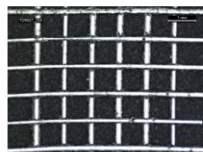
$50.4 \pm 4.1 \mu\text{m}$



BASECOAT BLACK
TOPCOAT 1



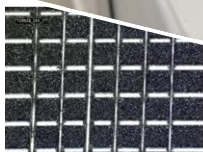
$21.0 \pm 5.3 \mu\text{m}$



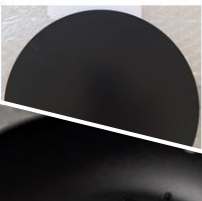
BASECOAT BLACK
TOPCOAT 2



$17.0 \pm 4.1 \mu\text{m}$



BASECOAT BLACK
TOPCOAT 5



$17.0 \pm 4.1 \mu\text{m}$



BASECOAT BLACK M8
TOPCOAT 6



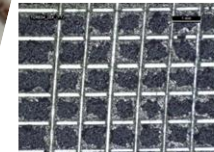
$17.0 \pm 4.1 \mu\text{m}$



BASECOAT BLACK M8
TOPCOAT 7



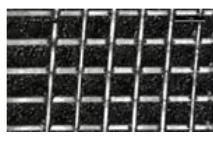
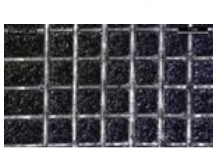
$34.8 \pm 2.3 \mu\text{m}$



BASECOAT BLACK
TOPCOAT 3



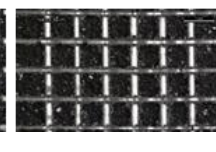
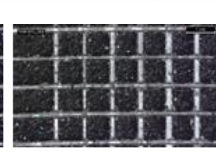
$20.9 \pm 3.0 \mu\text{m}$



BASECOAT BLACK 3
TOPCOAT 9

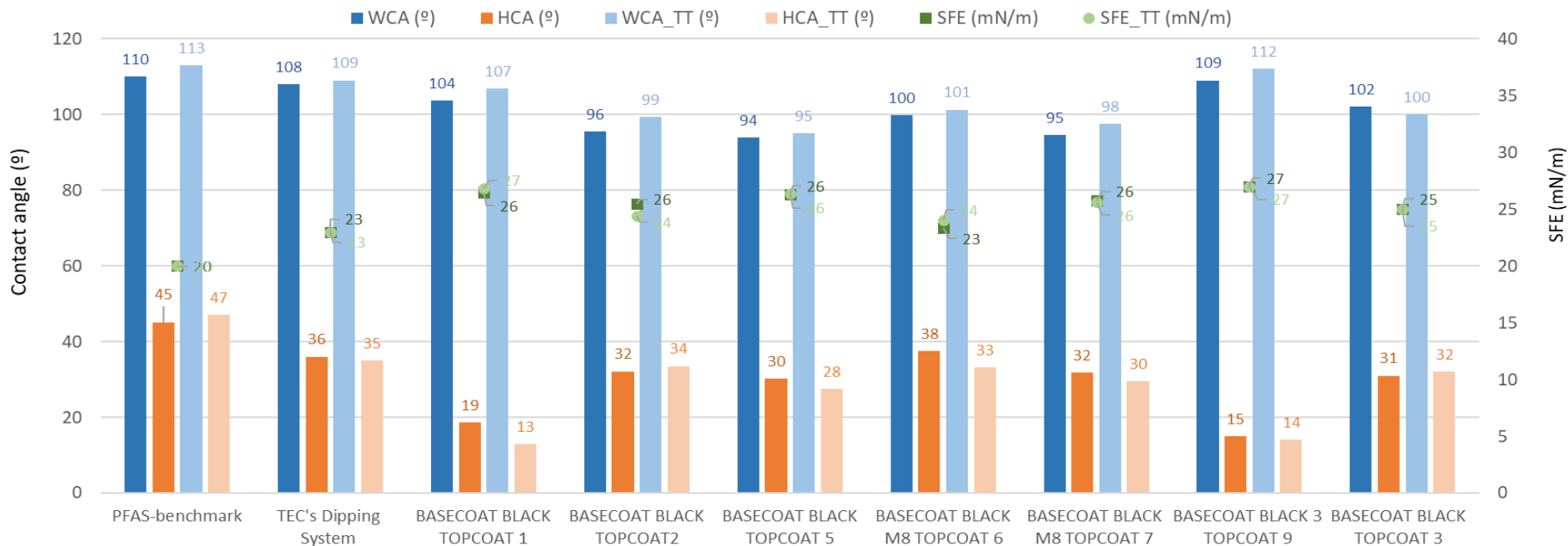


$16.0 \pm 2.6 \mu\text{m}$



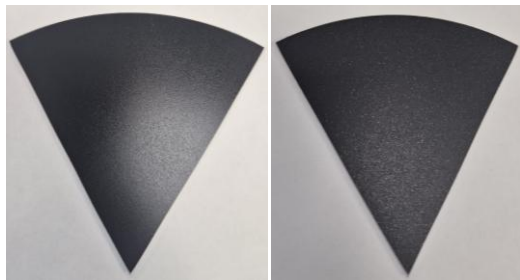
Adherencia tras tratamiento térmico (250°C - 30 min)

