INNOVATIVE COATINGS FOR YOUR TECHNOLOGY

Satellite and Launcher Coatings

map

A SHARED CHALLENGE

The origins of MAP lie in a human encounter and the political and historical desire for France to play a role in the space race. These are the past influences that made it possible for MAP to travel its current path and find its current position as a leader in the European market.

—

Olivier Guillaumon
Managing Director

A SHARED VISION OF SPACE CONQUEST

SPACE AT OUR FINGERTIPS

During the 60s, the world was growing fast and new horizons were opening. The conquest of space was a dream, but it also represented decisive economic and strategic challenges.

Facing the United States and the USSR, Europe built its strategy on technological independence and a fabric of innovative institutional and economic stakeholders.

MAP's creation occurred within this context; one which combined technological expertise and national supremacy. At CNES, the "Materials" research laboratory headed by Jean-Claude Guillaumon designs and produces coatings for use in space. His meeting with Paul Maes, founding director of the paint manufacturer Maestria, would sow the seed for the foundation of MAP.

1988-2018

30 YEARS of bonds built on trust, going beyond simple client-supplier relationships - an implicit shared vision combining innovation and a quest for excellence.

OUR MISSION, OUR JOB

"We develop efficient coatings and services for satellites and launchers, with high technological heritage that create value for our customers"

OUR CONCERN... TO HELP OUR CUSTOMERS IN THEIR SEARCH FOR EFFICIENCY

- ☑ Reliable coatings with a flight heritage and which can withstand ageing in space environment
- ☑ Sustainable process that limits the risk of vagaries
  - ITAR/EAR free, CNES qualified products
  - Manufacturing process & raw materials that are not subject to environmental regulations (REACh, RoHs)
- ☑ Improved product-process combination to save time on the critical path

