

Multiscale Characterization of Advanced Metallization for Microcrack Reduction

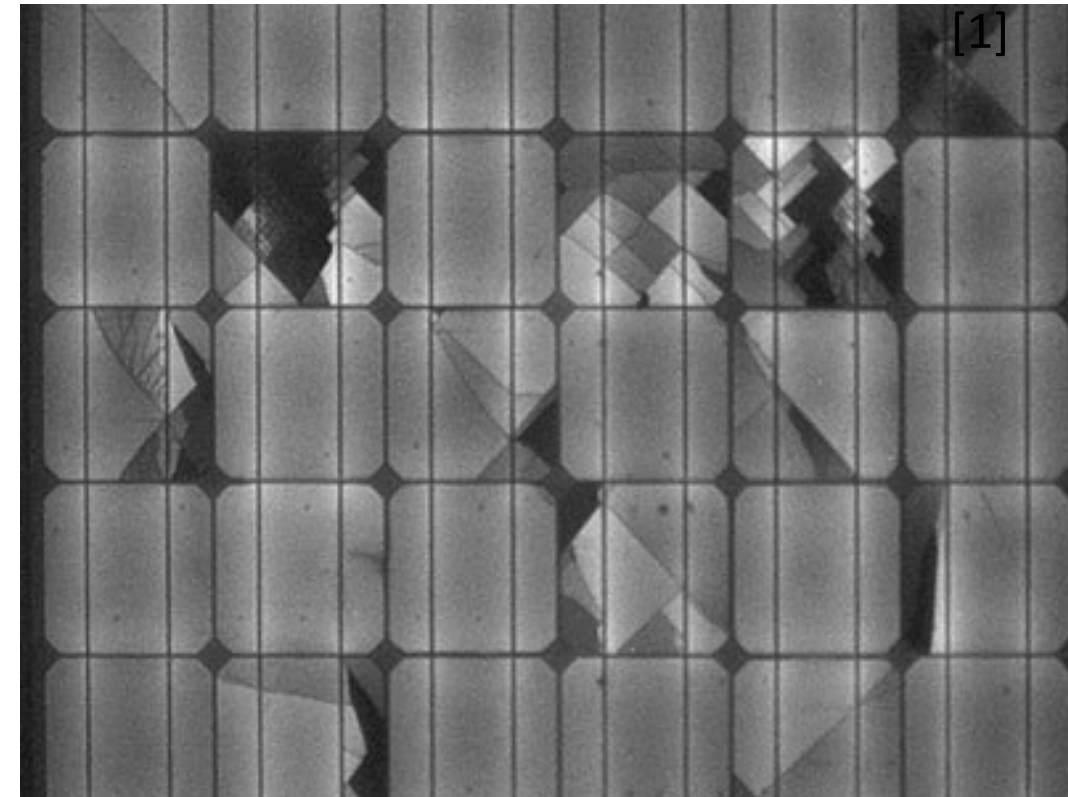
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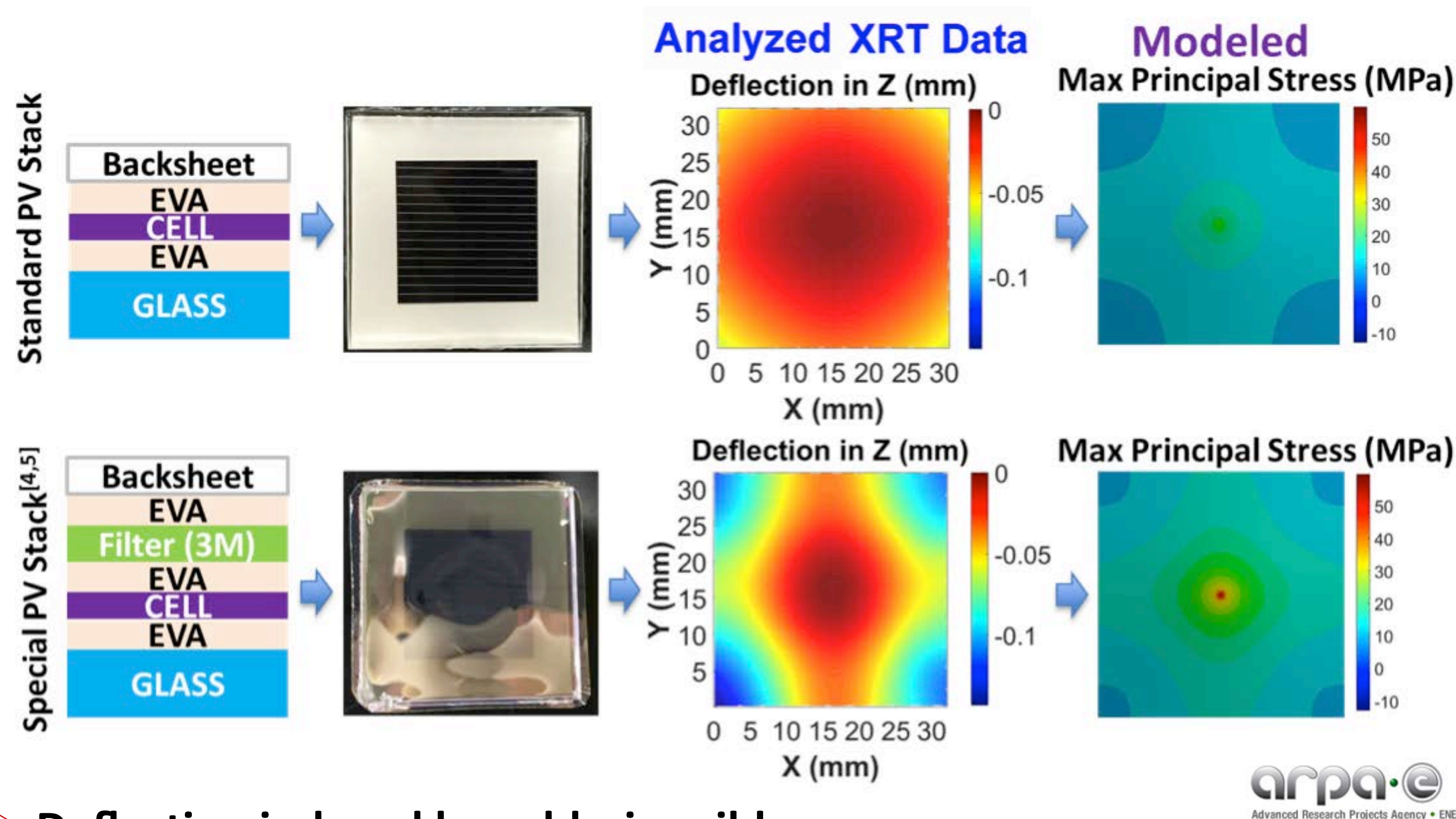
Introduction