Angulos de contacto / SFE antes y después de TT (250°C-30 min)



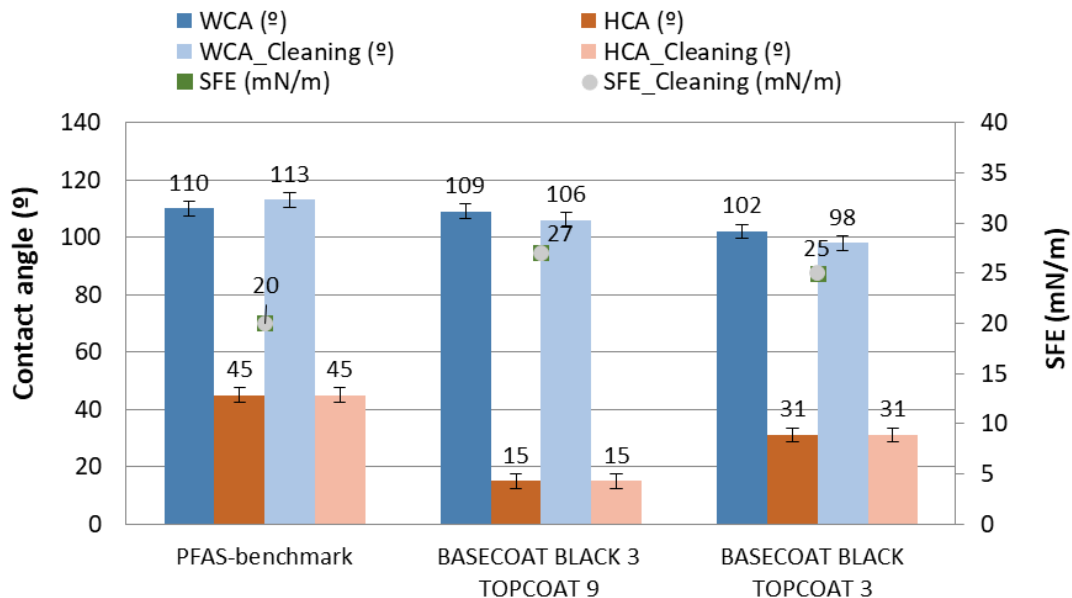
Angulos de contacto / SFE antes y después de test de limpieza con estropajo verde y jabón lavavajillas (5 pasadas)

BASECOAT BLACK TOPCOAT 3 **BASECOAT BLACK 3 TOPCOAT 9**



PFAS Benchmark

Contact angle: as coated and after cleaning simulation



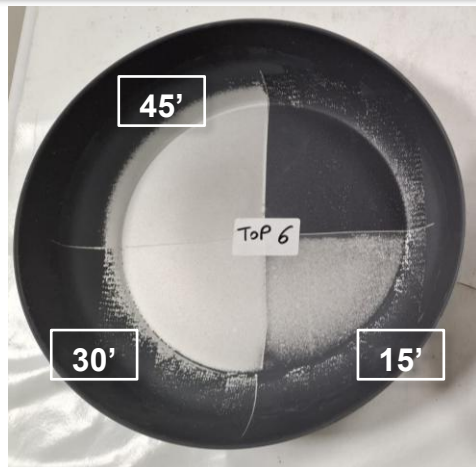
Tras la limpieza: las sartenes permanecen intactas, mientras que la muestra comparativa con PFAS muestra signos de rayado



Ensayo de abrasion por vibrado

Abrasion test:

- Abrasive powder + water + stainless steel balls vibrating together
- The pan is divided in four quarters. From top right: no abrasion, then following in clockwise direction: abrasion for 15' (x0,5), 30'(x0,3) and 45' (x0,2)



**PFAS
benchmark**



TORNADO's sol-gel

Tras el ensayo de 30 minutos, el panel aún presenta trazas del recubrimiento



Ensayo de la leche quemada



Se vierte leche en la sartén y se mantiene el calentamiento hasta que comienza a quemarse

+ chorro de agua a 2atm



+ limpieza suave con esponja (sin frotar)

Se evalúa el aspecto final



PFAS-benchmark



TORNADO's sol-gel

Ensayo del huevo



GRADE 5: release without spatula
GRADE 4: release with spatula
GRADE 3: release but partially stick
GRADE 2: hard release and stick
GRADE 1: completely stick

1. **Precalentamiento:** 300 °C durante 30 min → enfriamiento a RT
2. **Calentamiento:** Calentar hasta alcanzar 180 °C ± 10 °C.
3. **Ensayo:** Cocción de un huevo durante 100 segundos.

