

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)

Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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DEGRADATION PROCESSES OF AL/MGF₂ UV TELESCOPE MIRRORS UNDER HIGH ENERGY
PHOTONS**Abstract**

Thin-film Al/MgF₂ bilayers are widely used for mirrors of extraterrestrial telescope astronomy (such as the Spectr UF). The stability of these coatings is incredibly important. But mirrors are degraded during operation or transportation. In the first case, the mirrors are exposed by high-energy photons. The interaction can consist of heat fluxes coming on the sample, physical and chemical interactions between the layers. In the second case, the presence of O₂ leads to the formation of aluminum oxides and spinel. Aluminum oxides are opaque for wavelengths shorter than 115 nm.

In this work the degradation processes of Al/MgF₂ UV telescope mirrors were studied under exposure of ultraviolet radiation. Calculations of the reflectance with and without aluminum oxides were made to determine the degree of reflectivity reduction. The radiation source in this work was magneto-plasma compressor. Based on the results, it was concluded that the source is quasi-spherical and energy flux was in the range from 42.9 to 109 mJ/cm². The studies were carried out for samples with the Al/MgF₂ coating (Al (100 nm) and MgF₂ (30 nm)) deposited on sital. The discharge was carried out in 3 various gases – neon, argon, air to control the photon energy. Changes of the reflectance of the samples (Cary 7000 Universal Measurement Spectrophotometer), roughness and 2D and 3D profiles of the samples (probe nanolaboratory INTEGRA) were studied. The thickness and depth of cracks and the size of spots were measured using digital microscope and profilometer.

If the energy of quanta reaching the sample is less than 6 eV, slight increase of roughness and visible cracks are observed on the surface of the sample. Energy of quanta is 6-15 eV – MgF₂ layer partly-completely evaporates, roughness increases gradually, depth of the cracks reaches 55 nm. Energy of quanta is less than 21 eV – coating completely evaporates, degradation of the substrate with the cracks (depth – less than 200 nm) is observed.

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