- Cracking and micro defects are a significant cause of power losses and reduction in LCOE
- Applied stresses from soldering and lamination process promote the formation of microcracks
- Operating conditions → crack propagation
- Most cracks are evident when cracks are of considerable size and/or affect performance
- Need to correlate Materials and processes → Microcracks formation → Performance through time

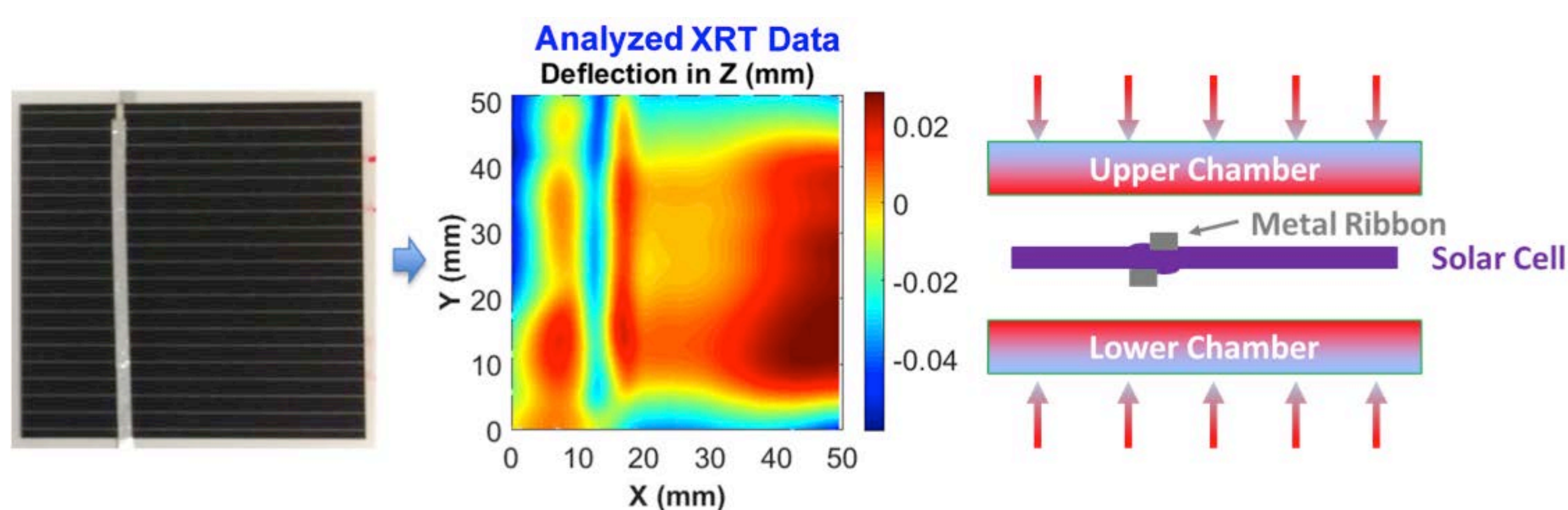


Deformation and Stress Quantification