El ensayo se da por finalizado tras obtener dos resultados consecutivos de Grado 1

TORNAD
Alluflon group



250+ huevos

PFAS-benchmark: 3/5



197 huevos



TORNADO's sol-gel: 3/5

DESCRIPTION	Appearance	Adhesion	Corrosion	Pad abrasion	Vibrating abrasion	Scratch resistance	Pencil hardness (room T)	Pencil Hardness (200°C)	Dishwasher test	Impact test	Non-stick burned milk test	Non-stick egg test
PFAS BENCHMARK	OK	✓	✓	8000 CYCLES	VERY GOOD	GOOD	9H	7H	✓	GOOD	VERY GOOD	250+
BASECOAT BLACK	OK	✓	✓	1000 CYCLES	NOT ACCEPTABLE	GOOD	9H	9H	✓	GOOD	NOT GOOD	/
BASECOAT BLACK TOPCOAT1	OK	✓	✓	3500 CYCLES	ACCETTABLE	GOOD	9H	9H	✓	GOOD	NOT GOOD	/
BASECOAT BLACK TOPCOAT2	OK	✓	✓	3700 CYCLES	ACCETTABLE	GOOD	9H	9H	✓	GOOD	GOOD	/
BASECOAT BLACK TOPCOAT3	OK	✓	✓	3500 CYCLES	GOOD	GOOD	9H	9H	✓	GOOD	GOOD	12
BASECOAT BLACK TOPCOAT5	OK	✓	✓	2500 CYCLES	ACCETTABLE	GOOD	9H	9H	✓	GOOD	NOT GOOD	/
BASECOAT BLACK 1 TOPCOAT4	OK	✓	✓	5000 CYCLES	GOOD	GOOD	9H	9H	✓	GOOD	GOOD	128
BASECOAT BLACK M8 TOPCOAT6	OK	✓	✓	2500 CYCLES	ACCETTABLE	GOOD	9H	9H	✓	SATISFACTORY	NOT GOOD	/
BASECOAT BLACK M8 TOPCOAT7	OK	✓	✓	2500 CYCLES	ACCETTABLE	GOOD	9H	9H	✓	SATISFACTORY	NOT GOOD	/
BASECOAT BLACK 2 TOPCOAT8	OK	✓	✓	5500 CYCLES	GOOD	GOOD	9H	9H	✓	GOOD	GOOD	20
BASECOAT BLACK 3 TOPCOAT9	OK	✓	✓	6000 CYCLES	GOOD	GOOD	9H	9H	✓	GOOD	VERY GOOD	197

Food contact tests – Tests de migración

TEST REPORT N°

ITAH26006975 of 24/04/2026

START DATE 14/04/2026

END DATE 24/04/2026

intertek
Total Quality. Assured.

ALLUFLON SPA
Loc. Pianaccio, 71
61040 Mondavio PU

APPLICANT

SAMPLE DESCRIPTION
Sample Received 14/04/2026
Quotation No. 944.FCA
Order Nr.: 50/2026
Reference: TORNADO 3.9
Colour nero/black
End Use: per cucinare/to cook
Material Type: ceramica sol-gel/ sol-gel ceramic
Buyer's Name: ALLUFLON SPA

Test	Rating	Failure result
Determination of extractable PFAS in coated and impregnated solid articles, liquids and fire fighting foams IHTM methanol extraction 2h; 60°C Reg. EU 2023/40 Packaging and packaging waste regulation (PPWR)	NR	
Overall Migration Reg. EU 1935/2004 Art. 9 bis DM 21/3/73 + EN 1186.1:2002	P	
None of Italian Health Institute 0020072-P-20/05/2014	P	
Heavy Metals Migration EDQM 2024 edition Council of Europe Resolution CM/res(2020)9 + Reg. CE 1935/2004	P	
Specific migration of Formaldehyde EN 13130-1:2005 + CEN/TS 13130-2:2005	P	
PAA - Primary Aromatic Amines Reg UE 10/2011 14/01/2011 GU UE L12 15/01/2011+Reg UE 2016/1416 24/08/2016 GU UE L230/25/06/2016+Reg UE 2020/1245 02/09/2020 GU UE L268 05/09/2020, UNI EN 13130-1:2005, JRC IHCP EU EL FCM Aromatic amines Protocol A rev.	P	
Dyes Migration DM 21/03/1973 GU n° 104 20/04/1973 All IV sec 7 + Reg. CE 1935/2004	P	
Presence of Odour - Sensory Test DIN 10955-2:2014-01	P	
Fiche métaux et alliages DGCCRF - Dosage spectrophotométrique par UV-Vis Fiche MCDA n°1 (V02 01/04/2017)	P	
Food contact suitability of metals and alloys Total Lead and Cadmium Content - EPA 3050B ANNEX XVII, REACH n. 1907/2006 & Reg. (UE) N. 484/2011 & Reg. (UE) N.836/2012	P	

