Detecting acetic acid in photovoltaic modules through changes in the relative reflectance of tin films

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1. Introduction
One of the factors responsible for the deterioration of photovoltaic (PV) modules is acetic acid, which is generated by a hydrolysis reaction involving ethylene vinyl acetate (EVA) encapsulants and the water that infiltrates a module [1].

Previous method…
- Destructive.
- The temporal change is unanalyzable.

1) Propose a non-destructive method that detects acetic acid by tin films [3].
2) Damp heat (DH) test (85°C, 85%RH) can be used to investigate the relative reflectance changes of tin films enclosed in PV modules.

2. Principle
2.1 Reaction to acetic acid of tin

\[ Sn + 4CH₃COOH \rightarrow Sn(CH₂COO)₄ + 2H₂ \]

Optically transparent

- Decrease of intensity of reflected light.
- Detect the relative reflectance.
- Detect the acetic acid in PV modules.

2.2 Measurement method

Optically transparent

Fabrication of metal films on cover glasses by a vacuum evaporator.
- Sn film: 70 nm
- Au film: 100 nm

1. Measure the reflected light from Au film.
2. Measure the reflected light from Sn film by the same optical power.
3. Calculate the relative reflectance of Sn film to the Au film.

3. Reaction to acetic acid moisture

- Acetic acid moisture: 500 ppm
  - Ultrapure water (99.95 g) + Acetic acid (0.05 g)
- High temperature / humidity chamber (85°C, 79%RH)
- Calculate the relative reflectance of Sn film for the Au film.

4. Acetic acid detection in the PV module during the DH test

- Edge: Gradually decreased.
- Center: Decreased after remaining relatively stable.

Different reaction with the acetic acid in edge and center of the cell.

Indicate that a non-destructive method for detecting acetic acid in the PV modules is possible and that the temporal distribution of acetic acid can be evaluated.

5. Conclusions
- We suggested the non-destructive detection method of the acetic acid in the PV module in the damp heat test.
- We confirmed the relative reflectance change of the tin film for the acetic acid moisture.
- We indicated that the temporal distribution of acetic acid can be evaluated.

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References