CONTAMINATION STUDY OF SPACE SENSITIVE SURFACES BY PACKAGING MATERIALS

Delphine Faye[1], David Cheung[2]

(1) Centre National d'Etudes Spatiales, 18 avenue Edouard Belin, 31401 Toulouse, Cedex 9, France ; e-mail : delphine.faye@cnes.fr
(2) Entegris Cleaning Process, 395, rue Louis Lépine, 34000 Montpellier, France ; e-mail : david.cheung@entegris.com

MOTIVATION

Cleanliness is crucial for space hardware : the presence of contaminants, either organic residues or particles, on sensitive parts such as optics, mechanisms, detectors, electronics or thermal control coatings may alter significantly their properties and their nominal operating mode. Even if the AIT activities take place in controlled environments, it is highly recommended to protect the equipment during long-term storage and sometimes during short-term periods as well and of course during the numerous shipments in containers. Special care has to be taken to the packaging constraints that are dependent on the cleanliness specifications of the sensitive surfaces to be protected. Further to several anomalies and some alerts coming to the user community, the cross contamination due to materials and/or packaging methods is a real concern. Despite the guidelines described in standards, it still happens that some packaging materials are poorly known and therefore misused.

The purpose of this benchmark study was to develop a methodology and measurement protocols to assess the risk of molecular and/or particulate contamination on different substrates from a wide variety of flexible and rigid packaging materials, in stress conditions or not, in order to the user to select the most appropriate one for his dedicated applications.





examples of sensitive equipment before and after integration on satellite protected for short or long-term storage

SELECTED MATERIALS

LDPE

- Low Density Polyethylene
- ISO 5 - 6
- Medical, Pharma, Space, Microelectronics

LDPE-ULO

- Low Density Polyethylene, Ultra Low Outgassing
- ISO 5 – 50 A/10 (STD 1246E)
- Space, Microelectronics, Vacuum applications

HDPE-UHMW

- High Density Polyethylene, Ultra High Molecular Weight
- ISO 5
- Microelectronics

PE-Al (JPL)

- Al-Low Density Polyethylene
- Moisture barrier
- ESD S20.20, EN 61340-5-1
- Space, Microelectronics

antistatic LDPE

- Low Density Polyethylene
- Antistatic additive
- ESD S20.20, EN 61340-5-1
- Space, Microelectronics

EAE

- Polyethylene-polyamide-polyethylene
- Air tightness
- ISO 6
- Medical, Pharmaceutical

membrane

- Body : polycarbonate
- Membranes: phthalate
- Part holding during transport
- Space, Microelectronics

wafer

- polypropylene
- Part holding during transport
- Microelectronics, Space

heat-formable blisters

- polyethylene terephtalate glycol
- ISO 7
- Medical, Pharmaceutical

substrates

METHODOLOGY

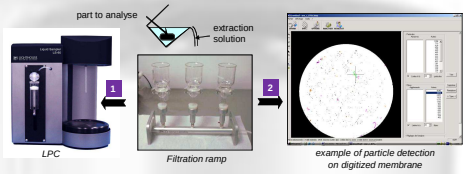
initial state control

conditioning storage/stress

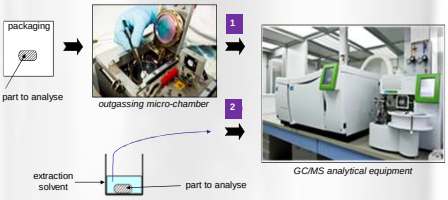
3 modes
- Shaking via back-and-forth table (*120 strokes/min, 30 min*)
- Heating in oven (*60°C, 2 days*)
- Long term exposure (*room temperature, 2 months*)

