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Large-Area Material and Junction Damage in c-Si Solar Cells by Potential-Induced Degradation

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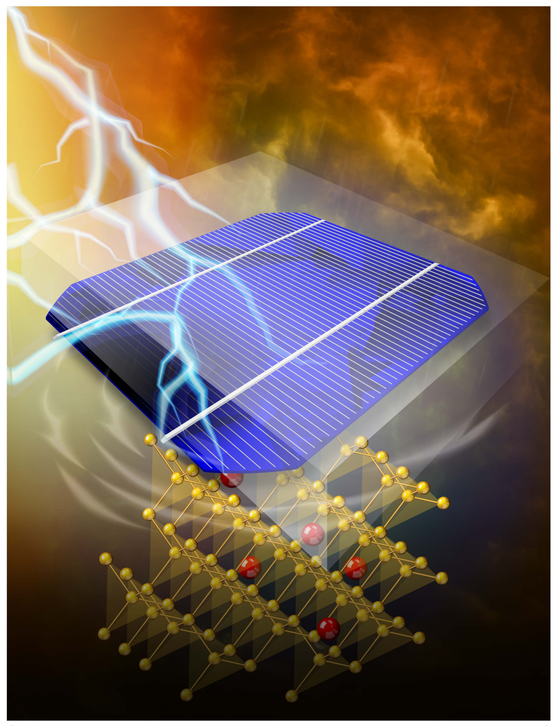
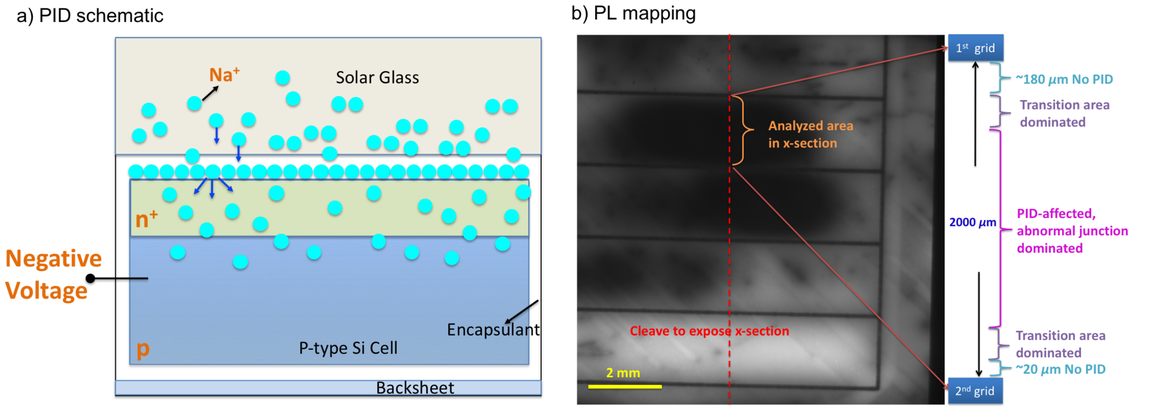
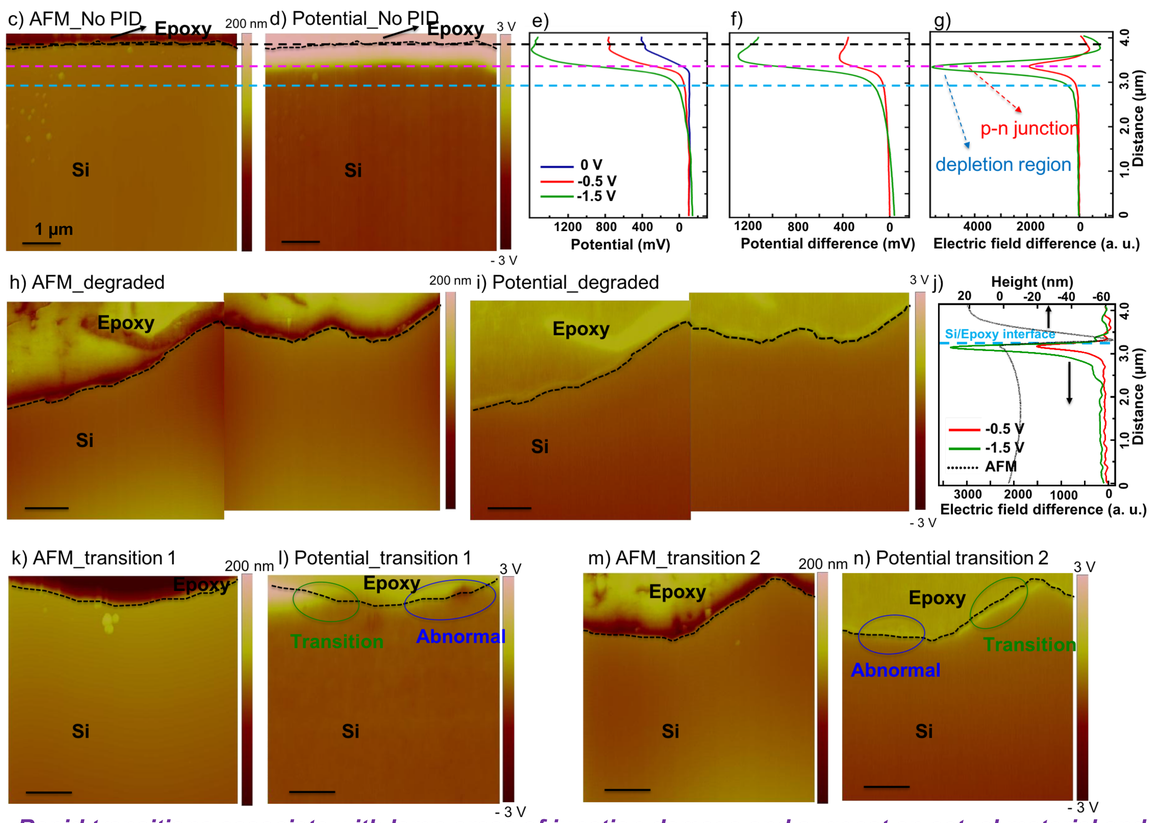
Introduction



