THE EFFECTS OF ATOMIC OXYGEN ON POLYMERIC MATERIALS

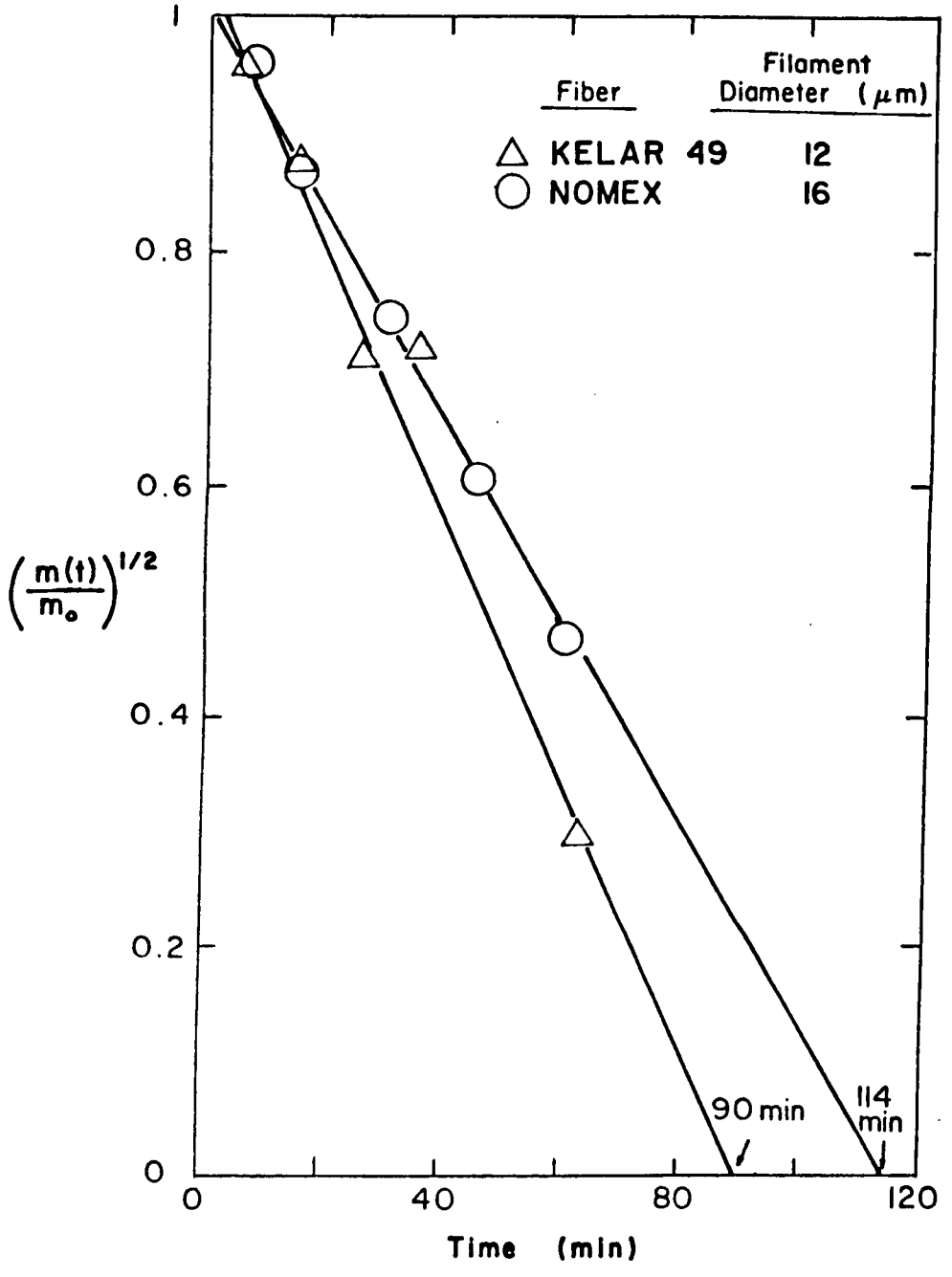
by

Robert A. Orwoll
Professor
Department of Chemistry
College of William and Mary
Williamsburg, VA 23185

At the altitudes of low-earth orbit (LEO) atomic oxygen (AO) is the most abundant chemical species. This strong oxidizing agent reacts with virtually any organic material that is not already fully oxidized. Erosion by AO can be extensive and jeopardizes any protective coatings, thermal blankets, adhesives, and structural composites exposed on the exterior of satellites in LEO.

We have prepared and tested organic materials for their susceptibility to AO using a commercial plasma asher which approximately simulates the oxygen effects in LEO. Experiments have been performed on a polyimide, a polysulfone, and two epoxy adhesives into which low molecular-weight additives have been dissolved. Incorporated in the molecular structure of these additives are elements such as silicon whose nonvolatile oxides, which are formed on exposure to AO, remain as a coating on the surface to create a barrier between the remainder of the organic material and the AO. We find that the additives protect the materials but the low solubility of some limit their utility. Concurrent studies are underway to measure the effect of the additives on the thermal expansion coefficients of the materials.

Tows of aramid fibers, which are important components in the proposed tether satellite systems, have been eroded in the asher. The results which show that the square root of the mass remaining decreases linearly with the time of exposure (see the figure) are consistent with a constant rate of surface erosion. The tensile strength of these eroded tows decreases with time of exposure also; additional measurements are in progress.



Variation of mass for Kevlar and Nomex aramid fibers as a function of time in the asher; here m and m_o are the masses at time t and at $t = 0$.