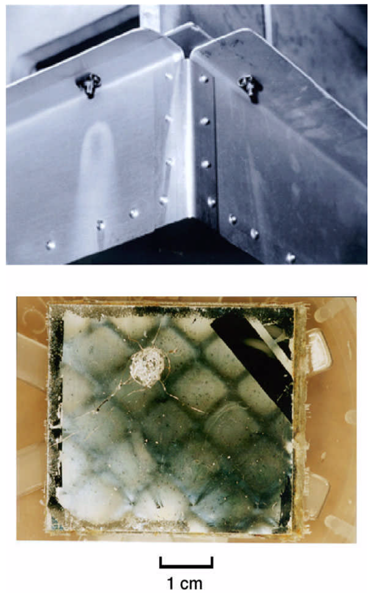
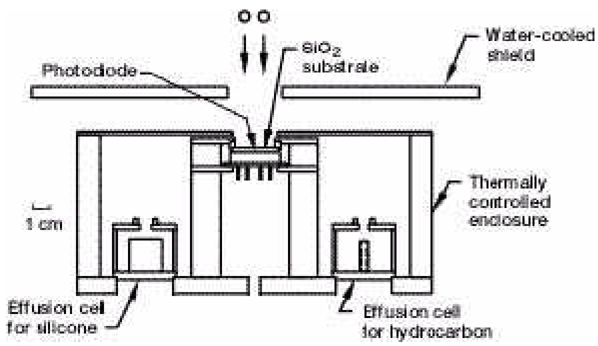
Atomic Oxygen Interactions With Silicone Contamination on Spacecraft in Low Earth Orbit Studied

Silicones have been widely used on spacecraft as potting compounds, adhesives, seals, gaskets, hydrophobic surfaces, and atomic oxygen protective coatings. Contamination of optical and thermal control surfaces on spacecraft in low Earth orbit (LEO) has been an ever-present problem as a result of the interaction of atomic oxygen with volatile species from silicones and hydrocarbons onboard spacecraft. These interactions can deposit a contaminant that is a risk to spacecraft performance because it can form an optically absorbing film on the surfaces of Sun sensors, star trackers, or optical components or can increase the solar absorptance of thermal control surfaces. The transmittance, absorptance, and reflectance of such contaminant films seem to vary widely from very transparent SiO_x films to much more absorbing SiO_x-based films that contain hydrocarbons.

At the NASA Glenn Research Center, silicone contamination that was oxidized by atomic oxygen has been examined from LEO spacecraft (including the Long Duration Exposure Facility and the Mir space station solar arrays) and from ground laboratory LEO simulations. The findings resulted in the development of predictive models that may help explain the underlying issues and effects. Atomic oxygen interactions with silicone volatiles and mixtures of silicone and hydrocarbon volatiles produce glassy SiO_x-based contaminant coatings. The addition of hydrocarbon volatiles in the presence of silicone volatiles appears to cause much more absorbing (and consequently less transmitting) contaminant films than when no hydrocarbon volatiles are present. On the basis of the LDEF and Mir results, conditions of high atomic oxygen flux relative to low contaminant flux appear to result in more transparent contaminant films than do conditions of low atomic oxygen flux with high contaminant flux. Modeling predictions indicate that the deposition of contaminant films early in a LEO flight should depend much more on atomic oxygen flux than it does later in a mission.



Top: LDEF SiO_x-based contaminant streaks. Bottom: SiO_x-based contamination on Mir solar cell optical solar reflector.



Ground laboratory system for simulation of atomic oxygen interaction with combined silicone and hydrocarbon contamination on SiO_2 windows.

Find out more from Glenn's Electro-Physics Branch (http://www.grc.nasa.gov/WWW/epbranch/ephome.htm)

Glenn contacts: Bruce A. Banks, 216-433-2308, Bruce.A.Banks@grc.nasa.gov; Sharon K. Miller, 216-433-2219, Sharon.K.Miller@grc.nasa.gov; and Aaron Snyder, 216-433-5918, Aaron.Snyder@grc.nasa.gov; Kim K. de Groh, 216-433-2297, Kim.K.deGroh@grc.nasa.gov; and Dr. David J. Brinker, 216-433-2236, David.J.Brinker@grc.nasa.gov
Dynacs Engineering Company, Inc., contacts: Edward A. Sechkar, 216-433-2299, Edward.A.Sechar@grc.nasa.gov; and Thomas J. Stueber, 216-433-2218, Thomas.J.Stueber@grc.nasa.gov
Author: Bruce A. Banks
Headquarters program office: OSS (ATMS)
Programs/Projects: Space Power Technology