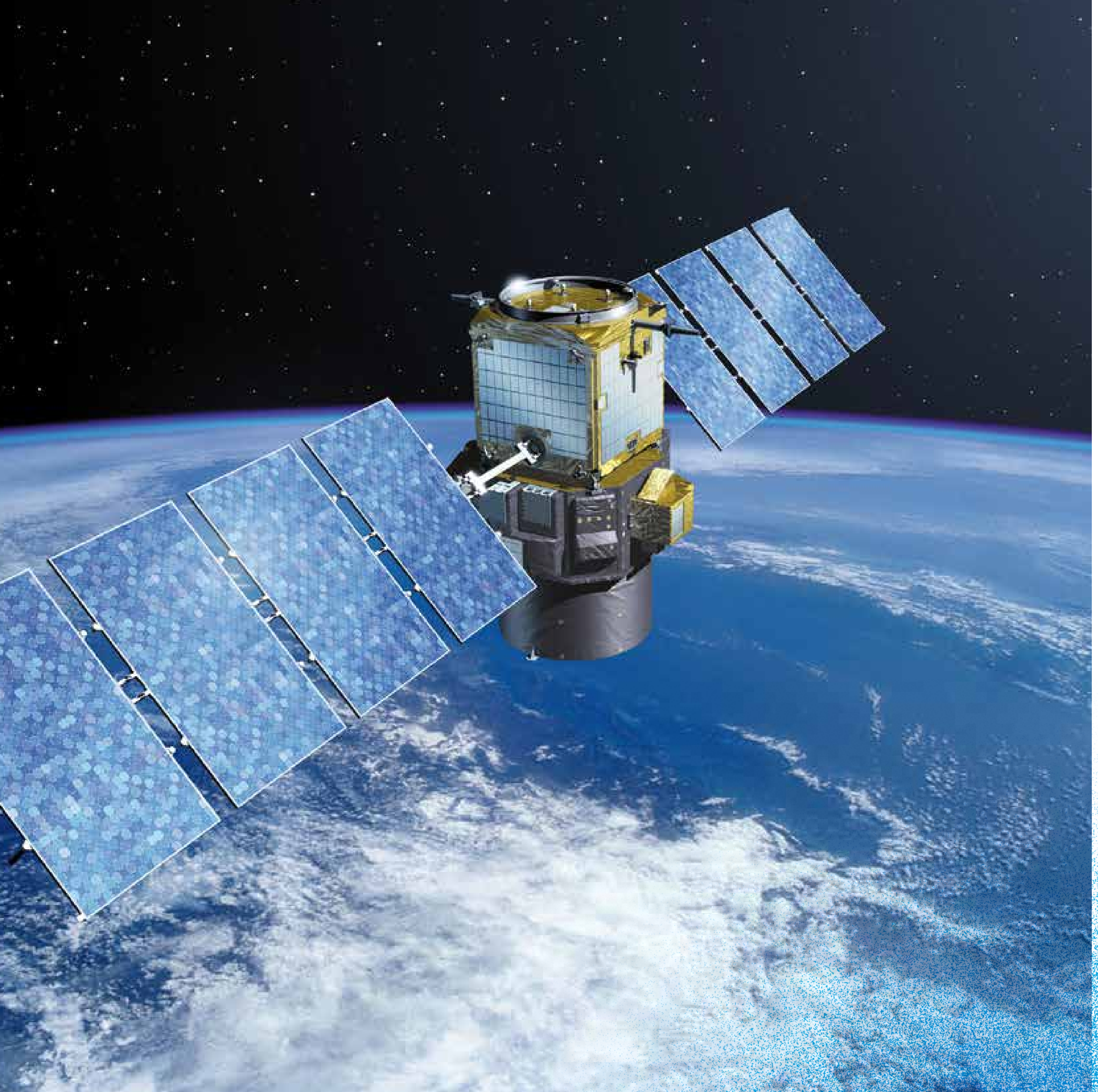
OUR QUALIFICATIONS, OUR REFERENCES

Our products are evaluated or qualified by European organizations like CNES, ESA, according to space standards.

Organizations such as JAXA, NASA and scientific institutes also selected our coatings for testing.

The space industrialists worldwide have been trusting us for 30 years, by allowing us to participate in the thermal regulation of their satellites.

MAP Company certified Management system: EN 9100 / AS 9100 C / JISQ 9100 / ISO 9001



OUR CUSTOMERS WORLDWIDE

- ☑ Launcher manufacturers
- ☑ Satellite Prime contractors
- ☑ Thermal or mechanical subcontractors
- ☑ Electro-optical subcontractors
- ☑ Scientific centres

