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Analysis of proton irradiation effects on fluorine-doped tin oxide thin films for optoelectronic applications in the LEO environment

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Fluorine-doped tin oxide (FTO) is an n-type semiconductor transparent conducting oxide (TCO) widely adopted for various applications, including gas sensors, digital displays, touch switches, optical windows, and electrochromic applications. To investigate its suitability for optoelectronic applications in the Low Earth Orbit (LEO) environment, FTO thin films were exposed to different fluences of 2 MeV protons at a ground-based particle accelerator facility. The induced changes in the properties of the proton-irradiated films were analyzed using atomic force microscopy (AFM), UV-vis-NIR spectrophotometry, and X-ray diffraction (XRD) techniques.

The results showed that the 2 MeV protons considerably reduced the optical transparency and decreased the optical bandgap of the films, indicating the existence of electronic defects and structural disorder. The XRD analysis revealed slight irradiation-induced enhancement in the percentage crystallinity and shifts in peak positions of the diffraction spectral lines. Also, surface modification of the films was also observed as a reduction in the surface roughness of the films with increasing proton fluence. Generally, this work highlights the distinct radiation tolerance and suitability of FTO for use in the space environment and contributes to the fundamental understanding of metal oxide thin films for space applications.

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