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Probing mechanical reliability of perovskite and two-terminal silicon/perovskite tandem solar cells using cross-sectional nanoindentation.

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Abstract: Integrated circuits fabricated in the microelectronic industry heavily rely on complex interfaces which drive switching of the electrical components; i.e., transistors at the front end; capacitors & resistors at the back end. A combination of low resistive metal (Cu) and a low dielectric constant material (SiO_2) are a requirement to form a multi-level metallization scheme with electrical wiring to reduce the time constants (RC), which facilitate faster and efficient signal and data processing. However, adhesion at these intricate interfaces and structures remain an issue under operational conditions resulting in a wide range of failure mechanisms. Mechanical probing using cross-sectional nanoindentation (CSN) is a well-established method used to measure the fracture toughness and reliability of these interconnects and scanning electron microscopy (SEM) is performed after this test procedure to identify the modes of failure mechanism.[1] On similar grounds, the perovskite and two-terminal silicon/perovskite tandem solar cells involve a variety of low resitive metals (Au, Ag, Al) and polymeric dielectric materials (Spiro-OMeTAD, PTAA), hence making it feasible to apply CSN method to characterise solar cells.

In the current work, CSN testing method is extended to measure the interfacial delamination in perovskite and silicon/perovskite tandem solar cells (SPTS), which could lead to lowering of the fill factor (FF) under operating conditions of solar cells. An illustration of the testing configuration is presented in **Figure 1**, the indent is made on the substrate which is typically 2-20 µm away from the metal to air interface. The load-displacement curve (**Figure 2**) obtained from the nanoindentation testing will be used to determine the fracture energy with the aid of a semi-quantitative analytical model to compute and compare adhesion and mechanical properties of samples with different interfaces.[2] At the conference, details pertaining to the CSN test and subsequent analytical analysis to get the fracture energy will be presented for various configurations of perovskite solar cells.

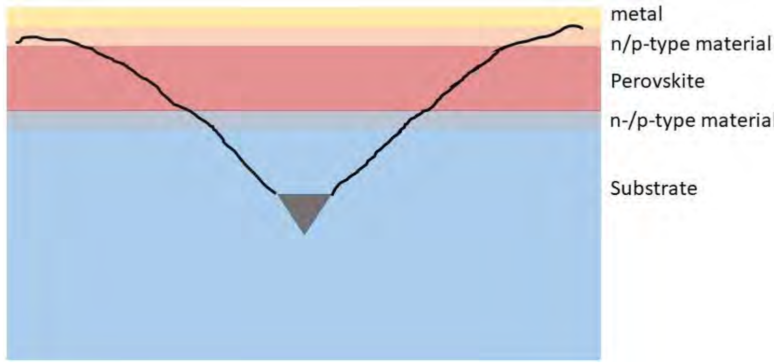

Figure 1 Schematic illustration of the CSN test configuration for solar cells.

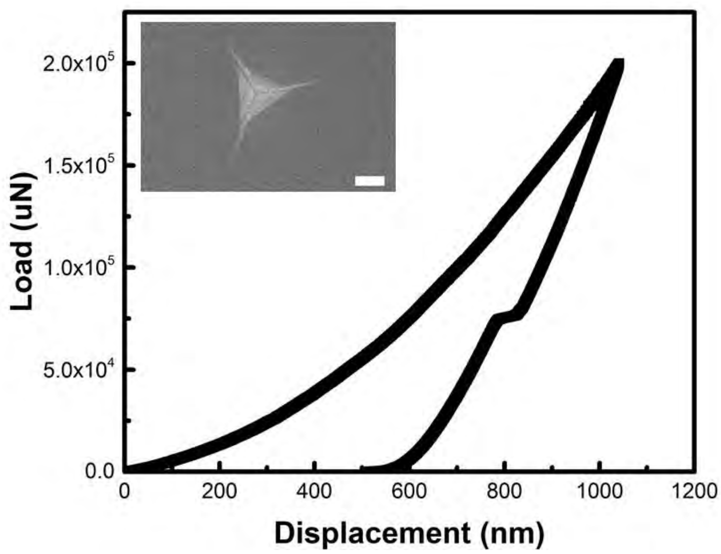

Figure 2 Load-displacement curve obtained by indenting on the cross-section of the silicon sample, inset is an SEM image of the indent on the silcon which was taken after the nanoindentation testing was performed, scalebar: 1µm.

References

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