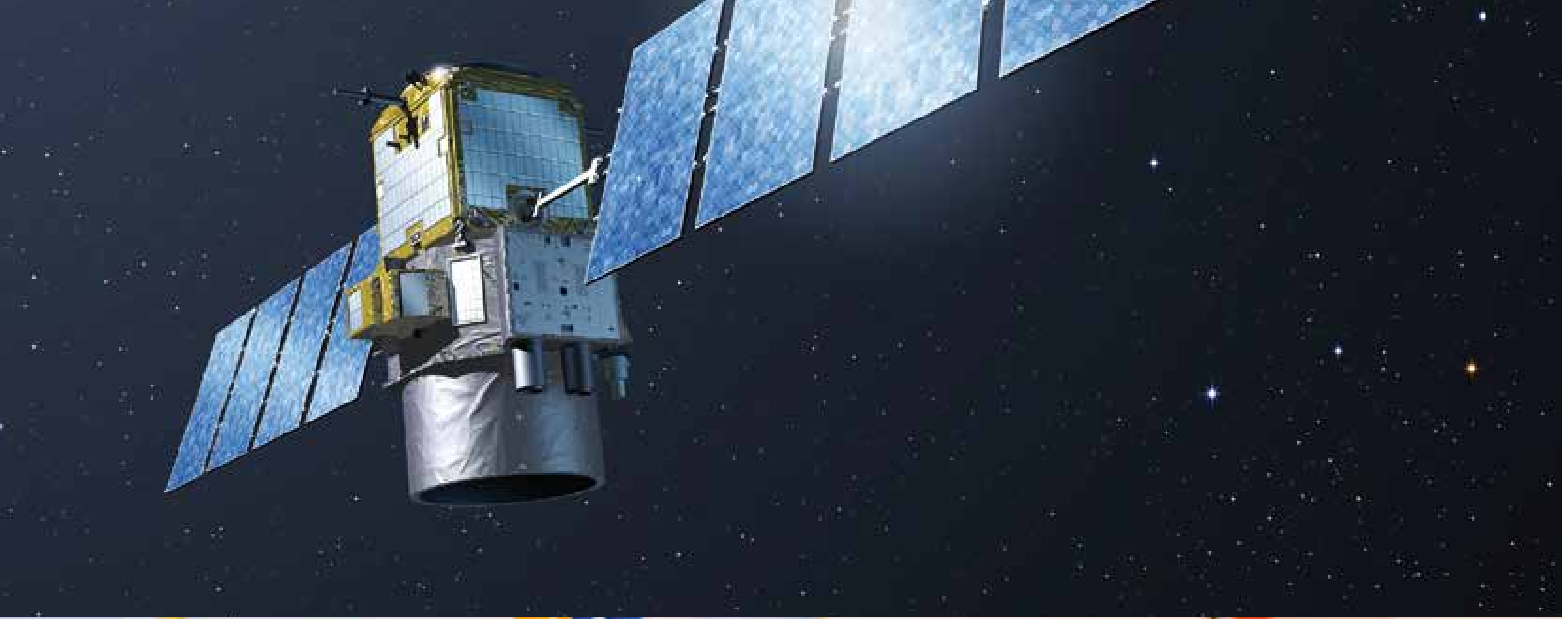
OUR PRODUCTS

LOW OUTGASSING COATINGS FOR SATELLITES

- Thermal Control Coatings (TCC)
- Thermally/Electrically conductive adhesives
- Silicone Conformal Coatings (SCC)
- Lubricants

COATINGS FOR LAUNCHERS

- White antistatic coatings
- Cr Free anticorrosion primers
- Thermal protection



BLACK TCC

(Thermal Control Coatings)

Low outgassing coatings for thermal and electrical control

The satellite is being subject to harsh space environment during more than 15 years: the coatings have to withstand solar flux (e-, p+) and rays (UV,γ), heat (-170°C to 130°C), vacuum and atomic oxygen (LEO).

Main properties

- High emissivity
- Low outgassing rate
- Flat black colour
- Electrical conductivity

Main uses

- Internal walls
- Electronic boxes
- Optical baffles

Name	Binder	α	ε	α/ε	Surface resistance Rs (Ω/sq)	Outgassing	TIS	T° range	EST Tests	LEO ground testing
MAP®PU1 FAST CURING	PU (Solvent)	0.96	0.88	1.09	$> 1 \times 10^{12}$	RML = 0.39 % CVCM = 0.04 %	-	-180°C to +180°C	-	-
MAP®AQ PU1 FAST CURING	PU (Water)	0.95	0.90	1.06	$> 1 \times 10^{12}$	RML = 0.90 % CVCM = 0.00 %	3.65 % ±0.08 %	-170°C to +130°C	$-116\ V_{20°C}$	-
MAP®PUK FAST CURING	PU (Solvent)	0.96	0.91	1.06	$\leq 5 \times 10^{6}$	RML = 0.56 % CVCM = 0.00 %	-	-170°C to +130°C	-	-
MAP®AQ PUK FAST CURING	PU (Water)	0.95	0.88	1.08	$\leq 1 \times 10^{5}$	RML = 0.72 % CVCM = 0.00 %	3.70 % ± 0.2 %	-170°C to +130°C	-	-
MAP®PNC FAST CURING	Silicone	0.97	0.91	1.07	$\leq 1 \times 10^{6}$	RML = 0.52 % CVCM = 0.03 %	3.14 % ±0.09 %	-180°C to +135°C	$0V_{25°C}$ $0V_{-50°C}$ $0V_{-150°C}$	$ATOX_{1.8\text{-}1.9\ 10^{20}\ atom/cm^2}$ $\Delta\alpha s = -0.01 \pm 0.01$ $\Delta\varepsilon = 0$ $\Delta e = -0.10 \pm 0.1\ \mu m$ $UV_{2232\ esh}$ $\Delta\alpha s = -0.001 \pm 0.010$
MAP®HT1607	Silicone	0.96	0.89	1.08	$\leq 1 \times 10^{6}$	RML = 0.10 % CVCM = 0.00 %	4.51 % ± 0.2 %	-170°C to +400°C	-	-

