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EVALUATION OF ADVANCED CLEANING PROCESSES FOR SENSITIVE SURFACES IN OPTICAL INSTRUMENTATION

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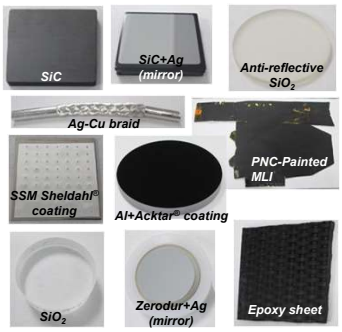
Introduction

Contamination has become a major issue in all high-tech industries, with increasingly stringent cleanliness requirements. It is the case for sensitive parts of space flight hardware, such as optics or other embedded equipment for which surface cleanliness is a critical topic, since even a thin layer of molecular contaminant can adversely affect performance.
Sometimes, cleaning may be needed to reach a specified cleanliness level at different integration phases of instrument or satellite, or as a corrective action in case of anomaly. Thus it is recommended to consider cleaning techniques without direct contact with the sensitive or fragile surface to prevent any damage after treatment.

Selected materials

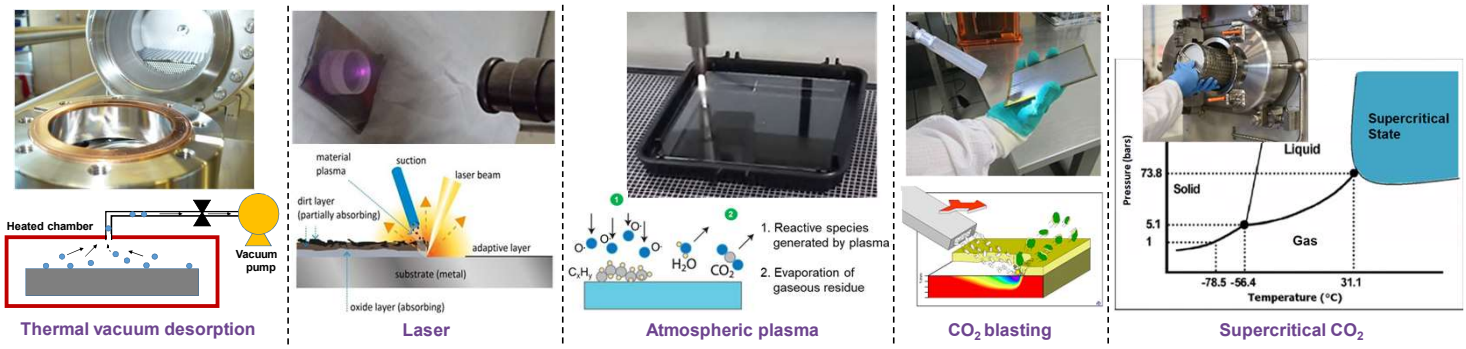
Materials	Applications
Ceramics (SiC)	Mirror and structure
Ag-coated Zerodur	Mirror
Glass (SiO_2)	Optical devices
Composite (Epoxy)	Shell structure
Acktar®-coated Aluminium	Low reflectance properties
Painted Kapton® (PNC)	Multilayer insulation
SSM Sheldahl® coating	Technical adhesive for insulation
Thermal braid (Ag-Cu)	Electrical cable

➡ **Samples are representative of sensitive materials surfaces of satellites or critical surfaces in a close environment.**



Methodology

Cleaning processes evaluated



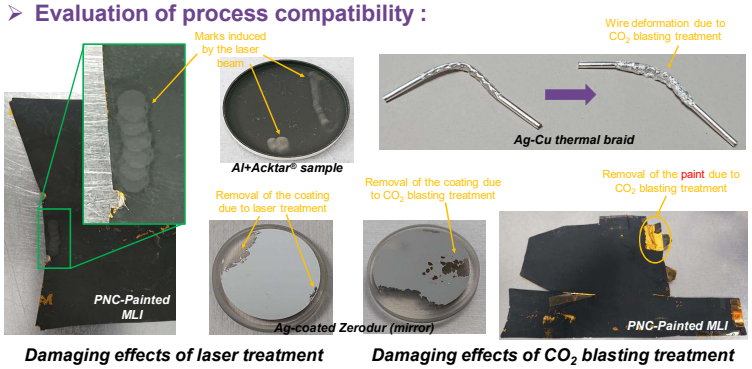
Main results

➢ **Synthesis of molecular cleaning efficacies of the various tested processes according to the type of sample :**

Sample	Vacuum desorption	Supercritical CO_2	Atmospheric plasma	CO_2 blasting
Treatment duration	24h	30 min	< 1 min	< 1 min
Ceramics (SiC)	100%	99%	60%	99%
Mirror (SiC + Ag)	Non detected	97%	91%	93%
Composite (epoxy)	99%	97%	86%	94%
Al + Acktar® coating	100%	100% (siloxane)	97% (siloxane)	69%*
Glass slide (SiO_2)	50%	98%	73% (phthalate)	95%
Anti-reflective glass (SiO_2)	99%	99%	97%	99%
Miroir (Zerodur + Ag)	83%	98%	99%	Qualitative test*
Thermal braid (Ag-Cu)	100%	99%	NA	77%*
SSM Sheldahl® coating	100%	100%	100%	100%*
MLI sheet (Kapton + PNC)	Non evaluated	Non evaluated	Qualitative test	Qualitative test*
Average	**91%**	**98%**	**89%**	**91%**

*surface alteration observed on samples tested after treatment

➢ **Evaluation of process compatibility :**



Damaging effects of laser treatment ***Damaging effects of CO_2 blasting treatment***

➡ **Cleaning efficacy of the evaluated processes :**

Supercritical CO_2 > Vacuum desorption ≈ CO_2 blasting > Atmospheric plasma

References

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[2] ECSS-Q-ST-70-05C, Space product assurance - Detection of organic contamination of surfaces by infrared spectroscopy (2019)

[3] ECSS-Q-ST-70-54C, Space product assurance - Ultracleaning of flight hardware (2017)

[4] Cheung D., Faye D., Evaluation of decontamination processes adapted to large optical components, *14th International Symposium on Materials in Space Environment (2018)*

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