CRAFTECH®
INDUSTRIES, INC.

Low Outgassing Materials

GENERAL DESCRIPTION

In many critical aerospace and semiconductor applications, low-outgassing materials must be specified in order to prevent contamination in high vacuum environments. Outgassing occurs when a material is placed into a vacuum (very low atmospheric pressure) environment, subjected to heat, and some of the material's constituents are volatilized (evaporated or "outgassed").

ASTM TEST METHOD E595

Although other agency-specific tests do exist (NASA, ESA, ESTEC), outgassing data for comparison is generally obtained in accordance with ASTM Test Method E595-93, "Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment".

In Test Method E595, the material sample is heated to 125°C for 24 hours while in a vacuum (typically less than 5 x 10-5 torr or 7 x 10-3 Pascal). Specimen mass is measure before and after the test and the difference is expressed as percent total mass loss (TML%). A small cooled plate (at 25°C) is placed in close proximity to the specimen to collect the volatiles by condensation ... this plate is used to determine the percent collected volatile condensable materials (CVCM%). An additional parameter, Water Vapor Regained (WVR%) can also be determined after completion of exposures and measurements for TML and CVCM.

ASTM Test Method E595 data is most often used as a screening test for spacecraft materials. Actual surface contamination from the outgassing of materials will, of course, vary with environment and quantity of material used. The criteria of TML < 1.0% and CVCM < 0.1% has been typically used to screen materials from an outgassing standpoint in spaceflight applications. Semiconductor applications may often be more sensitive to contamination during certain processes and may have even lower limits of acceptability.

OUTGASSING TEST DATA REFERENCES

Besides the specific material information provided in the paragraphs below, there are comprehensive references about materials which have been tested for outgassing, primarily for spaceflight applications.

Goddard Space Flight Center (NASA) maintains an on-line searchable reference of Outgassing Data for Selecting Spacecraft Materials at http://outgassing.nasa.gov/. Note: This link was correct as of August 2003. When you visit the site, use the SEARCH function to find the material information you need. Related reference information is also available at that site.

The European Space Agency (ESA) maintains a similar on-line searchable reference Outgassing Database at http://esmat.esa.int/Services/outgassing_data/outgassing_data.html. Note: This link was correct as of November 2014. When you visit the site, use the "Go to Outgassing Search" link to find data on the material you need.

The paragraphs below describe specific materials and their uses in these industry applications.

Vespel® (Polyimide)

DuPont Vespel® SP-1 is one of the most-used high-temperature plastic materials used in applications where high-purity and electrical properties are needed. Vespel is frequently used in ultra-clean semiconductor and chemical applications. It is also one of the most expensive materials sold, but is flight-approved for NASA, USAF and other aerospace agencies. Its NASA outgassing values are listed as 1.09% TML, 0.00% CVCM, 0.40% WVR.

Torlon® 4203 unfilled PAI (PolyAmide-Imide)

Unfilled Torlon® 4203 has high dielectric properties and low thermal expansion, and is much less expensive than some advanced polymers. Torlon 4203 is typically used for insulators, spacers, and mechanical parts up to 520°F. Its outgassing values are listed as 1.85% TML, 0.00% CVCM and 0.49% WVR.

Torlon® 5530 glass-filled PAI (PolyAmide-Imide)

Torlon 5530 (30% glass-filled) is typically used for applications where dimensional stability over a wide temperature range is needed, as with temperature test sockets, nests, and fixtures. Its outgassing values are listed as 0.58% TML, 0.00% CVCM (% WVR is not shown). NOTE: Torlon's moisture absorption is a bit high, so critical dimensional stability can be an issue.

Neoflon® PCTFE (PolyChloroTetraFluoroEthylene)

PCTFE exhibits high chemical resistance, low and high temperature capability, resistance to most chemicals (including strong acids and bases), low friction, electrical and thermal insulation, and "slipperiness". PCTFE has the lowest outgassing values of any thermoplastic material we sell ... 0.01% TML, 0.00% CVCM, 0.00% WVR.

Ertalyte® PET-P (Polyethylene Terephthalate)

Ertalyte® offers the dimensional stability of acetal with the wear resistance of nylon. Ertalyte® PET-Polyester is clean, chemically resistant, stable, and also has relatively low outgassing values (0.13% TML, 0.00% CVCM ... % WVR is not shown). PET-P is considerably less expensive than most of the other materials listed above, but may not have the mechanical or thermal performance needed for all applications.

PEEK (PolyEtherEtherKetone)

PEEK is pure, easily machinable, chemically resistant, stable, and also has relatively low outgassing values (0.31% TML, 0.00% CVCM, 0.06 % WVR). PEEK has good mechanical properties, but will not take temperatures over 350°F, so it may not have the mechanical or thermal performance needed.

Ultem® PEI (PolyEtherImide)

Ultem® has good dielectric properties and low thermal expansion, and is considerably less expensive than some other polymers. PEI is also clean and stable, but is not particularly resistant to chemicals or solvents ... it has outgassing values of 0.40% TML, 0.00% CVCM and 0.06 % WVR. PEI has good mechanical properties up to approximately 410°F.

PPS (PolyPhenylene Sulfide)

Techtron® PPS is easily machined to close tolerance, has excellent mechanical, thermal and chemical stability and has one of the lowest outgassing values of any thermoplastic material we offer (0.04% TML, 0.00% CVCM ... % WVR is not shown). Techtron PPS is generally a bit less expensive than PEEK or Torlon, but again, will not take as high temperatures.