Technical data are indicative and non-contractual

ALUMINIUM TCC

(Thermal Control Coatings)

Low outgassing coatings for thermal and electrical control

The satellite is being subject to harsh space environment during more than 15 years: the coatings have to withstand solar flux (e-, p+) and rays (UV,γ), heat (-170°C to 130°C), vacuum and atomic oxygen (LEO).

Main properties

- Medium ratio of emissivity & solar absorptance
- Low outgassing rate
- Aluminium colour
- Electrical conductivity

Name	Binder	α	ε	α/ε	Surface resistance Rs (Ω/sq)	Outgassing	T° range
MAP®RM27	Silicone	0.27	0.27	1.00	$\leq 1 \times 10^3$	RML = 0.68 % CVCM = 0.06 %	-174°C to +132°C

Technical data are indicative and non-contractual

WHITE TCC

(Thermal Control Coatings)

Low outgassing coatings for thermal and electrical control

The satellite is being subject to harsh space environment during more than 15 years: the coatings have to withstand solar flux (e-, p+) and rays (UV,γ), heat (-170°C to 130°C), vacuum and atomic oxygen (LEO).

Main properties

- High emissivity
- Low solar absorptance
- Low outgassing rate
- Flat white colour
- Electrical conductivity

Main uses

- Radiators
- Antennas
- Waveguides
- Back side of solar panels
- Manned flights

Name	Binder	α	ε	α/ε	Surface resistance Rs (Ω/sq)	Outgassing	T° range	ESD Tests	8 years GEO ground testing	LEO ground testing
MAP® SG121FD FAST CURING	Silicone	0.18	0.88	0.20	> 1 x 10^{12}	RML= 0.28 % CVCM = 0.08 %	-170°C to +130°C	Sp = -45$V_{20°C}$	Δαs = +0.22 Δε = -0.01	ATOX $_{2 \times 10^{20}\ atom/cm^2}$ Δαs = +0.01 ±0.01 Δe = -0.59 µm UV $_{4054\ esh}$ Δαs = -0.03 ±0.010
MAP® SG122FD FAST CURING	Silicone	0.20	0.90	0.20	> 1 x 10^{12}	RML= 0.74 % CVCM = 0.07 %	-180°C to +135°C	Sp = 0$V_{20°C}$	Δαs = +0.29 Δε = -0.01	ATOX $_{5.7 \times 10^{20}\ atom/cm^2}$ Δαs = +0.02 ±0.01 Δε = -0.01 ±0.01 Δe = -0.20 µm
MAP® PSBN FAST CURING	Inorganic	0.13	0.92	0.14	≤ 1 x 10^{12}	RML = 0.29 % CVCM = 0.00 %	-175°C to +135°C	Sp = 0$V_{20°C}$	Δαs = +0.24 Δε = -0.00	ATOX $_{3.8 \times 10^{20}\ atom/cm^2}$ Δαs = +0.06 ±0.01 Δε = -0.00 Δe = -0.74 µm UV $_{3298\ esh}$ Δαs = +0.018 ±0.010
MAP® PCBE FAST CURING	Silicone	0.24	0.88	0.27	< 1 x 10^{3}	RML= 0.43 % CVCM = 0.08 %	-193°C to +130°C	Sp = 0$V_{20°C}$	Δαs = +0.33 Δε = -0.01	UV $_{1100\ esh}$ Δαs = +0.003 ±0.010
MAP® SCK5	Silicone	0.27	0.89	0.30	< 1 x 10^{9}	RML = 0.89 % CVCM = 0.12 %	-180°C to +135°C	-	Δαs = +0.38 Δε = -0.00	

Technical data are indicative and non-contractual

SILICONE ADHESIVE ELASTOMERS

Low outgassing coatings for thermal and electrical control

Silicone adhesive elastomers are used for their mechanical and thermal/electrical properties.