Meaning of Rating section:

P = MEETS REQUIREMENT / F = DOES NOT MEET REQUIREMENT / A = ACCEPTABLE / NR = NO REQUIREMENT / SC = STILL CONTINUES / X = NOT PERFORMED / NA = NOT APPLICABLE

Limits are based on Customer's Manual in force available at Intertek Italia S.p.A. Via di Stagno, 17 F/G - 50055 Lastra a Signa (PI)

Values in brackets represent limits



PFAS: <ILD

Overall migration: <ILD

Heavy metals migration: <ILD

Formaldehyde specific migration: <ILD

PAA - Primary Aromatic Amines: <ILD

Dyes Migration transmittance: >95%

Pasa los tests de migración

Food contact tests – Panel sensorial

SENSORY TESTING OF FOOD CONTACT MATERIAL
Test Report No 202607041 of 16/04/2026



RESULT OF THE TEST		PASSED	
DATE OF ISSUE		16/04/2026	
DRAFTING	SIGNATURE	VERIFICATION AND APPROVAL	SIGNATURE
Nico Lippi		Lucia Bailetti	
Sensory Consumer & Neuro Marketing Specialist		Sensory Consumer & Neuromarketing Manager	
nico.lippi@intertek.com		lucia.bailetti@intertek.com	

SAMPLE (tested in two replicates)



SAMPLE INFORMATION

Reference: ITAH26006975 –

Order Nr: 50/2026
TORNADO 3,9 colour
nero/black end Use per
cucinare/To cook
material typer ceramica
sol-gel/ /sol-gel ceramic

Off-odour/flavour intensity scale

INTENSITY SCALE OF DIFFERENCE	0 = Not perceived	1 = Barely perceptible	2= Slightly perceptible	3 = Marked difference	4 = Big difference
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MEDIAN OF THE INTENSITY OF THE DIFFERENCE AND NUMBER OF THE IDENTIFICATIONS

ITAH26006975;

– 1

Appearance=0 Odour= 1 Flavour= 1

N° of identifications: 4/9

Not perceived

ITAH26006975;

– 2

Appearance=0 Odour= 1 Flavour= 1

N° of identifications: 5/9

Not perceived

OBSERVATION:

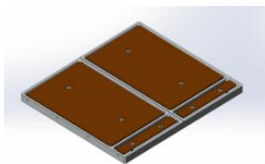
No difference was found by the panel in both the replicates.

The sample is suitable for use in contact with food.

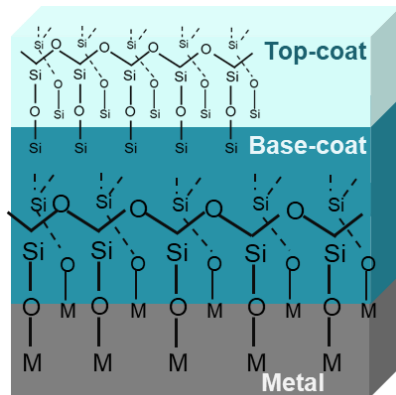
Sensory test: No difference was found by the panel in odour and flavour.

Apto para uso alimentario





Placas de sellado para
máquinas de
termoformado/termosellado



Recubrimiento híbrido con alta estabilidad térmica,
propiedades de lubricación y antiadherencia

+ Aditivos

Reforzar las propiedades arriba indicadas, +
anticorrosión, +antidesgaste

☐ Buena adherencia al metal

☐ Durabilidad:

☐ Anti-adherencia:

➤ WCA > 95°

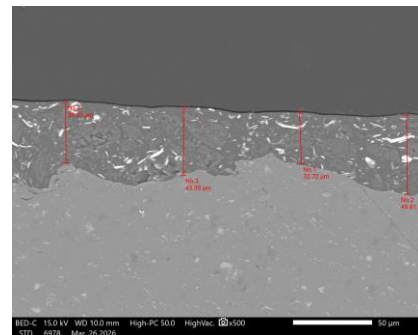
➤ HCA > 30°

➤ SFE < 30 mN/m

➤ Resistencia tras uso a altas temperaturas

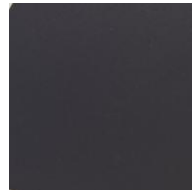
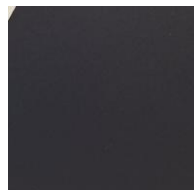
➤ Resistencia a procesos de lavado

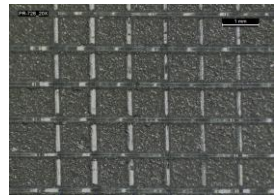
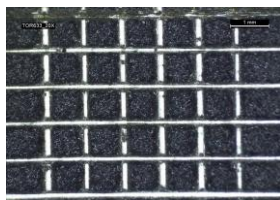
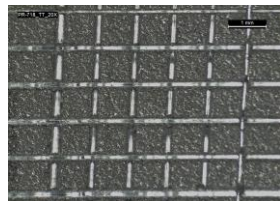
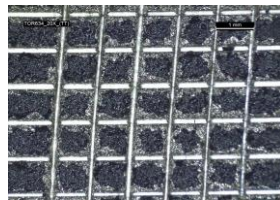
➤ Resistencia al desgaste





