Estimation of Amount of Free Acetic Acid Desorbed in EVA Encapsulant with Infra-Red Spectrum

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Back Ground

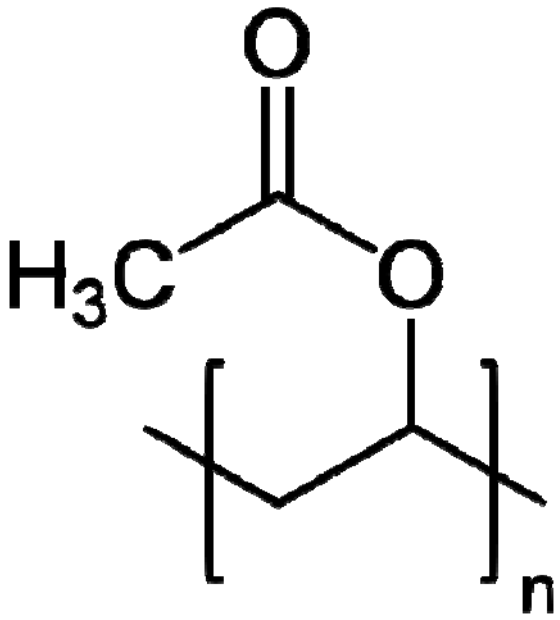
Understanding of PV module degradation mechanisms involved in encapsulant is very important for predicting the lifetime of PV modules for encapsulant manufacturers. In general, Ethylene Vinyl Acetate (EVA) desorbs free acetic acid by high stresses with moisture. The generation of free acetic acid causes degradation of PV module. However as far as we know, there have been no data for the amount of free acetic acid in EVA desorbed during accelerated test.

Our goal in our study is to understand the correlation between amount of free acetic acid of encapsulant and module properties. First of all, we have attempted to come up with a method to estimate easily the amount of free acetic acid in EVA.

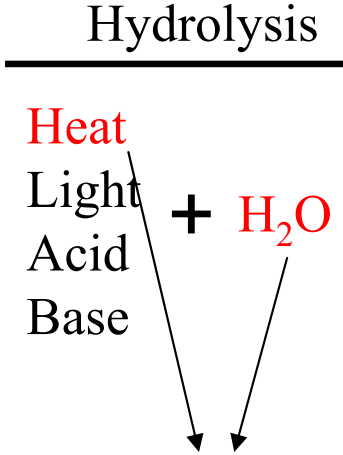
This work

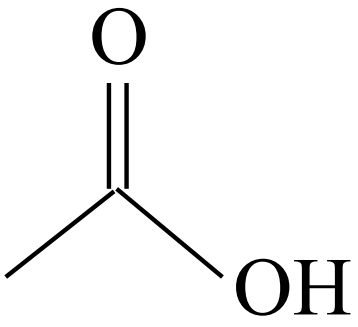
In this study, we propose a method with infra-red (IR) spectrum to measure the amount of free acetic acid in EVA desorbed during damp heating (DH) test. Generally, free acetic acid is able to be measured by hot water extraction method (HWEM), because the acetic acid can be directly detected with ion chromatograph technique. However in HWEM, large amount (large area) of sample is needed. In addition, when backsheet with low moisture barrier is used, acetic acid penetrates the backsheet. As a result, detected amount of acetic acid is underestimated. To avoid these problems, we have attempted to detect chemical changes in EVA with infra-red spectrum.

