School of Photovoltaic and Renewable Energy Engineering

ADHESION TESTING OF METAL CONTACTS FOR SOLAR CELLS

Strong adhesion of metal contacts to silicon is required for reliable silicon photovoltaic devices. At the busbar level, adhesion is typically quantified using pull-tests, however, such tests cannot be used to test the adhesion of metal fingers to cells. Finger-based adhesion tests are required if cells are to be interconnected using strategies which do not require a busbar to be printed or plated on the cell. They can also be used to evaluate adhesive quality and variability in the metallisation across a wafer. We are developing a stylus based testing method [1, 2] which is similar to the concept of a scratch test used to for thin films. This method enables quantitative measurements of the cohesive and adhesive properties of metal fingers and can be used to map these properties over the surface of a 156 mm cell.

Fig. 2. Stylus dislodging and breaking a Ni/Cu plated finger.

The stylus can either dislodge (see Fig. 1) or cut-through a metal finger (see Fig. 2), with dislodgement typically occurring with metal fingers with strong cohesive strength and cut-through occurring when metal fingers have either strong adhesive strength and/or weak cohesive strength. Dislodgement and cut-through failure modes can be observed for plated fingers depending on the properties of the plated metal and how the plating was performed, however typically only cut-through mode is observed for screen-printed fingers due to their weaker cohesive strength.

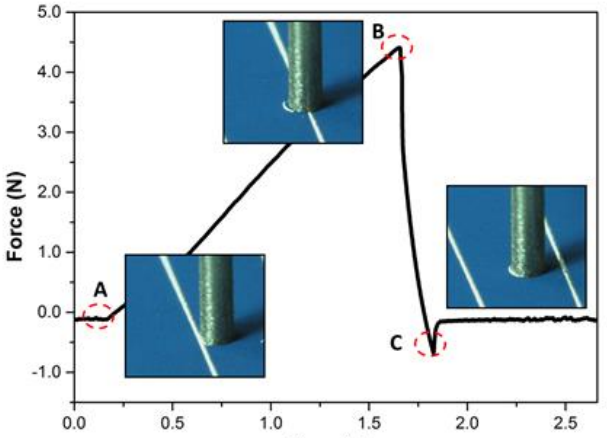

Fig. 1. Measured force scan showing the stylus impacting a screen-printed finger and cutting through the finger.

The developed software can detect peaks in the measured force and these data can be recorded and used to map an entire wafer surface as shown in Fig. 3 or create frequency histograms as shown in Fig. 4. Ongoing research aims to relate the measured forces to physical properties of the metal fingers (e.g., residual stress). The analysis of the measured data and captured video is also being further developed with automated linking between the measured forces and video capture being used to validate classifications and eliminate erroneous measurements.

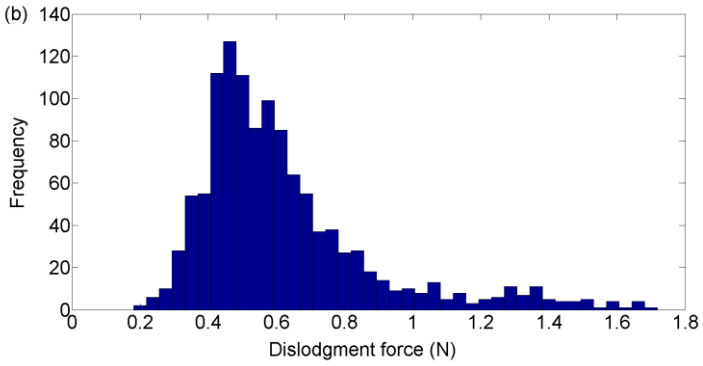

Fig. 4. Frequency histogram of measured dislodgement force across a Ni/Cu plated 156 mm cell.

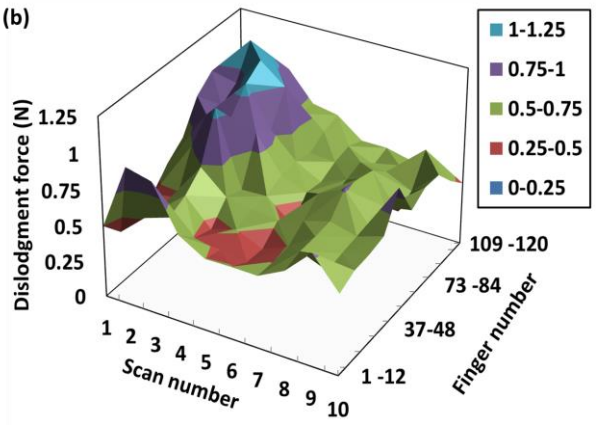

Fig. 3. Contour maps of the measured dislodgement force across a Ni/Cu plated 156 mm cell.

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[1] T. Young, K. Khee, A. Lennon, R. Egan, O. Wilkie, and Y. Yao, "Design and characterization of an adhesion strength tester for evaluating metal contacts on solar cells," in *40th IEEE Photovoltaics Specialist Conference*, Denver, CO, USA, 2014, pp. 2550 - 2553.

[2] R. Chen, W. Zhang, X. Wang, X. Wang, and A. Lennon, "Failure Modes Identified during Adhesion Testing of Metal Fingers on Silicon Solar Cells," *Energy Procedia*, vol. 67, pp. 194-202, 2015.