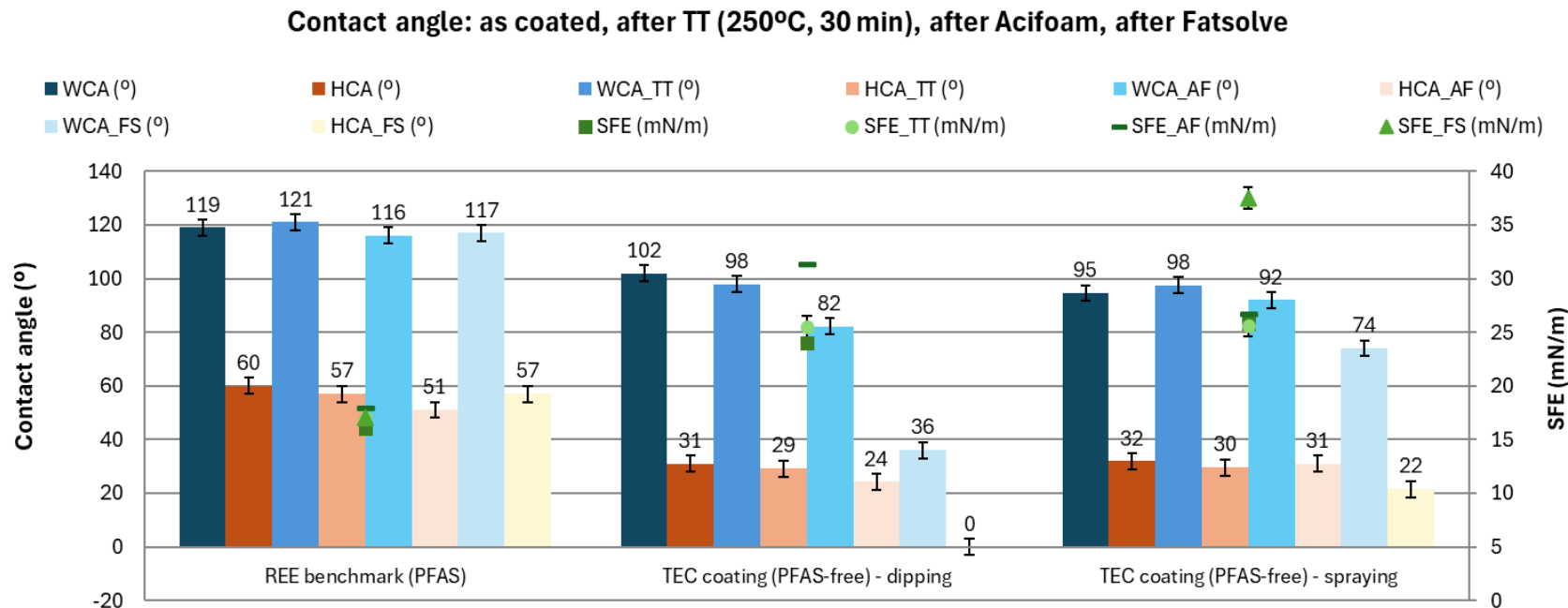
Resistencia térmica y a ciclos de lavado

	As coated	After Acifoam	After Fatsolve
PFAS Benchmark 44.9 ± 3.1 mm			
TEC coating PFAS-free (dipping) 15.3 ± 2.2 μm			
TEC coating PFAS-free (spraying) 34.8 ± 2.3 mm			