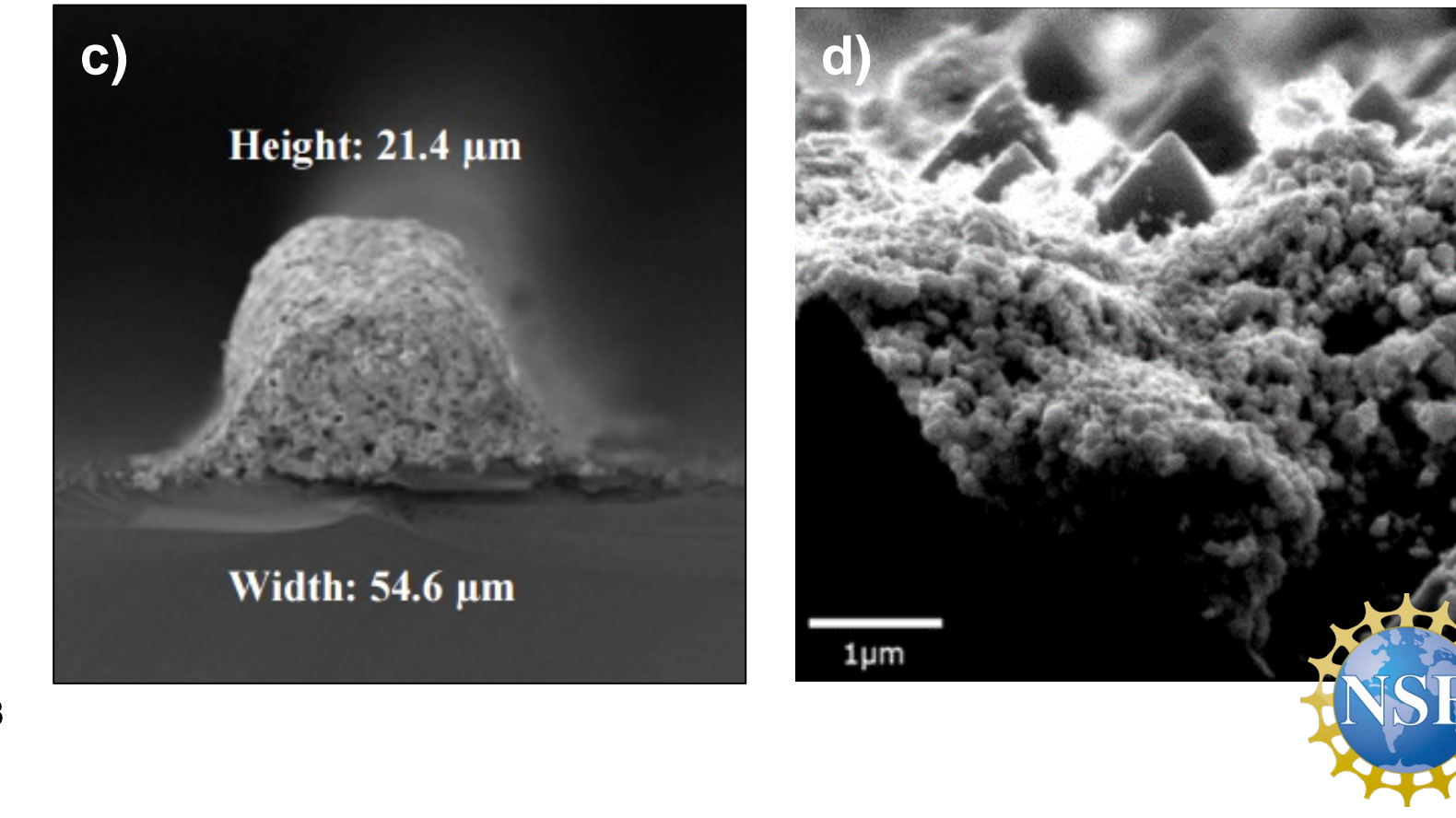
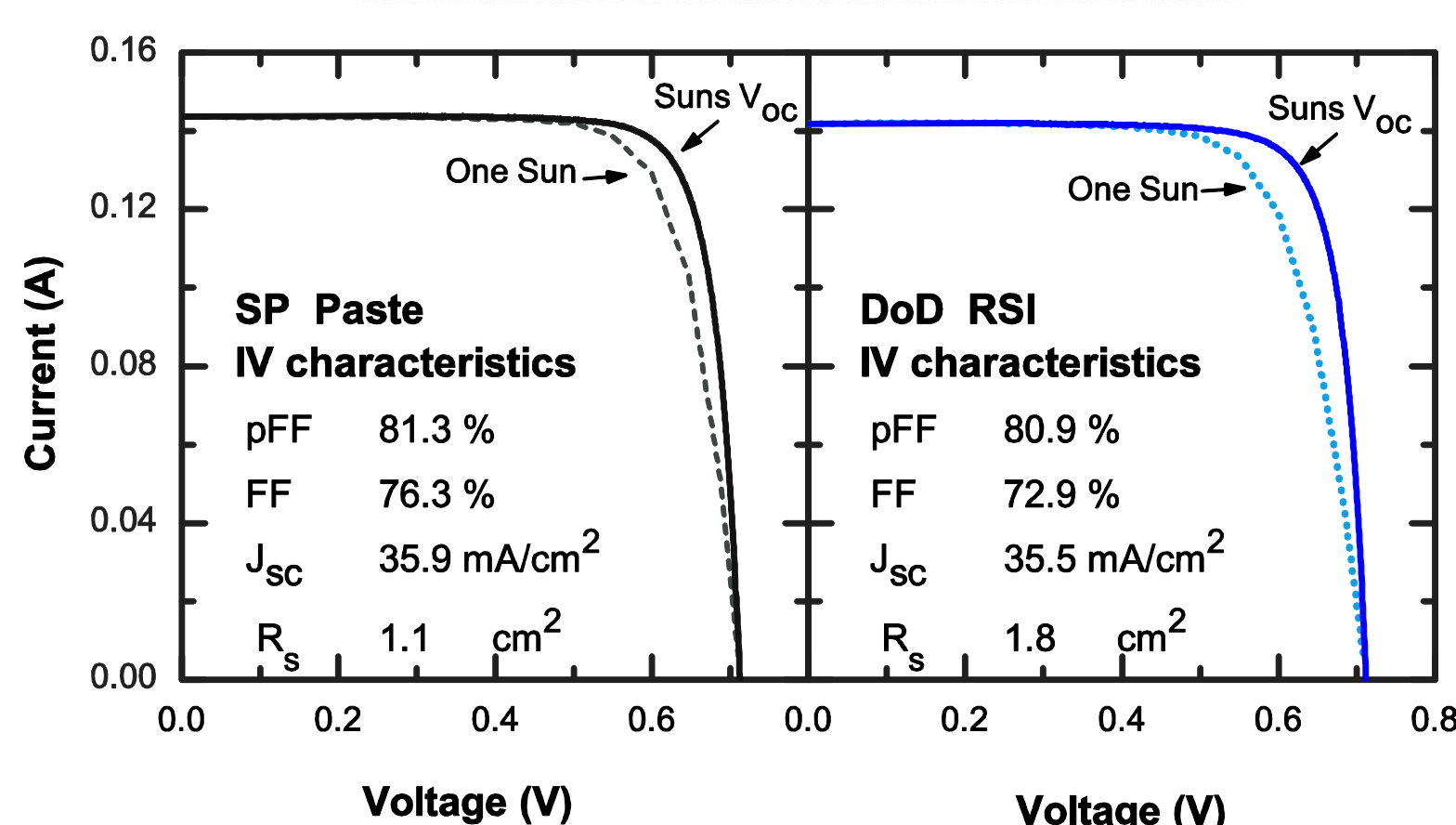
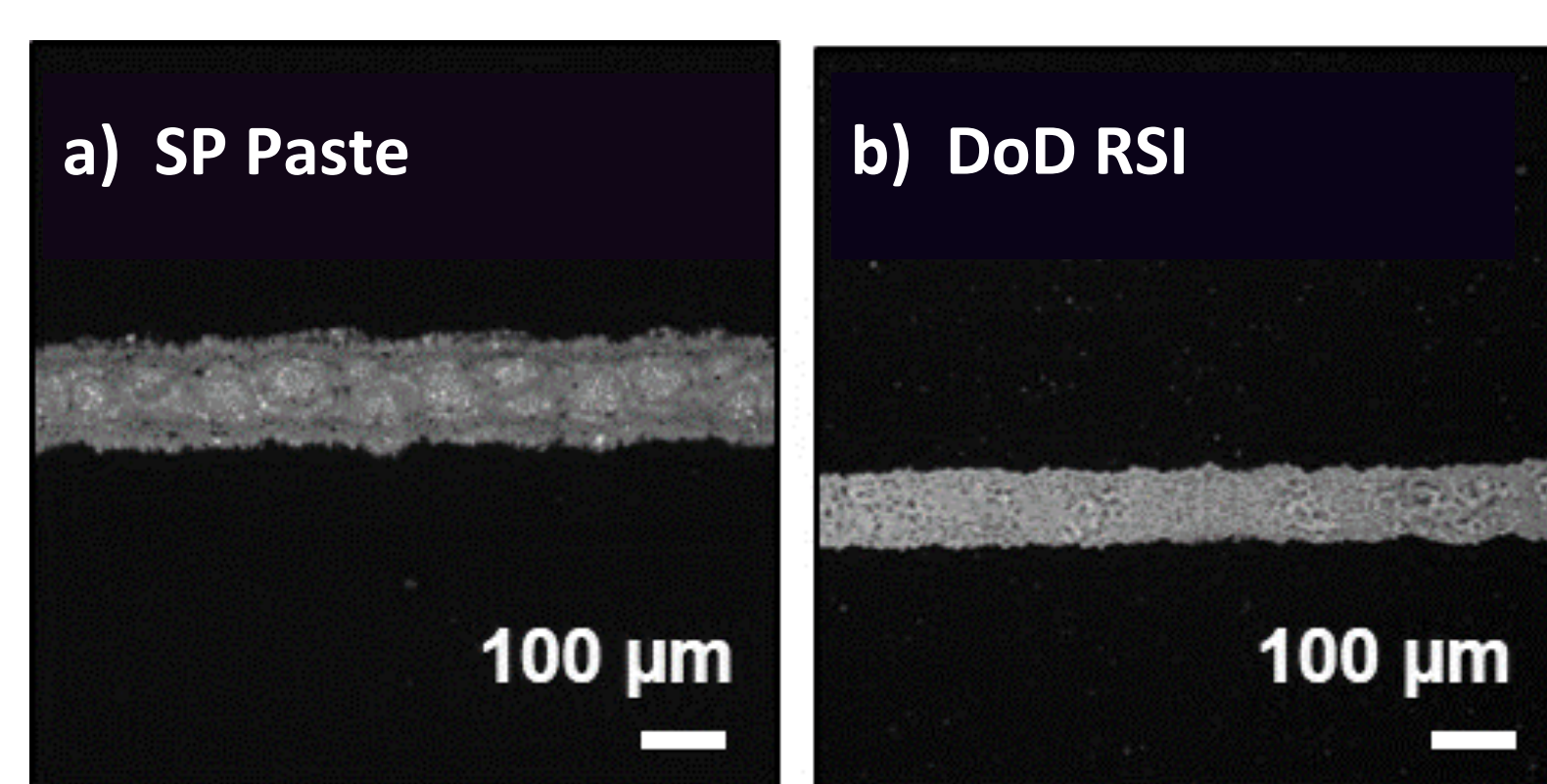
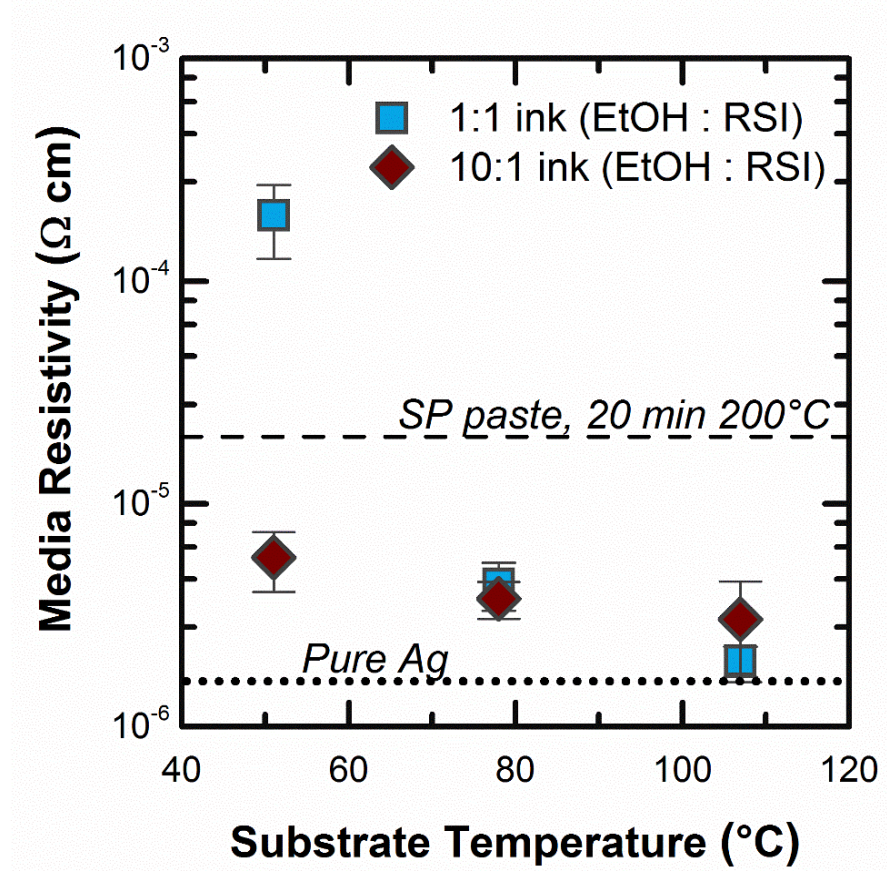
- Deflection comparison of different lamination stacks