Main properties

- Excellent outgassing
- Thermal conductivity, Electrical insulation or conductivity
- Optical transparency
- Stability under ATOX, UV and rays
- Easy repair - Self healing product
- Chemically inert
- Good performance at low temperature (Tg)

Main uses

- Bonding and shock absorption: to reduce mechanical stress of assemblies, thanks to low CTE property
- Heat transfer: to allow a thermal interface between metallic parts
- Electrical grounding: to ensure electrical conductivity between parts

Characteristics	MAPSIL®QS1123 ELEC LD	MAPSIL®QS1123 TA77	MAPSIL®QS1123 THIXO-B	MAPSIL®QS1123 EA83
Durometer Shore A	74	80	48	79
Young Modulus	7.1 MPa	16 MPa	1.2 MPa	12.3 MPa
CTE (Before/after Tg)	$CTE_{-150°C\ to\ -120°C} = 20 \times 10^{-6}\ K^{-1}$ $CTE_{-115°C\ to\ -58°C} = 61 \times 10^{-6}\ K^{-1}$ $CTE_{-58°C\ to\ -36°C} = 240 \times 10^{-6}\ K^{-1}$ $CTE_{-36°C\ to\ 150°C} = 157 \times 10^{-6}\ K^{-1}$	$CTE_{-150°C\ to\ -135°C} = 18 \times 10^{-6}\ K^{-1}$ $CTE_{-82°C\ to\ -62°C} = 74 \times 10^{-6}\ K^{-1}$ $CTE_{-35°C\ to\ -50°C} = 200 \times 10^{-6}\ K^{-1}$ $CTE_{-55°C\ to\ 150°C} = 180 \times 10^{-6}\ K^{-1}$	$CTE_{-150°C\ to\ -120°C} = 69 \times 10^{-6}\ K^{-1}$ $CTE_{-113°C\ to\ -56°C} = 210 \times 10^{-6}\ K^{-1}$ $CTE_{-52°C\ to\ -37°C} = 625 \times 10^{-6}\ K^{-1}$ $CTE_{-37°C\ to\ 150°C} = 264 \times 10^{-6}\ K^{-1}$	$CTE_{-150\ °C\ to\ -140°C} = 21 \times 10^{-6}\ K^{-1}$ $CTE_{-110\ °C\ to\ -60°C} = 137 \times 10^{-6}\ K^{-1}$ $CTE_{-40\ °C\ to\ 300°C} = 211 \times 10^{-6}\ K^{-1}$
Shrinkage	nil	nil	nil	nil
Thermal conductivity	$0.36\ W.m^{-1}.K^{-1}$ (Under Vacuum) $0.25\ W.m^{-1}.K^{-1}$ (ASTMC177)	$0.77\ W.m^{-1}.K^{-1}$ (ISO 22007-4: 2008 ; atmospheric pressure)	$0.16\ W.m^{-1}.K^{-1}$ (ASTMC177)	$1.51\ W.m^{-1}.K^{-1}$ (ASTMC177)
Glass transition T°	-123°C	-123°C	-123°C	-123.5°C
Electrical volume resistivity	$1.17 \times 10^{4}\ \Omega.cm$	$> 10^{12}\ \Omega.cm$	$6.5 \times 10^{12}\ \Omega.cm$	$4.1 \times 10^{3}\ \Omega.cm$
RML	0.27 %	0.39 %	0.30 %	0.09 %
CVCM	0.04 %	0.02 %	0.01 %	0.00%

Technical data are indicative and non-contractual – all properties measured at 23°C

SILICONE CONFORMAL COATINGS (SCC)

Low outgassing Conformal Coatings for PCB's protection

Silicone Conformal Coatings are used to protect electronic components from pollution (conductive particles), vibration, atomic oxygen and electric discharges.