As coated	After TT
PR131 – PTFE (REE) x20   	PR132_PTFE- TT_x20   



Ángulos de contacto / SFE tras temperatura y ciclos de lavado





Validación industrial

Máquina ReeSeal 32 S de REEPACK con
placa de rec. PFAS-free de TECNALIA



Ensayo realizado a la temperatura máxima
(230 °C) y bajo condiciones de desgaste

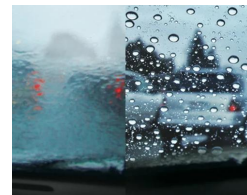


Bandejas tras el ensayo

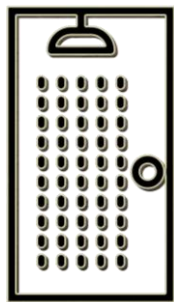


Recubrimientos omnifóbicos sol-gel de capa delgada





Automotive
window glasses

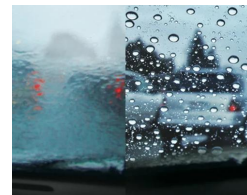


Shower doors

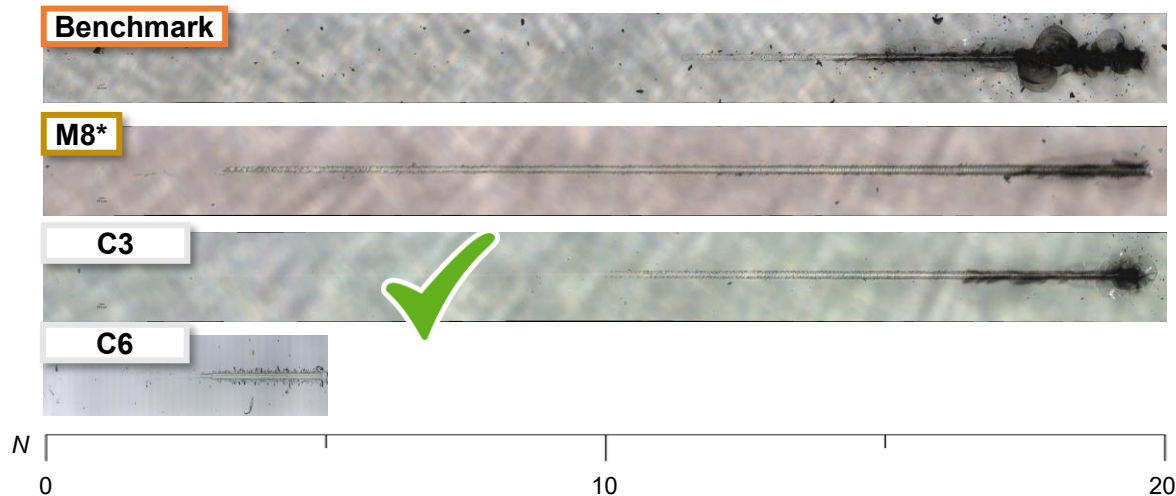


Requerimientos:

- ☐ Buena adherencia al vidrio
- ☐ Hidrofobicidad:
 - $WCA > 95^\circ$
- ☐ Calidad óptica:
 - Transmission $> 90\%$
 - Haze $< 0.4\%$
- ☐ Durabilidad:
 - Sin pérdida de propiedades tras ciclos de limpieza



Adherencia del recubrimiento (scratch test)

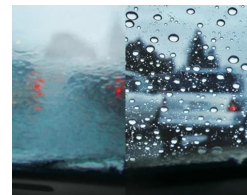


Sample	Lc3-average (N)	Lc3 (N)
Benchmark	11.2	10.0 ± 3.7
C3	8.4	9.2 ± 1.5
C6	3.0	3.0 ± 0.5
M8*	3.5	3.7 ± 1.9

An increasing force (from 0 to 5 N)
is applied over a length of 10 mm length



*Lc1 is the force applied for a first breaking point
Lc2 is the force applied to reach the substrate
Lc3 shows the catastrophic failure*