- Deflection induced by soldering ribbons



Novel Metallization

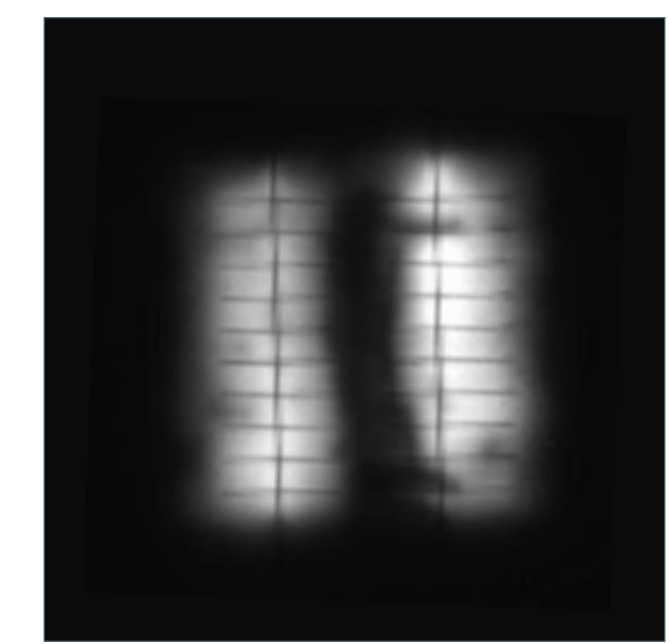
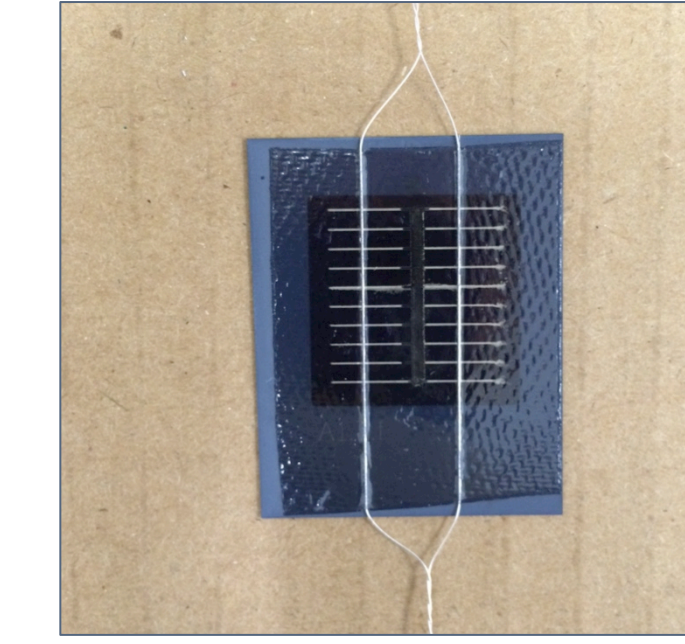
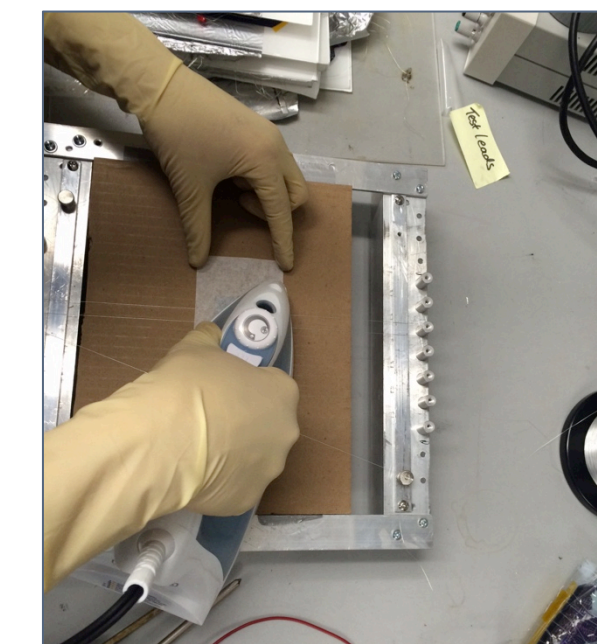