Main properties

- Excellent outgassing rate
- Mechanical properties (young modulus, elongation, loss factor)
- Easy repair - Self healing product
- Chemically inert
- Electrical insulation and/or thermal conductivity
- Stability under ATOX, UV and rays
- Good performance at low temperature (Tg)

Main uses

- PCBs varnishing
- Potting

Characteristics	MAPSIL®QS1123	MAPSIL®213	MAPSIL®213-B	MAP ATOX 41-B	MAPSIL®214
Durometer Shore A	50	35	37	43	53
Young Modulus	1.9	1.3	1.8	1.3	
CTE	$CTE_{before\ Tg}$ = 95 x 10^{-6} K^{-1} $CTE_{after\ Tg}$ = 338 x 10^{-6} K^{-1}	$CTE_{before\ Tg}$ = 108 x 10^{-6} K^{-1} $CTE_{after\ Tg}$ = 326 x 10^{-6} K^{-1}	$CTE_{before\ Tg}$ = 123 x 10^{-6} K^{-1} $CTE_{after\ Tg}$ = 362 x 10^{-6} K^{-1}	-	
Poisson ratio's	0.49	0.49	0.49	0.49	0.49
Shrinkage	nil	nil	nil	nil	nil
Thermal conductivity Under vacuum / ASTM	λ = 0.22 $W.m^{-1}.K^{-1}$ @ 23°C λ = 0.16 $W.m^{-1}.K^{-1}$ @ 23°C	0.15 $W.m^{-1}.K^{-1}$	0.15 $W.m^{-1}.K^{-1}$	0.15 $W.m^{-1}.K^{-1}$	in progress
Glass transition T°	-123°C	-123°C	-123°C	-123°C	-123°C
Volume Electrical resistivity	3.5 x 10^{15} Ω.cm	8.28 x 10^{14} Ω.cm	1.14 x 10^{15} Ω.cm	2.38 x 10^{14} Ω.cm	>10^{14} Ω.cm
RML	0.07 %	0.20 %	0.36 %	0.45 %	in progress
CVCM	0.01 %	0.04 %	0.04 %	0.05 %	in progress

Technical data are indicative and non-contractual – all properties measured at 23°C

LAUNCHER COATINGS (lc)

Thermal control, Antistatic and Corrosion protection coatings for launchers

- On the launch pad: to avoid any launcher heat specially for the cryogenic stage
  ▶ Cold coating/white coating = α/ε<1
- During launching: to avoid any electrical surface discharge due to air friction
  ▶ Conductive coating = Rs< $10^9\Omega/\square$

Main properties

- High emissivity
- Low solar absorptance
- Antistatic surface resistivity
- Thermal protection

Main uses

ESD protection and/or corrosion protection:

- Rocket Fairing
- Solid rocket booster
- Rocket interstage
- Rocket nozzle

Name	Binder	VOC (g/l)	α	ε	α/ε	Surface resistance Rs (Ω/sq)	Max temperature service
MAP®AERO STATIC B	PU (Solvent)	651	0.39	0.85	0.46	10^6 to 10^8	+150°C
MASTIC AS	Silicone	495	0.38	0.85	0.45	10^6 to 10^9	+60°C
MAP®AQ STATIC	PU (Water)	18	0.30	0.90	0.33	10^5 to 10^9	+130°C Based on electrical measurements
MAPSIL®AS	Silicone	420	0.31	0.91	0.34	10^6 to 10^9	+130°C Based on electrical measurements
MAPSIL®SILICo AS	Silicone hybrid	605	0.38	0.90	0.42	10^3 to 10^8	> 130°C

Sprayable thermal protection

Name	Binder	VOC (g/l)	Hardness	Tensile strength	Elongation	Thermal conductivity at 150°C
MAPSIL®CORK	Silicone	396	60 Sha	1.6 MPa	9 %	0.07 $W.m^{-1}.K^{-1}$