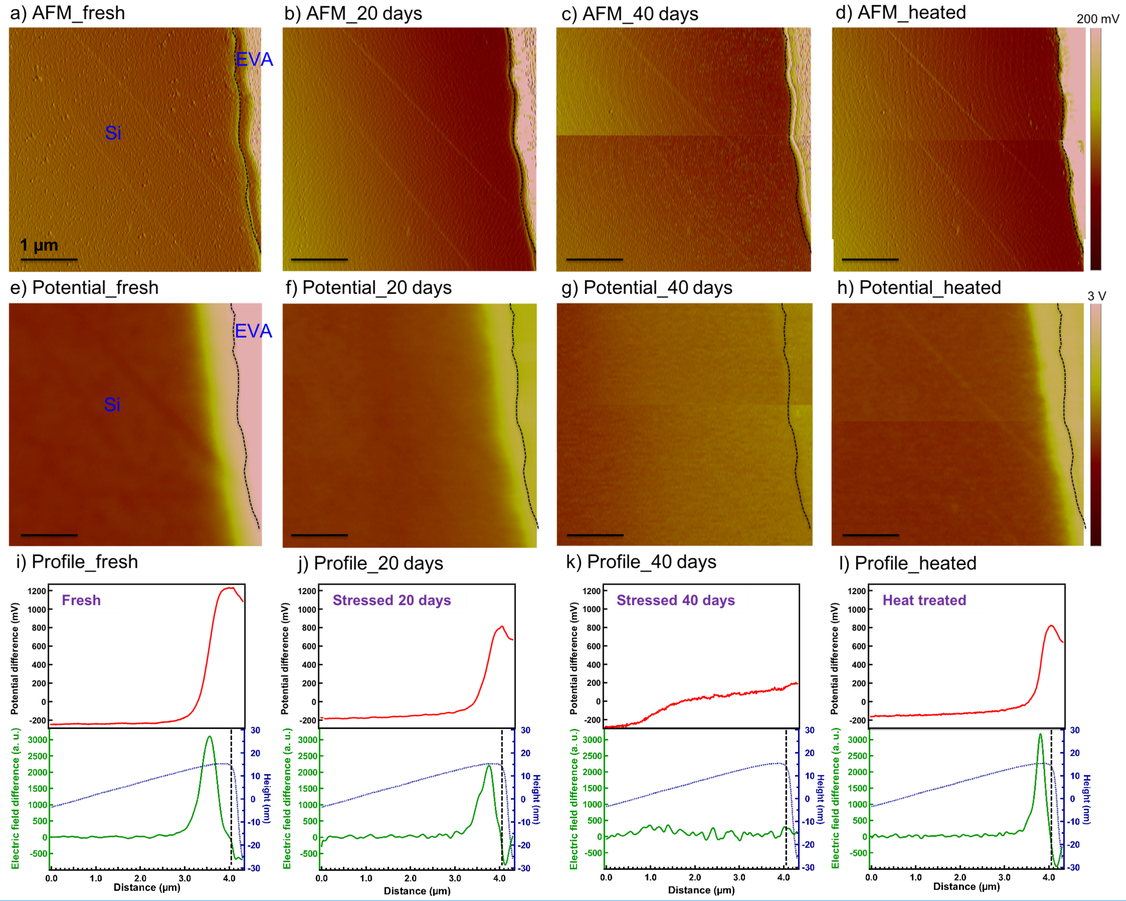
- **A new potential-induced degradation** (PID) mechanism for c–Si is reported. Multiple characterization techniques in various aspects of a material's chemical, structural, electrical, and optoelectrical nature, as well as in atomic, nanometer, micrometer, millimeter, and cell and module scales, are combined. All results point consistently to a new discovery: substantial large-area deterioration of materials and junctions plays a major role.
- Combined **multiple characterization techniques**—Kelvin probe force microscopy (KPFM), electron-beam induced current (EBIC), dark lock-in thermography (DLIT), transmission electron microscopy, time-of-flight secondary-ion mass spectrometry (TOF SIMS), and microwave photoconductance decay (μ-PCD)—as well as density functional theory calculations.
- DOI: 10.1002/solr.201800303. Selected to be featured on the **front cover** of **Solar RRL**. (Copyright @ 2019 John Wiley & Sons, Ltd.)