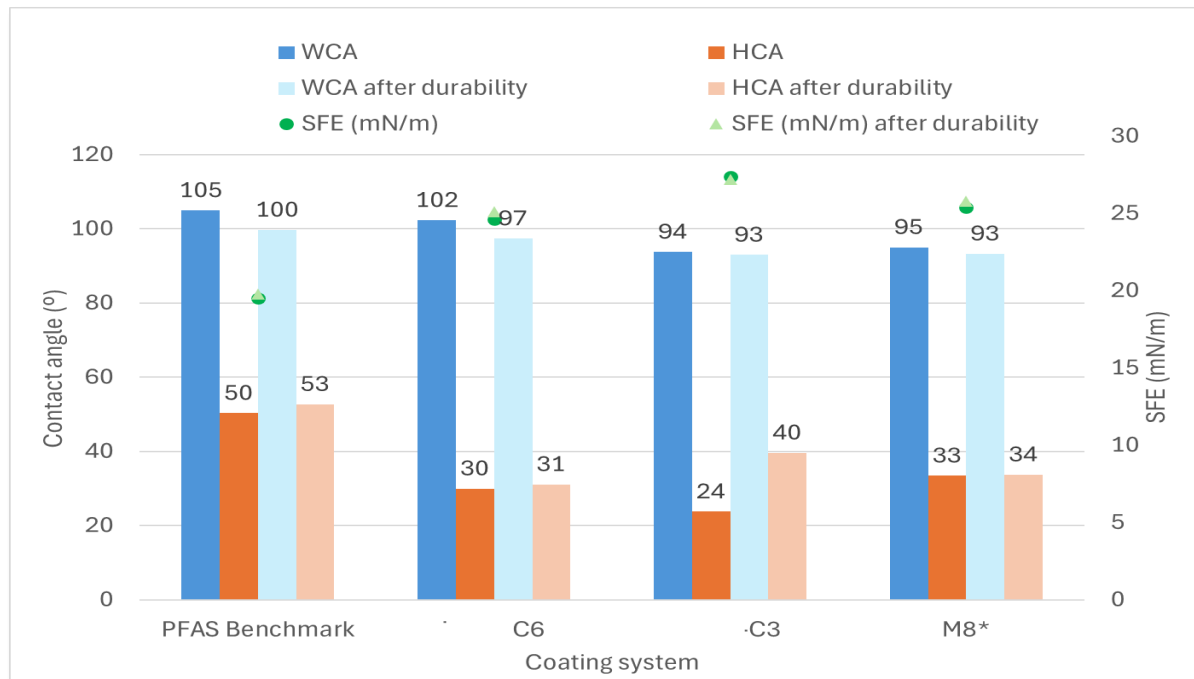


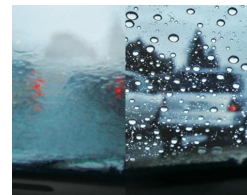
Durabilidad y ángulo de contacto



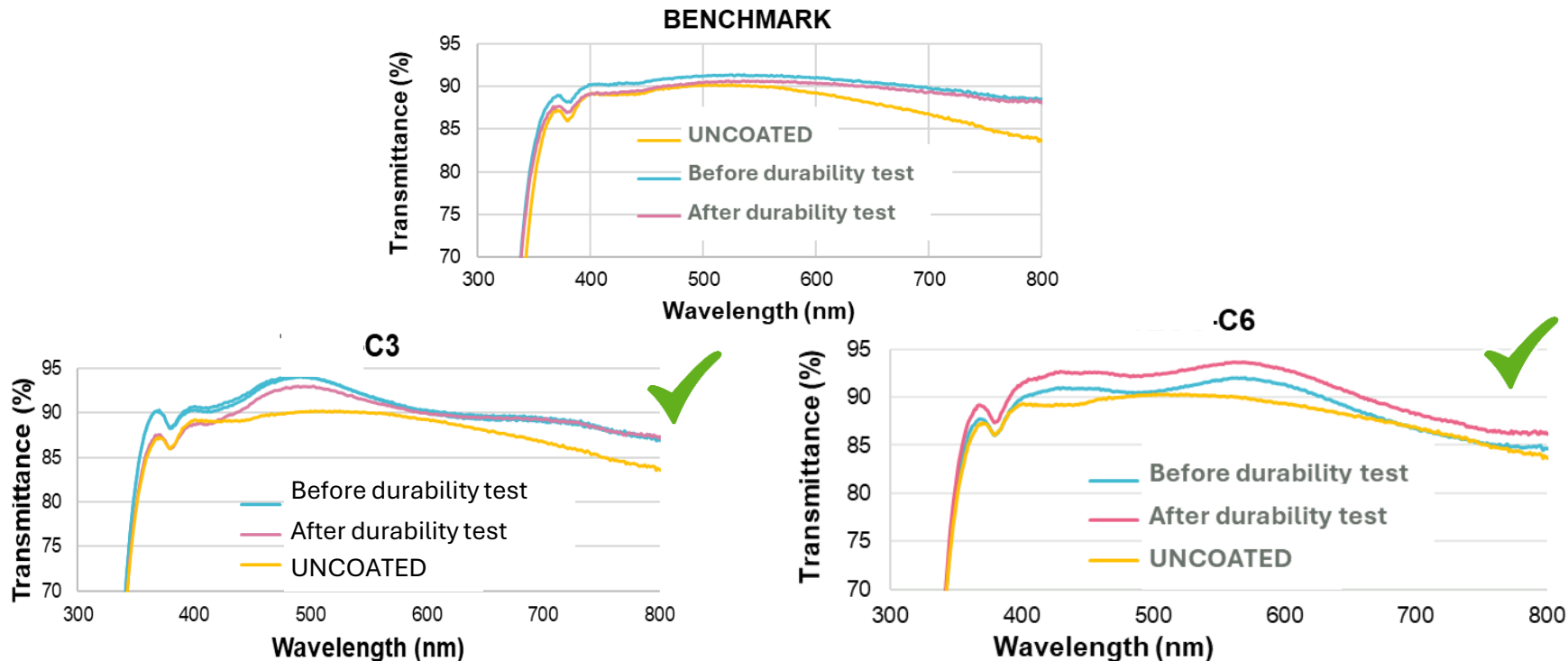
Tribometer Microtest

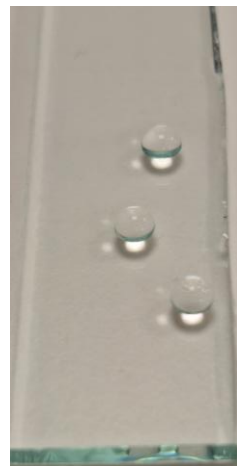
- ☐ Metal rod w/ felt pad soaked in cleaning product
- ☐ 10 N load
- ☐ Linear speed: 0.060 m/s
- ☐ 500 cycles, w/out any coating being removed





