Combined UV-irradiation and pyrolysis-GC/MS approach for evaluating the deterioration behavior of ethylene vinyl acetate

K. Yamada, S. Kumagai, T. Shiratori, T. Kameda, Y. Saito, A,. Watanabe, C. Watanabe, N. Teramae, T. Yoshioka

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Abstract:

Ethylene vinyl acetate (EVA), commonly used to encapsulate photovoltaic (PV) modules, deteriorates on prolonged exposure to sunlight. In this work, fresh and deteriorated EVA samples prepared by UV irradiation (500 Wm^{-2}) over different periods (0–168 h) are characterized by conventional elemental analysis, microscopic observations, Fourier transform infrared (FT-IR) spectroscopy, and thermogravimetry. To the best of our knowledge, this is the first work to employ pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) and micro-UV irradiation combined Py-GC/MS (UV/Py-GC/MS) to investigate the deterioration behavior of EVA, using in-situ identification of gases liberated during UV irradiation, such as H_2O, CO_2 , ketones, acetic acid, and lactones. In addition, the deterioration of the thermal stability on aging is confirmed using evolved gas analysis-mass spectrometry (EGA-MS). UV/Py-GC/MS revealed that acetaldehyde, acetone, acetic acid, γ-butyrolactone, succinic anhydride, and cyclobutanone are produced during UV irradiation. In addition, Py-GC/MS identified cyclopentanone, citraconic anhydride, γ-valerolactone, and cyclobutanone from the UV deteriorated EVA samples, which suggested the presence of ketone and lactone structures in the deteriorated EVA. This work establishes the combined usage of UV irradiation and Py-GC/MS as a promising method to investigate UV deterioration behavior in greater detail. These findings may contribute to a superior understanding of the breakdown of PV modules by the deterioration of EVA, and lead to the development of UV-resistant encapsulating materials.

* Excerpted from online journal website (Click on the title)

Frontier Labs Products used:

Multi-Shot Pyrolyzer (EGA/PY-303D), Micro puncher, Multi-sample micro-UV Irradiator (UV-1048E), UA^+-5, UADTM