LIFETIME IMPROVEMENT OF TIN FILM SENSOR FOR DETECTING ACETIC ACID PRODUCED IN PHOTOVOLTAIC MODULES

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1. Introduction
Previous studies have revealed that ethylene-vinyl acetate (EVA) used in PV modules as encapsulants produces acetic acid which induces degradation of PV modules during damp-heat (DH) test (85°C, 85% RH) [1]. We have proposed a non-destructive detection of acetic acid by tin film sensors, as shown in Fig. 1 [2]. Since the surface optical reflectance of the tin film decreases by reaction with acetic acid, it is possible to measure the amount of acetic acid generated by measuring the change in the reflectance of the tin thin film. In recent research, although the acetic acid was successfully detected by the DH test of the PV module using the tin sensor, the tin film of sensor at the edge of the PV module was completely exhausted in about 1500 h of DH test time, as shown in Fig. 2. Attempts to extend sensor life by increasing the sensor thickness have failed due to reduced reflection intensity shown in Fig. 3.

In this paper, we aim to develop a tin film sensor with long life by increasing the film thickness without lowering the sensor reflectance.

2. Evaporation condition
The tin film sensor was manufactured by depositing it on glass substrate having a diameter of 8 mm. When the film thickness was changed from 70 nm to 160 nm, experiments were performed using vacuum pressure and evaporation rate as deposition parameters. As shown in Fig. 4, varying the vacuum pressure during deposition between $10^{-4}$ and $10^{-3}$ Pa was not effective for increasing the relative reflectance. In contrast, raising the deposition rate shown in Fig. 5 had a major influence on maintaining good sensor reflectance.

3. DH test
The DH test was demonstrated until 3316 h and the relative reflectance of the sensors was measured periodically. Figure 6 shows that the average relative reflectance of 160 nm thickness sensors is higher than that of the 70 nm sensors for any DH time. Therefore, it is shown that the 160 nm sensor has longer life compared with the 70 nm sensor.

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References