Transmitancia y durabilidad

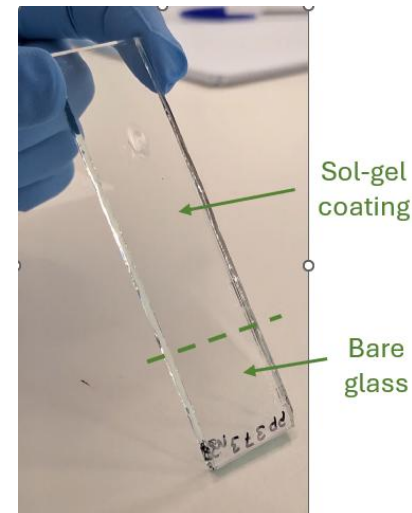




- ✓ WCA > 95°
- ✓ Transmission > 90%
- ✓ Haze < 0.4%
- ✓ Durable



- ✓ Improved results when applied by spraying



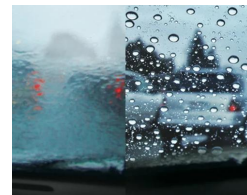
Conclusiones



Recubrimientos técnicos sol-gel multicapa

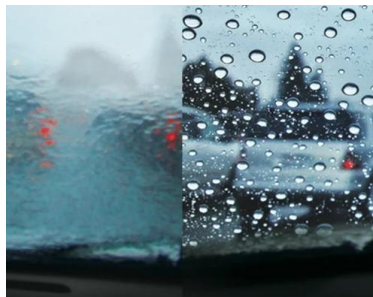
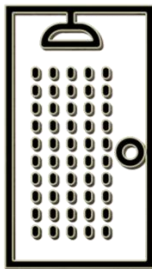
- Sistemas en base a **sol-gel híbridos orgánico-inorgánicos libres de PFAS**
- Fórmulas **optimizadas** para la antiadherencia, resistencia térmica, a la corrosión y al desgaste
- **Alta durabilidad** comparable al estándar de mercado con PFAS
- Aplicables por **esprayado**
- Formulaciones **mono-componente**
- **Viabilidad Industrial:** estudios para la fabricación industrial en marcha
- **Adaptables y escalables** a otras aplicaciones y sectores





Recubrimientos omnifóbicos sol-gel de capa delgada

- Sistemas **sol-gel híbridos orgánico-inorgánicos libres de PFAS**
- Fórmulas **optimizadas** para la antiadherencia
- **Alta durabilidad** comparable al estándar de mercado con PFAS (validado sobre vidrio)
- Formulaciones **mono-componente**
- Aplicables por **esprayado**
- **Viabilidad Industrial:** estudios para la fabricación industrial en marcha
- **Adaptables y escalables** a otras aplicaciones y sectores



Agradecimientos



PROPLANET addresses novel coating materials solutions, tackling the problem from a sustainable-business perspective, enabling overcoming the barrier for environmental protection, safety, chemical improvements, and circular value chains.



TORNADO's objective is to develop new biobased organic and hybrid coatings with water and oil repellence following Safe and Sustainable by Design criteria (SSbD) along all the value chain



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Our scopes of action are aligned with the **Sustainable Development Goals (SDG)**

With a **multi-sectoral** and **multi-technological** perspective, we listen and work with companies to respond to the **major global challenges**.



**We want to be the
technological partner of
all companies to generate high
impact business opportunities
through technology.**

1

**Laboratory
Services**

2

**R&D and
Innovation
Projects**

3

**Development
of Investment
Opportunities**

**We are committed
to a closer
collaboration with
companies to obtain
the highest level of
satisfaction for you.**

**Satisfied
clients***

8.8
/ **10**

* Client satisfaction index
for 2024.

tecnalia.com

Income

147 Million
Euros

27%
Large companies

>10,200

Clients
2011 - 2024

73%

SMEs

Surface Engineering

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◆ **Material and coating/surface treatment selection.**

◆ Design, optimization and validation of **coatings** and **surface modification** processes encompassing vacuum-based, plasma-assisted, thermal spray and wet-chemistry technologies (i.e. PVD, plasma treatments, thermal spray, sol-gel, electrochemical deposition, hybrid layers,...) to address **corrosion, high temperature, wear, fatigue, optical** performance, **H₂-barrier** challenges and multifunctionality.

◆ Comprehensive surface engineering capabilities, covering **advanced characterization**, ad-hoc testing under service-like conditions, and specialized methods tailored to industrial applications.

◆ **Industrial-scale design and implementation** of coating and surface treatment techniques, enabling reliable technology transfer to real operating environments.

◆ Development of **REACH-compliant surface solutions**, including **PFAS-free** and environmentally responsible alternatives for industrial coatings and treatments.

◆ Coating and surface treatment services on **prototypes and small batches**, enabling rapid evaluation and pre-industrial validation.

◆ **Failure analyses** to identify root causes related to materials, coatings and surface degradation mechanisms.

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& TECHNOLOGY ALLIANCE



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