Tabbing and Encapsulation Testbed

- Dichroic Films and Encapsulants

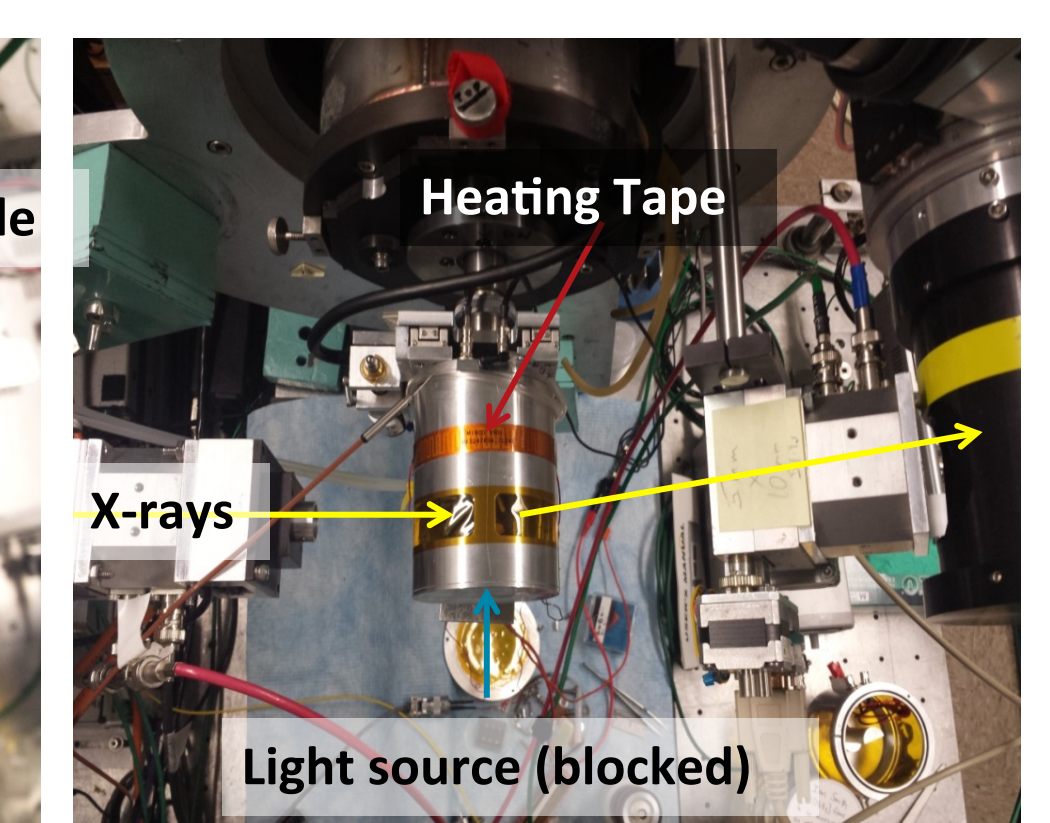