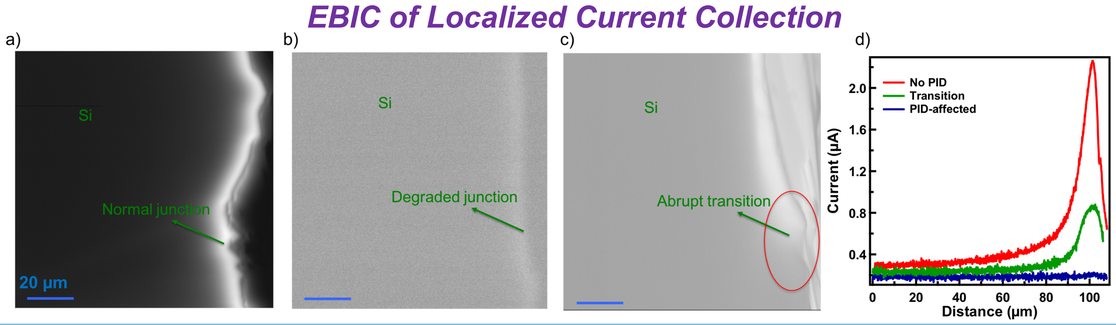


Rapid transitions associate with large areas of junction damage and suggest an actual material and junction degradation, rather than the well-reported local shunting induced by Na-decorated planar defects that penetrate p-n junction.

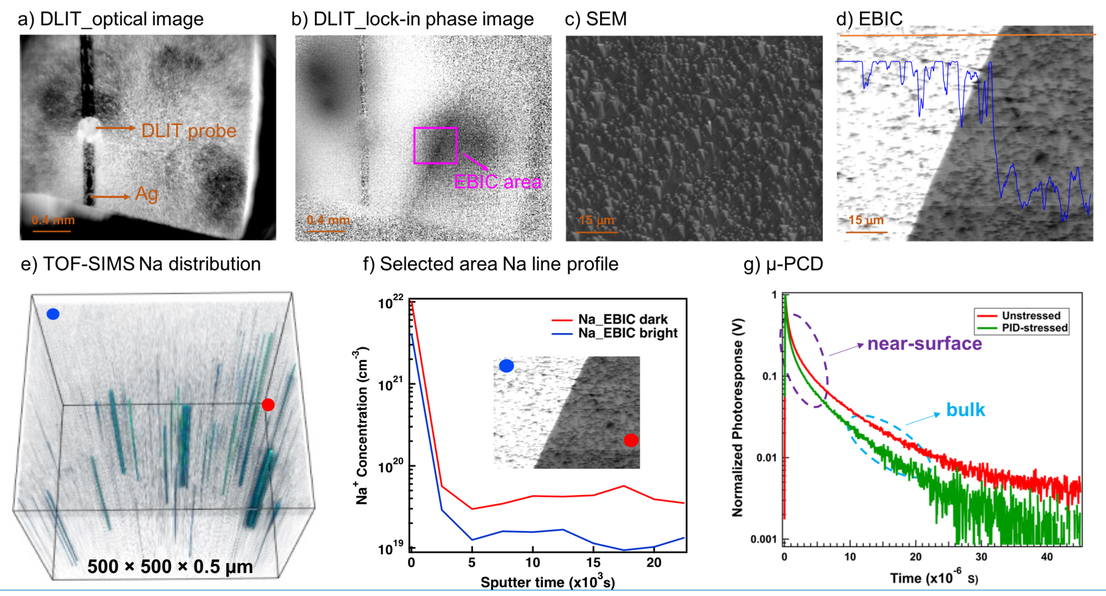
In-situ KPFM during long-term PID stressing



EBIC of Localized Current Collection



Chemical and Electrical Imaging



Summary

- *We proposed a new PID mechanism in conventional silicon modules that is essentially different from and complementary to the current knowledge that PID shunts are localized in small and separate spots.*
- *PID occurs not only at Na-decorated planar defects, but can also occur in large areas and can cause material and junction degradation.*
- *A large amount of Na can cause harmful point defects in silicon solar cells.*

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