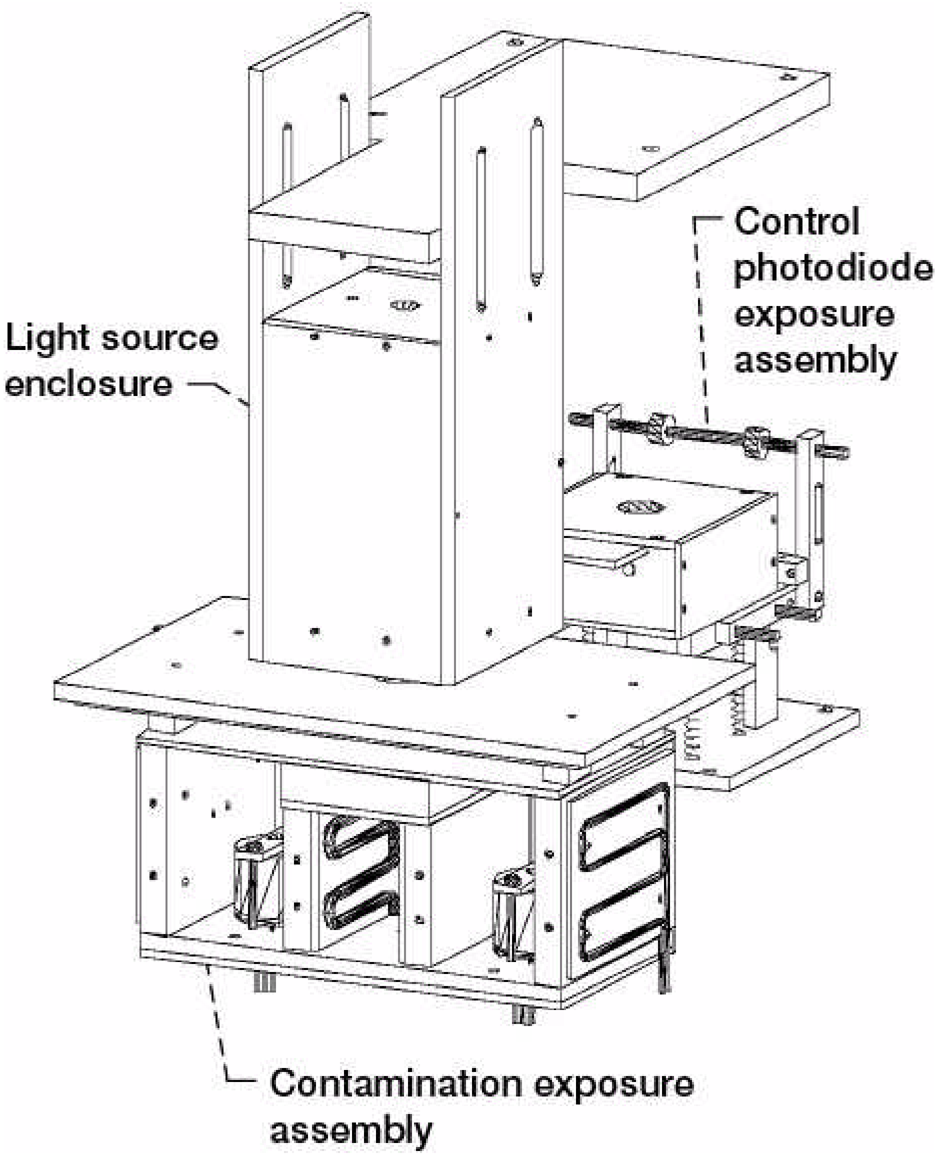
Facility Designed and Built to Investigate the Combined Effects of Contaminant and Atomic Oxygen on a Light-Transmitting Surface

A need exists to investigate changes in the transparency of a light-transmitting surface during simultaneous exposure to a contaminant and an atomic oxygen (AO) flux. This mechanism may be responsible for the degradation of the light-transmitting surfaces of both photovoltaic cells and photodiodes currently in use on many low-Earth-orbit spacecraft. To address this need, researchers from the Electro-Physics Branch of the NASA Glenn Research Center at Lewis Field built such a test system within their AO beam facility. This facility produces an effective AO flux of 1.4×10^{16} atoms/cm^2/sec and contains a three-axis positioning system that provides the motion capability necessary for test operations.

During testing, a target surface is held directly within the AO beam and close to two contaminant effusion cells. The effusion cells are shielded from the AO beam, and the outgassing contaminant is constrained to move across the target surface when heat is applied to either of the reservoirs. A light source is periodically moved over the target surface, and the transmitted light intensity is checked with a photodiode located below the target. This light source is also periodically checked with a separate photodiode, which is protected from contamination and AO exposure, to allow adjustments necessary to maintain a consistent light intensity.



Contamination test fixture hardware.

The test fixture hardware was designed to allow a wide variation of test parameters while providing necessary protection for vital system components. The temperatures of four separate regions are controlled by balancing the heating and cooling elements. These regions are each of the contaminant reservoirs, the target surface, and the enclosure surrounding (but not in contact with) the target surface.

A software program was designed to provide automated turnkey control and data acquisition capability for the entire duration of an exposure test. This program controls two electrometers for photodiode measurements (light intensity control and contaminant buildup assessment), the three-axis positioning system, closed-loop proportional integral differential (PID) temperature controllers for regulating the four separate regions, and a solenoid valve to provide water cooling.

The program performs an automated exposure test after being initialized with the PID controller parameters, PID temperature set points, temperature versus time plot parameters, light source intensity level, test cycle time, and number of cycles. In addition, it monitors many system conditions for quality and safety, and aborts the test if any condition exceeds user-supplied values.

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