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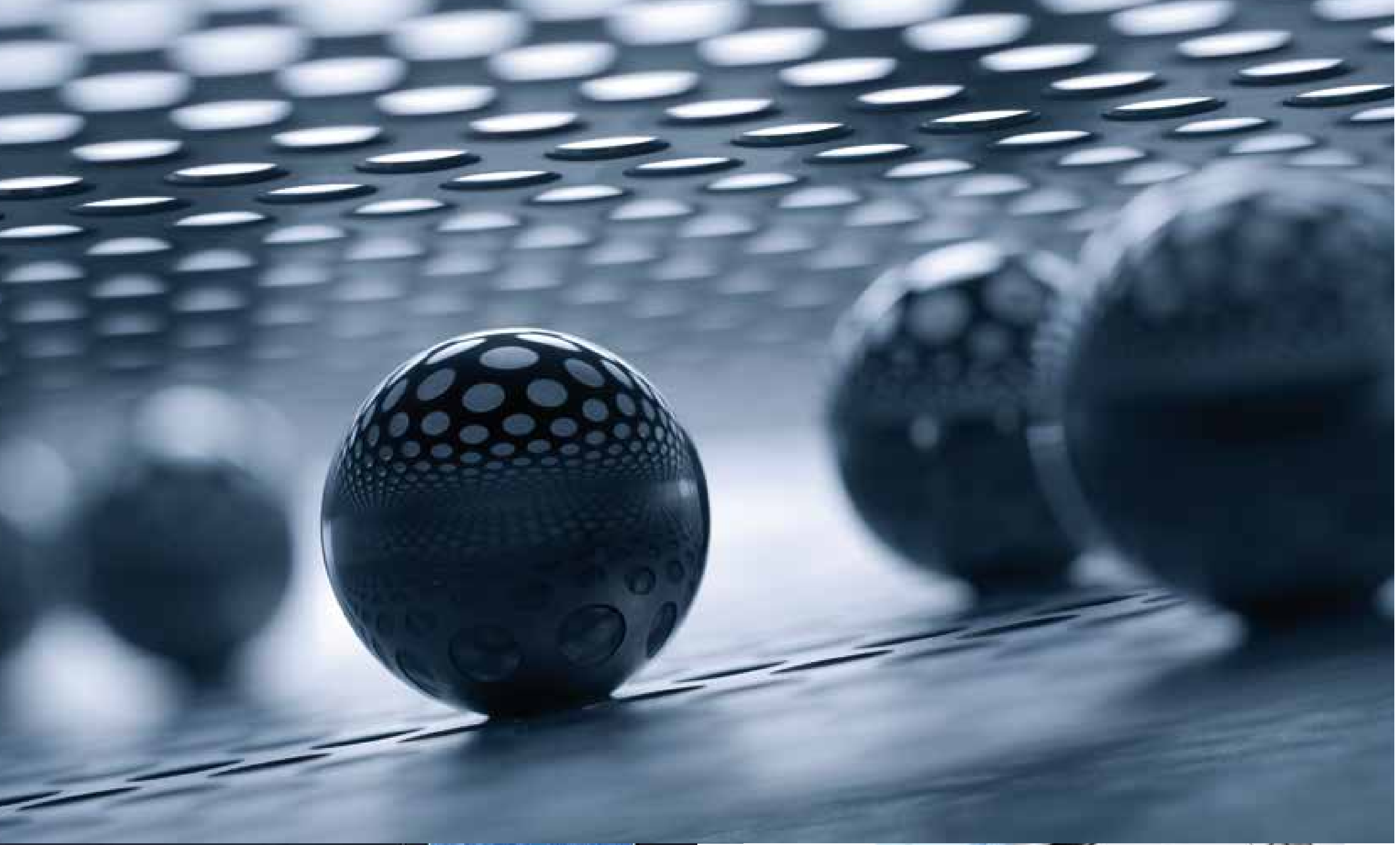
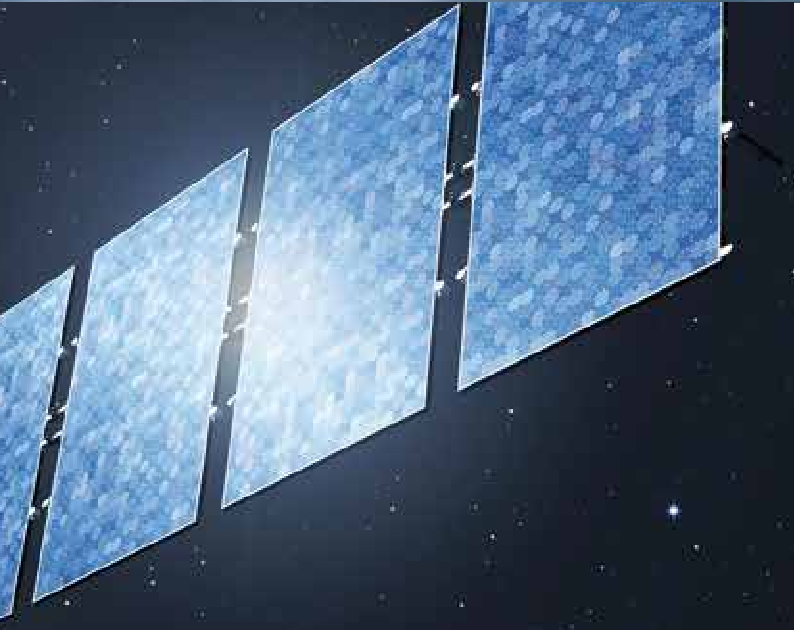