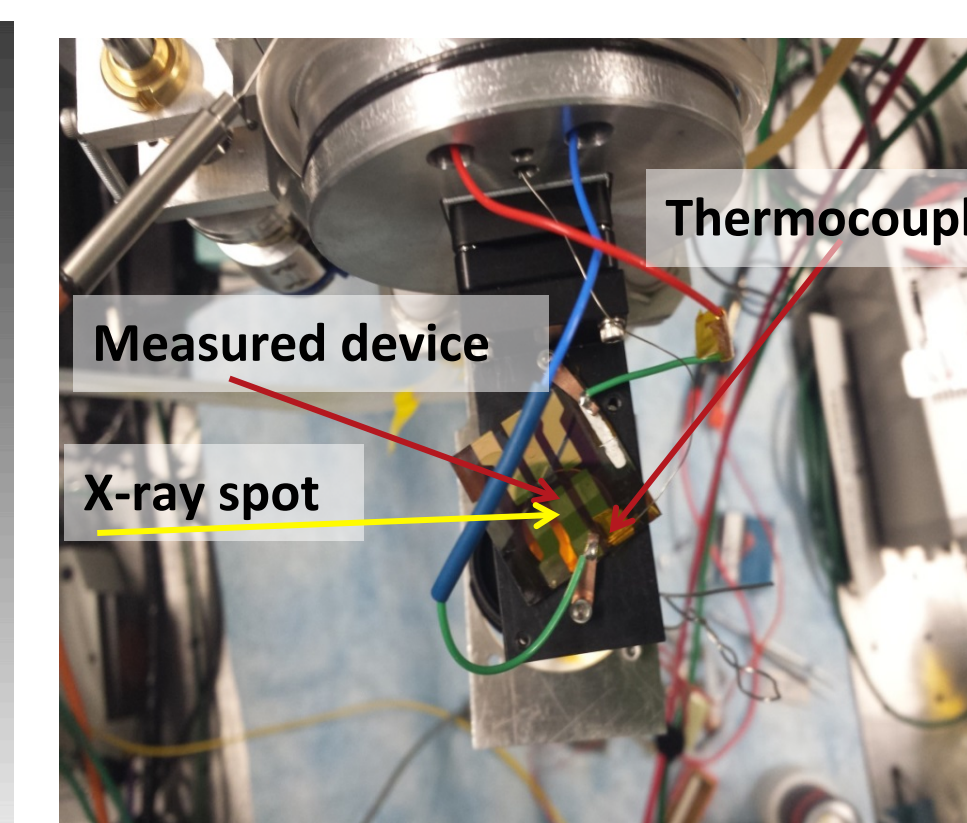
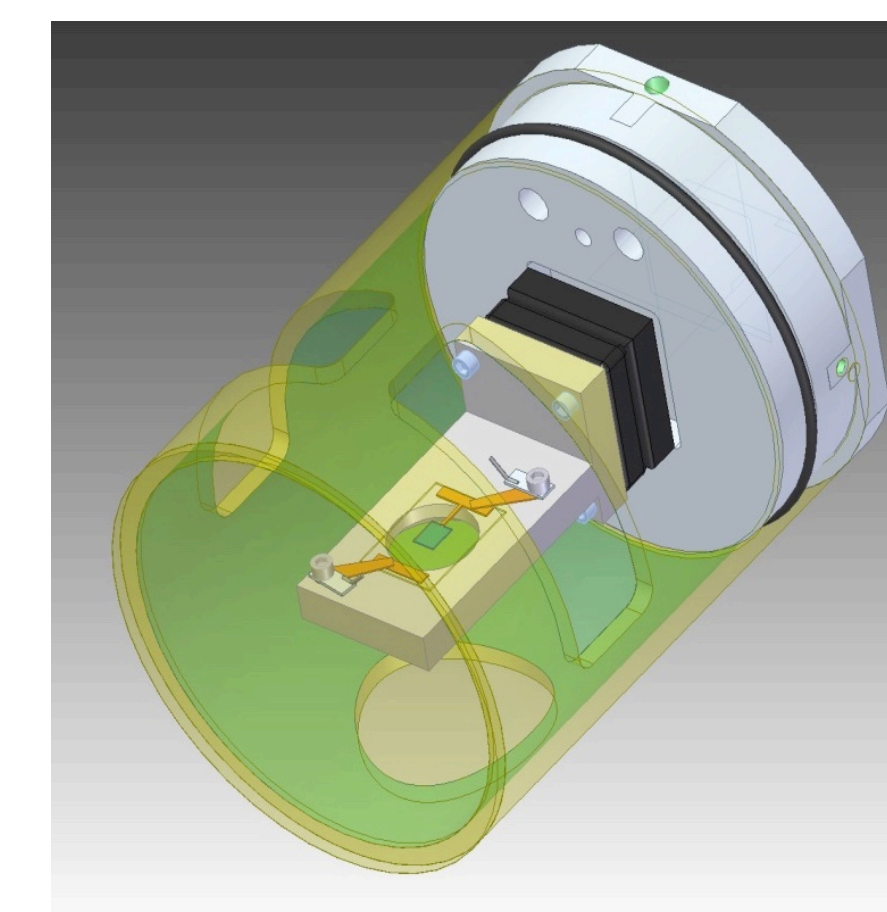