Hydrolysis of Vinyl Acetic Acid Groups



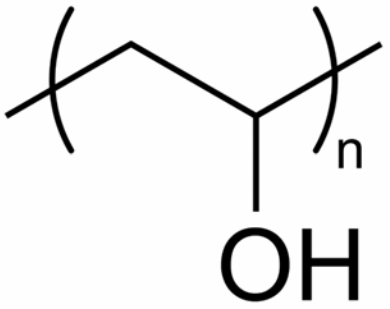
Vinyl Acetic Acid





Acetic Acid

+



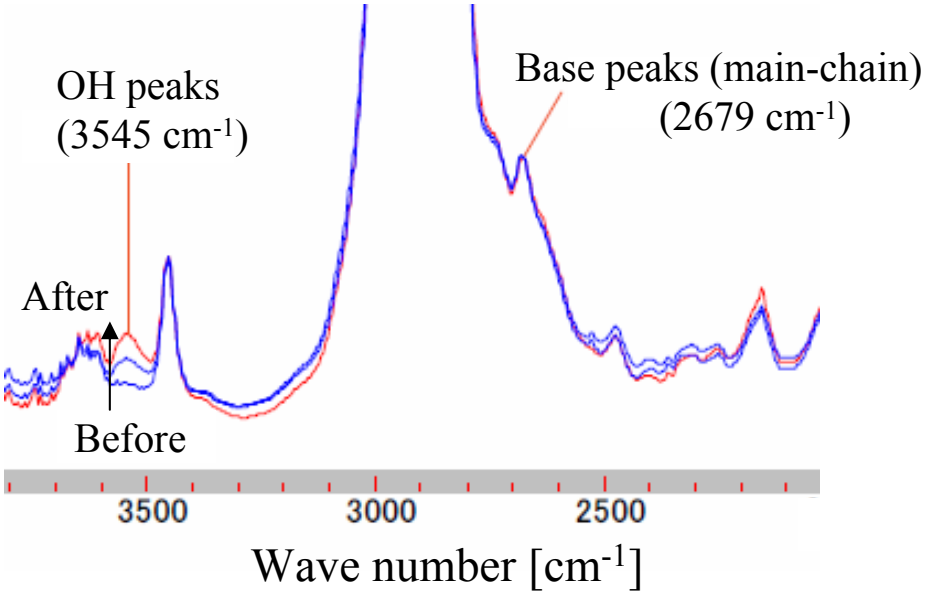
Vinyl Alcohol

Sample geometry

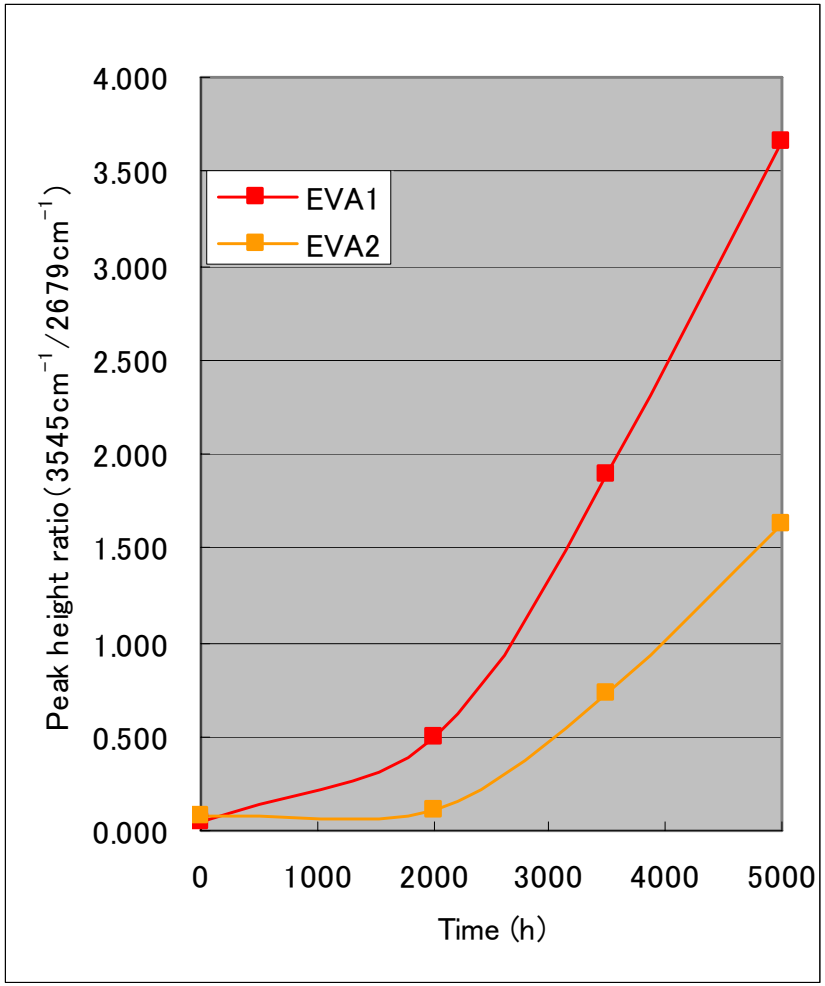
Hydrolysis needs water and high stress.
After hydrolysis, OH groups appear and main-chain does not change.

Infra-red (IR) spectra seem to be useful.

IR Method (IRM)



