BOND / Structural bonding

● Advanced compressive shear testing and in-situ failure analysis of glass-laminates

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Abstract content

Compressive shear testing (CST) is frequently used to assess the delamination performance of photovoltaic modules based on glass-encapsulant-laminates (Chapuis et al., 2014). While in previous work just force/displacement data were generated and evaluated, the main objective of this paper is to develop and implement an advanced CST methodology allowing for in-situ failure analysis. Glass-laminates with two different peroxide cross-linked encapsulants (based on ethylene vinylacetate copolymer (EVA) and polyolefin elastomer (POE)) were manufactured at 155°C (curing time: 15 min; pressure: 800 mbar). CST specimens with dimensions of 25 mm x 25 mm were cut using a diamond saw. CST experiments in tension mode were performed on a Zwick-Roell Z020 at room temperature and 50% rh. The displacement rate was 1 mm/min. The testing system was equipped with a digital image correlation system (DIC; Aramis GOM). Hence, shear strain distributions within the soft adhesive were recorded and used to evaluate the failure mechanisms. The generated DIC images were evaluated using the open source image processing program ImageJ (https://imagej.net). Depending on the encapsulant maximum shear loads in the range from 1 to 5 kN were obtained. In general, ultimate failure of EVA was ascertained at significantly higher load values. Prior to ultimate failure, fracture of the glass substrates was observed. Initiation of delamination occurred at significantly lower load values. As depicted in Fig. 1, the initial stage of delamination was characterized by distortion and a superimposed shift of the adhesive layer. Therefore, a region of interest (ROI) was marked digitally on the specimen cross-section and divided into 3 sub-sections (i.e., upper glass substrate, encapsulant, lower glass substrate). By tracking of ROI it was clearly shown that ultimate compressive shear strength is not a reliable indicator to assess the delamination performance. Moreover, localized failure analysis is indispensable for deduction of the critical load or stress at onset of delamination.

Acknowledgement

The financial support by the Austrian Federal Ministry for Digital and Economic Affairs, the National Foundation for Research, Technology and Development and the Christian Doppler Research Association is gratefully acknowledged.

References

https://doi.org/10.1002/pip.2270

Fig.1: DIC images of a glass-EVA-glass laminate