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Spectral Response Measurements and Materials Analysis of Ageing Solar Photovoltaic Modules

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Abstract : The design and reliability of solar photovoltaic modules are crucial to the development of solar energy, and efforts are still being made to extend the life of photovoltaic modules to improve their efficiency because natural aging is time-consuming and does not provide manufacturers and investors with timely information, accelerated aging is currently the best way to estimate the life of photovoltaic modules. In this study, the accelerated aging of different light sources was combined with spectral response measurements to understand the effect of light sources on aging tests. In this study, there are two types of experimental samples: packaged and unpackaged and then irradiated with full-spectrum and UVC light sources for accelerated aging, as well as a control group without aging. The full-spectrum aging was performed by irradiating the solar cell with a xenon lamp like the solar spectrum for two weeks, while the accelerated aging was performed by irradiating the solar cell with a UVC lamp for two weeks. The samples were first visually observed, and infrared thermal images were taken, and then the electrical (IV) and Spectral Responsivity (SR) data were obtained by measuring the spectral response of the samples, followed by Scanning Electron Microscopy (SEM), Raman spectroscopy (Raman), and X-ray Diffraction (XRD) analysis. The results of electrical (IV) and Spectral Responsivity (SR) and material analyses were used to compare the differences between packaged and unpackaged solar cells with full spectral aging, accelerated UVC aging, and unaged solar cells. The main objective of this study is to compare the difference in the aging of packaged and unpackaged solar cells by irradiating different light sources. We determined by infrared thermal imaging that both full-spectrum aging and UVC accelerated aging increase the defects of solar cells, and IV measurements demonstrated that the conversion efficiency of solar cells decreases after full-spectrum aging and UVC accelerated aging. SEM observed some scorch marks on both unpackaged UVC accelerated aging solar cells and unpackaged full-spectrum aging solar cells. Raman spectroscopy examines the Si intensity of solar cells, and XRD confirms the crystallinity of solar cells by the intensity of Si and Ag winding peaks.

Keywords : solar cell, aging, spectral response measurement
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