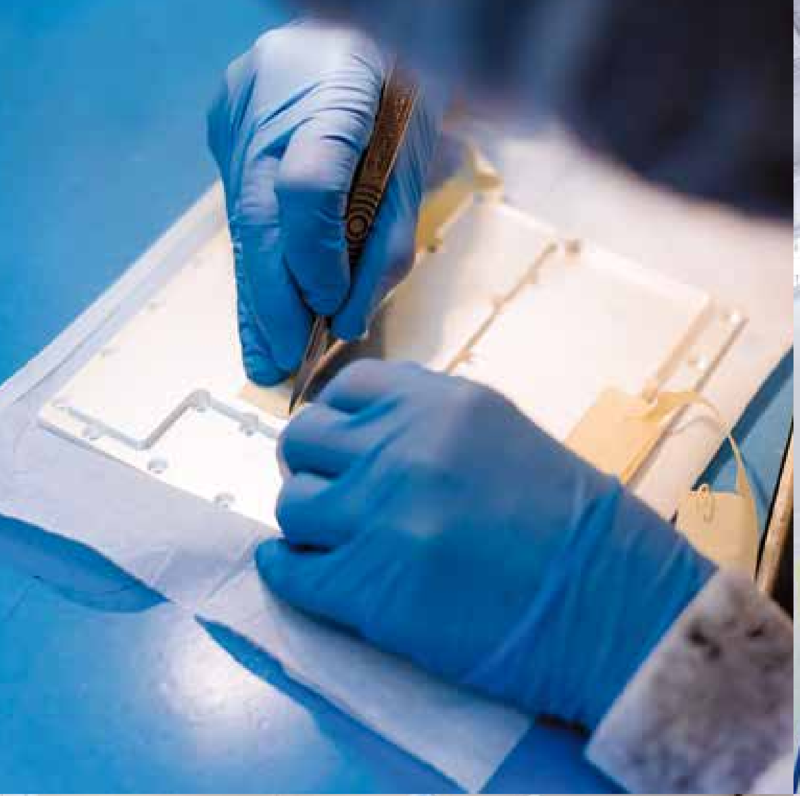
LUBRICANTS

Where does lubrication take place in spacecraft?

Improved lubrication of the mechanical systems is key to extend satellite life, resulting in more reliable and longer operating components. Deployment mechanisms for subsystems such as antenna dishes, solar panels,... (Satellites) and release mechanisms (Launchers), often use lubricant for their main properties:

- Excellent outgassing
- Low pour point and vapor pressure
- Low tension surface
- High viscosity index
- Inert, atomic oxygen resistance

Product	Nature	Application
MAPLUB® SH	Synthetic hydrocarbon oil + PTFE	Suitable for long lifetime applications
MAPLUB® PF	PFPE oil + PTFE	Suitable for wide working temperature range



OUR SERVICES

- TCC & Thermal adhesive implementation of space Hardware
- OSR Bonding
- Cost and time saving Fast Curing process
- Repairing service
- R&D service
- Specific characterizations
- Technical support, expertise and documentation (Technical data sheets, qualification reports)
- Workshops
- In house training & coating implementation

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