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Author: Dr. Nobunari Itoh
Japan, nitoh@edu.mie-u.ac.jp

THE EFFECT OF UV IRRADIATION ONTO OPTICAL SURFACES WITH GASEOUS CONTAMINANTS AND THE COMPARISON WITH ACTUAL SENSOR OUTPUTS

Abstract

The presence of propagated molecules around satellites is one of the most probable causes of optical degradations appeared on astronomical and earth-observing sensors equipped on the satellites. The optical degradation makes sensor's lifetime shorter and reliability of output signal lower since the strong and/or wide absorption bands of the contaminants prevent optical element from keeping transparent and then signals focused on detectors will be decreasing gradually. In addition, coloring of adsorbed molecules by photochemical reaction must induce transmittance and reflectance degradation of optical elements. Therefore it is necessary to quantify the relation between the amount of contamination onto optical surfaces and transmittance degradation to reduce the signal degradation. We built up the measurement systems in order to evaluate transmittance degradation with various kinds of gases. Our apparatus is able to expose UV irradiation onto an optical surface with gaseous contaminant under vacuum condition. The transmittances of optical surfaces can be measured from 200nm to 2.5um. In this study, the transmittance degradation due to the organic gas adsorption was measured. The coloring effects owing to photochemical reactions by UV irradiation were also estimated. Three kinds of organic molecules, diethylhexyl phthalate, di(propylene glycol) methyl ether acetate, and hexatriacontane, were adopted for the contaminants. The first are typical plasticizer, the second is a organic solvent of the black paint often used in spacecrafts, and the third is a material of cable coating. As for UV irradiation, both high- and low-pressure mercury lamps were adopted. Our measurement shows that changes of spectral transmittance after UV exposure were not significant in infrared for all kinds of contaminants but in UV-VIS range. The variation of spectral transmittance depended on not only the adsorbed contaminants but also wavelength of radiated UV light. DEHP and hexatriacontane were colored by a high-pressure mercury lamp, but not by low-pressure lamp. No significant coloring was detected for di(propylene glycol) methyl ether acetate. The obtained degraded spectra were compared with sensor output signals reported so far to examine the possibility that signal degradation occurred in orbit could be explained by the adsorption and photochemical processes of organic molecular contaminants treated in this study. Three sensors, OCTS, GLI, and SeaWiFS, all of which are earth observing sensors, were selected for comparison. The comparison indicated that it is hard to explain the signal degradations only by the contamination of the three molecules treated in this study.