- Smart wire and soldering



Operando Studies

- Coupled structural and device performance studies in
- Developments extended to degradation studies

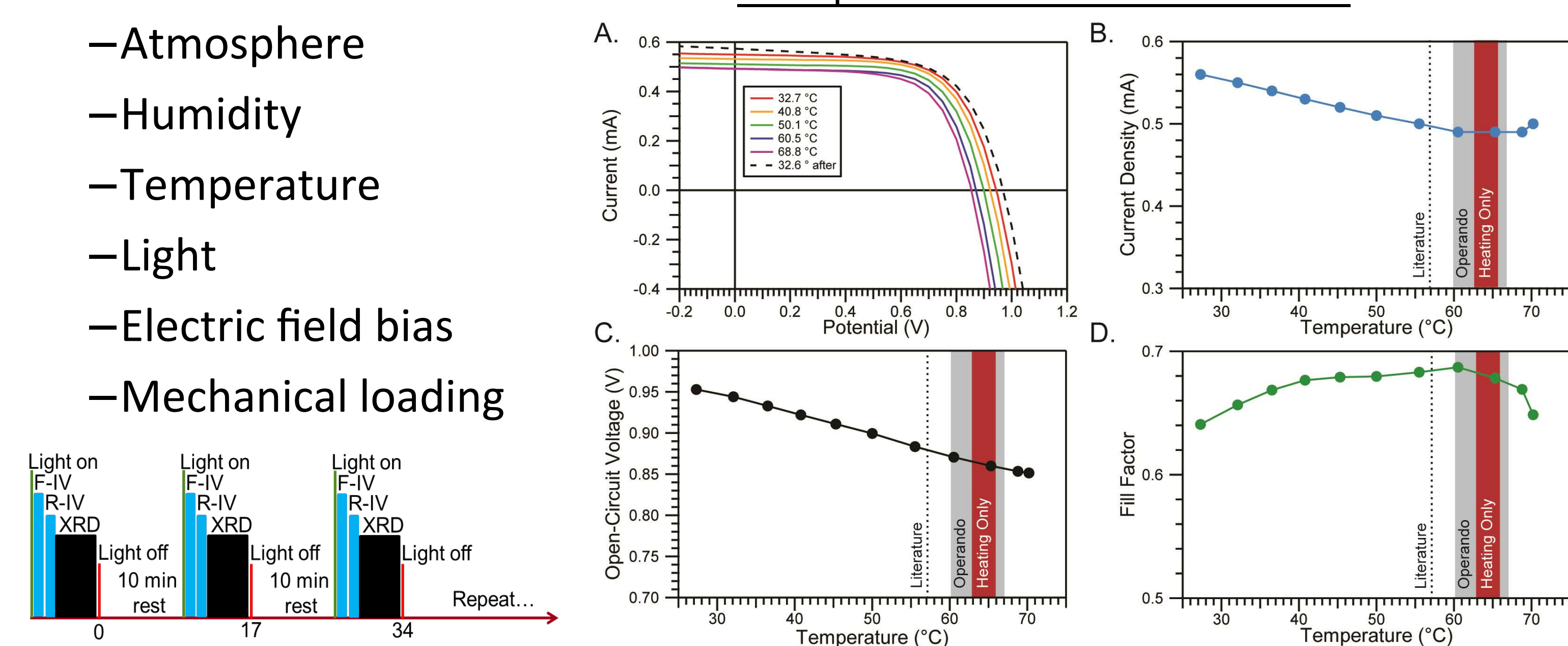


Operando chamber:

- White LED light (~ 1 Sun)
- Kapton heating tape
- Thermocouple on top of device
- He environment
- IV curves with light
- 1D and 2D XRD at temperature

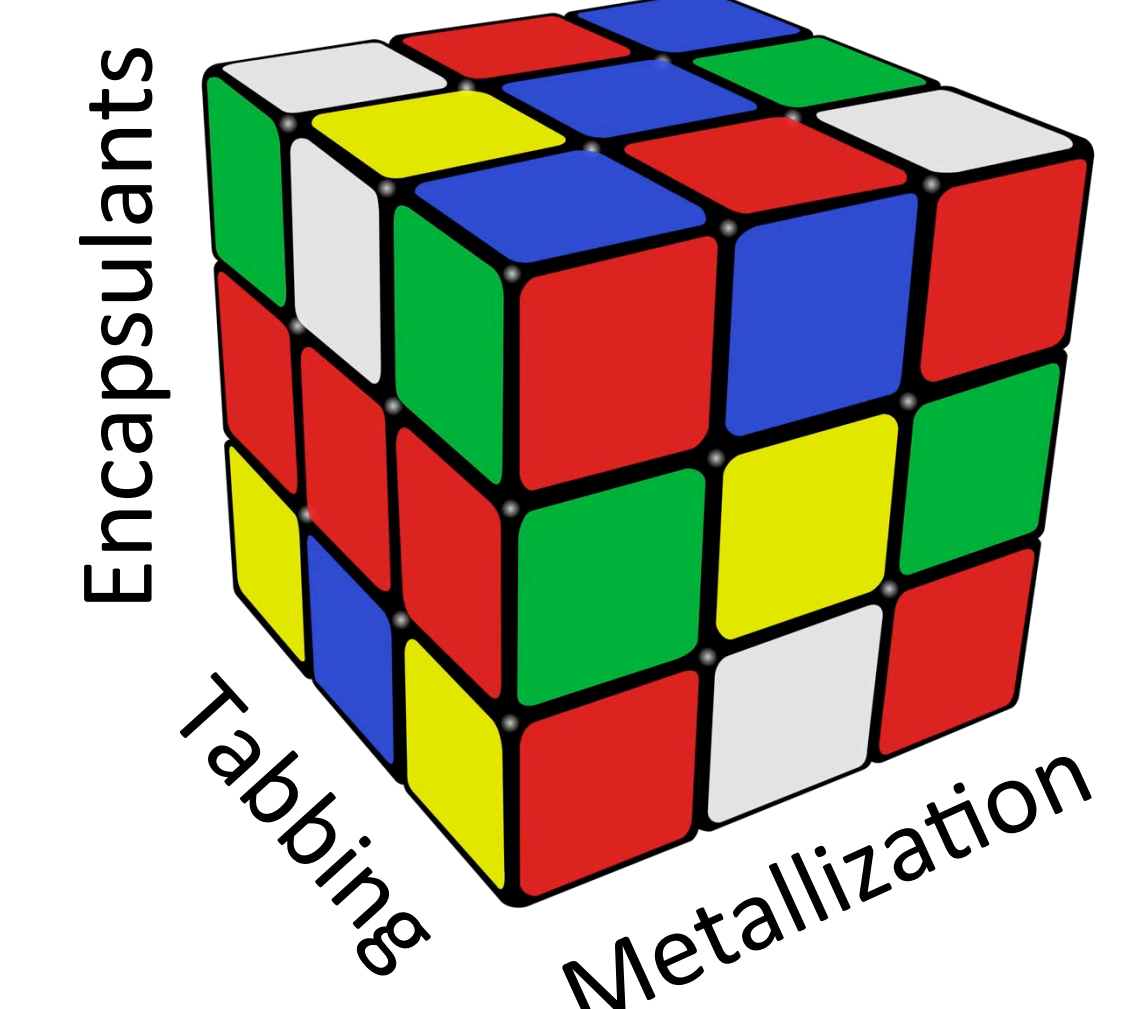
- Understand the effects of aging & thermal cycling
 - New and existing module materials (e.g. encapsulants)
- Operando Structural & Microstructural analysis
- Applied stressors
 - Atmosphere
 - Humidity
 - Temperature
 - Light
 - Electric field bias
 - Mechanical loading

Examples from Perovskites Studies



Proposed Work

- Test
 - Stress
 - Microstructure
 - Performance
 - Cracking
- Applied Stressors
 - Ambient
 - Temperature
 - Illumination
 - Mechanical loading
 - Bias
- Variables



Test before and after stressors