final state control

particulate contamination

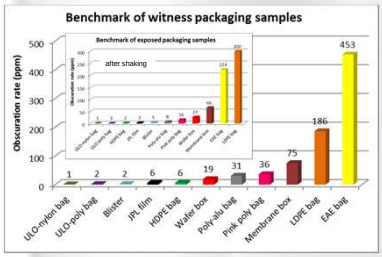


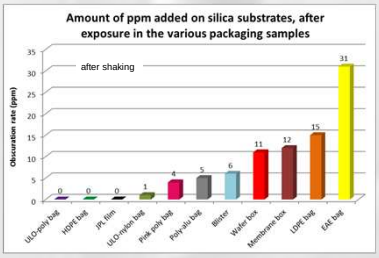
molecular contamination



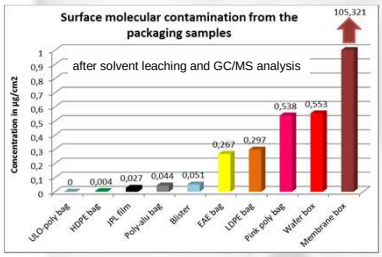
MAIN RESULTS

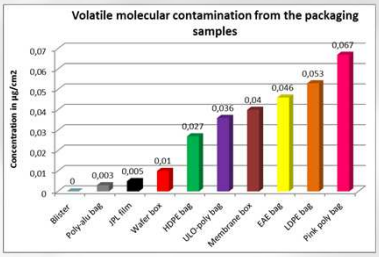
particulate contamination tests

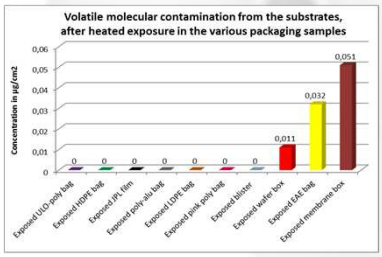


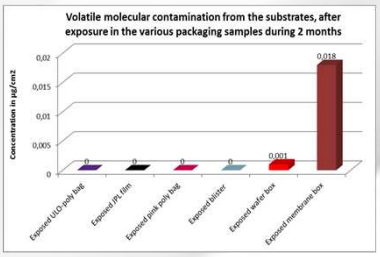


molecular contamination tests









RANKING

Concentrations in ppm	ULO-poly	ULO-nylon	HDPE	JPL film	Blister	Poly-alu	Pink poly	Wafer box	Membrane box	LDPE	EAE
Particulate contamination of witness packaging samples	2	1	6	6	2	31	36	19	75	186	453
Particulate contamination of packaging samples after exposure by shaking	1	1	2	3	5	8	16	27	66	300	224
Particulate contamination of SiO_2 substrates after exposure (shaking)	0	1	0	0	6	5	4	11	12	15	31
Total evaluation	3	3	8	9	13	44	56	57	153	501	708
Ranking	**1**	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Low contaminating — Moderately contaminating — High contaminating

Concentrations in µg/cm²	HDPE	JPL film	ULO-poly	Poly-alu	Blister	EAE	LDPE	Wafer box	Pink poly	Membrane box
Surface molecular contamination of witness packaging samples	0,004	0,027	0	0,044	0,051	0,267	0,297	0,553	0,538	105,3
Volatile molecular contamination of witness packaging samples	0,027	0,005	0,036	0,003	0	0,046	0,053	0,010	0,067	0,040
Molecular contamination of SiO_2 substrates after exposure (60°C, 2 days)	0	0	0	0	0	0,032	0	0,011	0	0,051
Total evaluation	0,031	0,032	0,036	0,047	0,051	0,345	0,350	0,574	0,605	105,39
Ranking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Low contaminating — Moderately contaminating — High contaminating

☹ Bag : pink poly, LDPE, EAE
Box : membrane box

☺ Bag : HDPE, PE-Al, ULO -poly or -nylon
Box : blister

Perspectives

- *appropriate choice of packaging according to the part to be protected*
- *elaboration of a blister prototype packaging for sensitive devices*

REFERENCES

1. ECSS-Q-ST-20-08C, Storage, handling and transportation of spacecraft hardware, 2014
2. S. Lin, S. Graves, Comparing the molecular contamination contribution of clean packaging films, MICRO, Volume 16, Number 9, pp. 95-106, 1998
3. Lockheed Martin, General requirements and commercial packaging, P-40, Revision 6, 2012
4. L. Elena, Contamination of sensitive components by packaging materials, *CNES internship report*, 2015