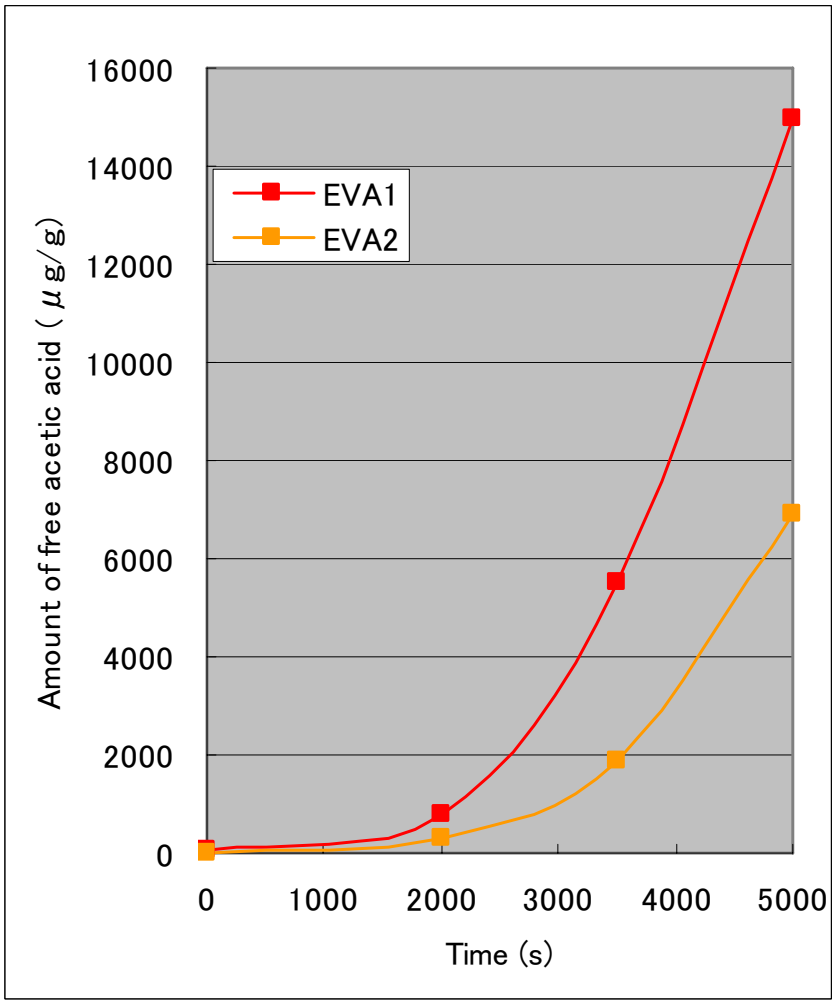
Change in IR spectra during DH test. The peak height at the wave number of 3545 cm^{-1} increases during DH test, because carbonyl groups change hydroxyl groups.



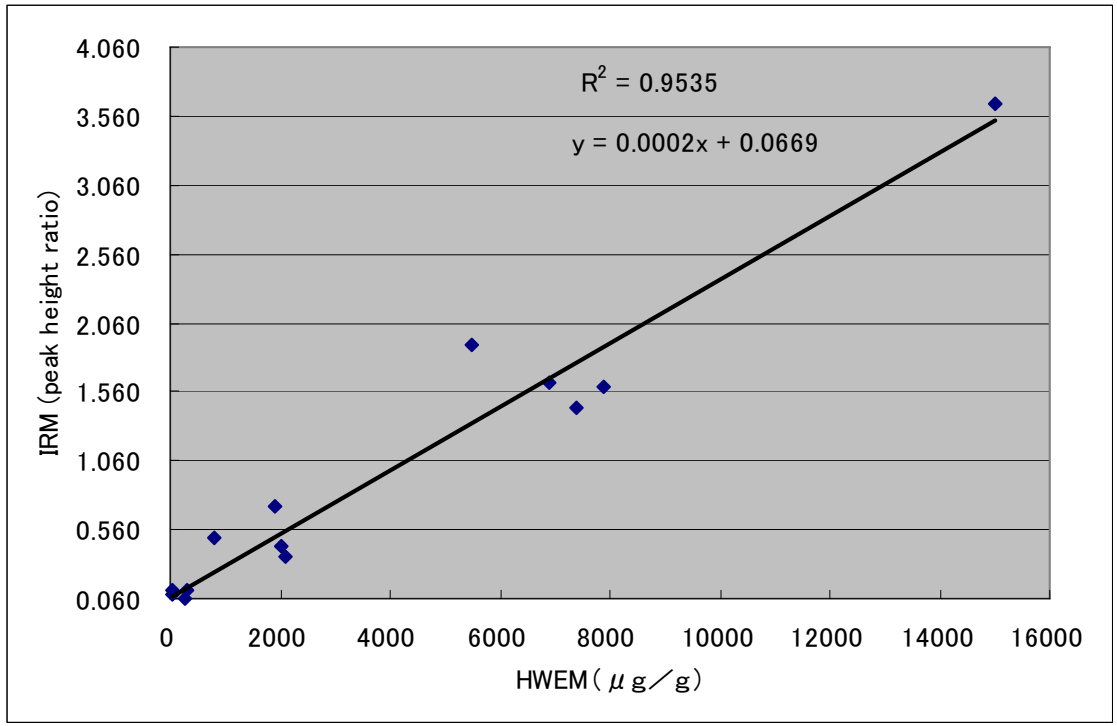
Increasing in peak ratio of (3545cm-1) / (2679cm-1) during DH test by IR method (IRM).

As we expected, the peak height of OH groups increases and the peak height of main-chain does not change during DH test.

Relationship of IRM and HWEM



Increasing in amount of free acetic acid during DH test by hot water extraction method (HWEM).



Correlation between amount of free acetic acid obtained by HWEM and the peak height ratio of (3545 cm-1) / (2679cm-1) by IRM.

The curves of IRM and HWEM are very similar curves, and moreover the calibration curve is reasonable. These results reveal IRM is simple and easy method to estimate amount of free acetic acid.

Summary

The curves of IRM and HWEM are very similar curves, and moreover the calibration curve is reasonable. These results reveal IRM is simple and easy method to estimate amount of free acetic acid. IRM does not need large amount of samples. In addition, even though acetic acid penetrates the backsheet, we can detect chemical changes due to hydrolysis

The difference of amount change of free acetic acid during DH test in two products of EVA encapsulant. To figure out the difference is under investigation.