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Low Cost and Durable Perovskite Solar Cells

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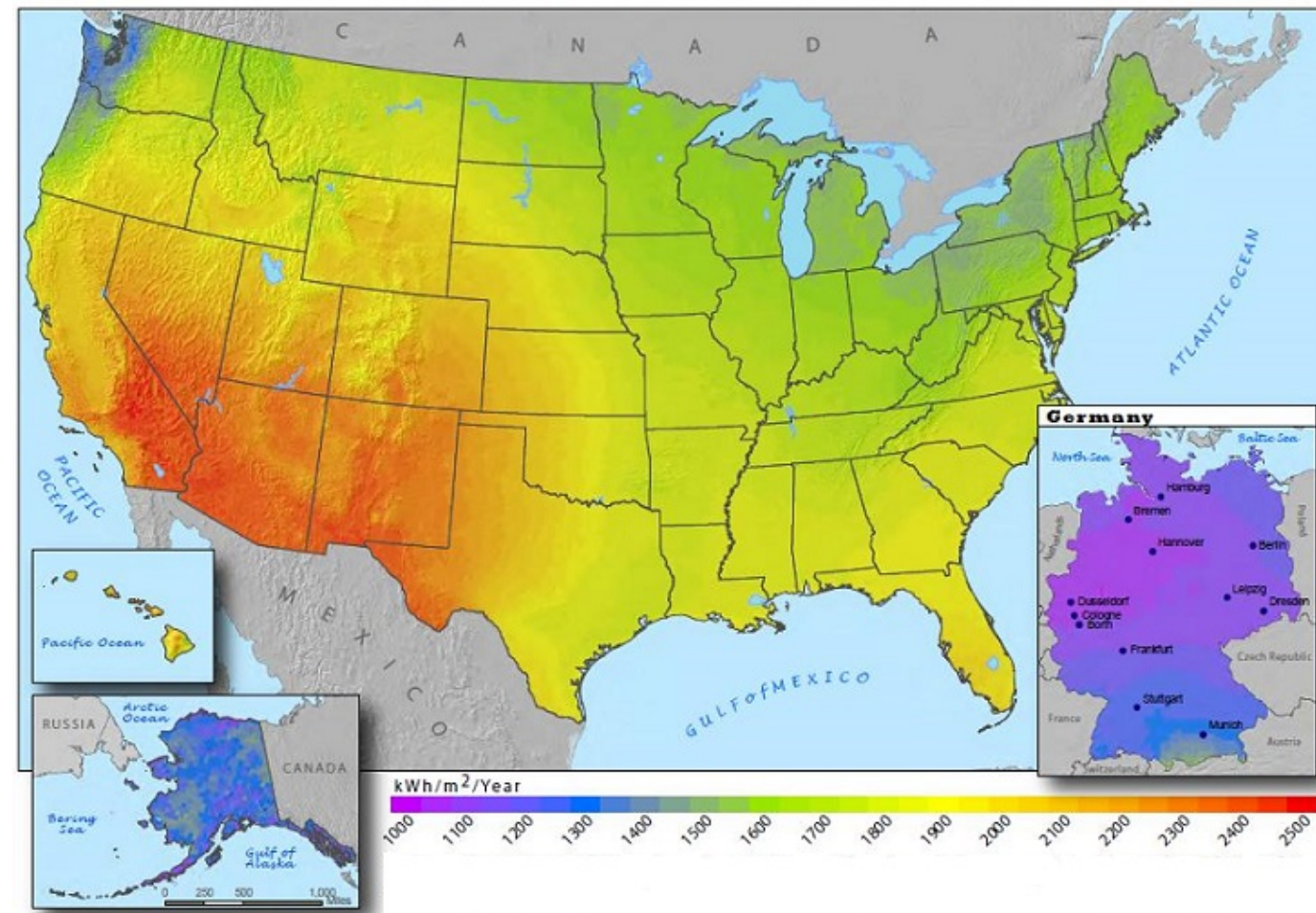


Low Cost and Durable Perovskite Solar Cells

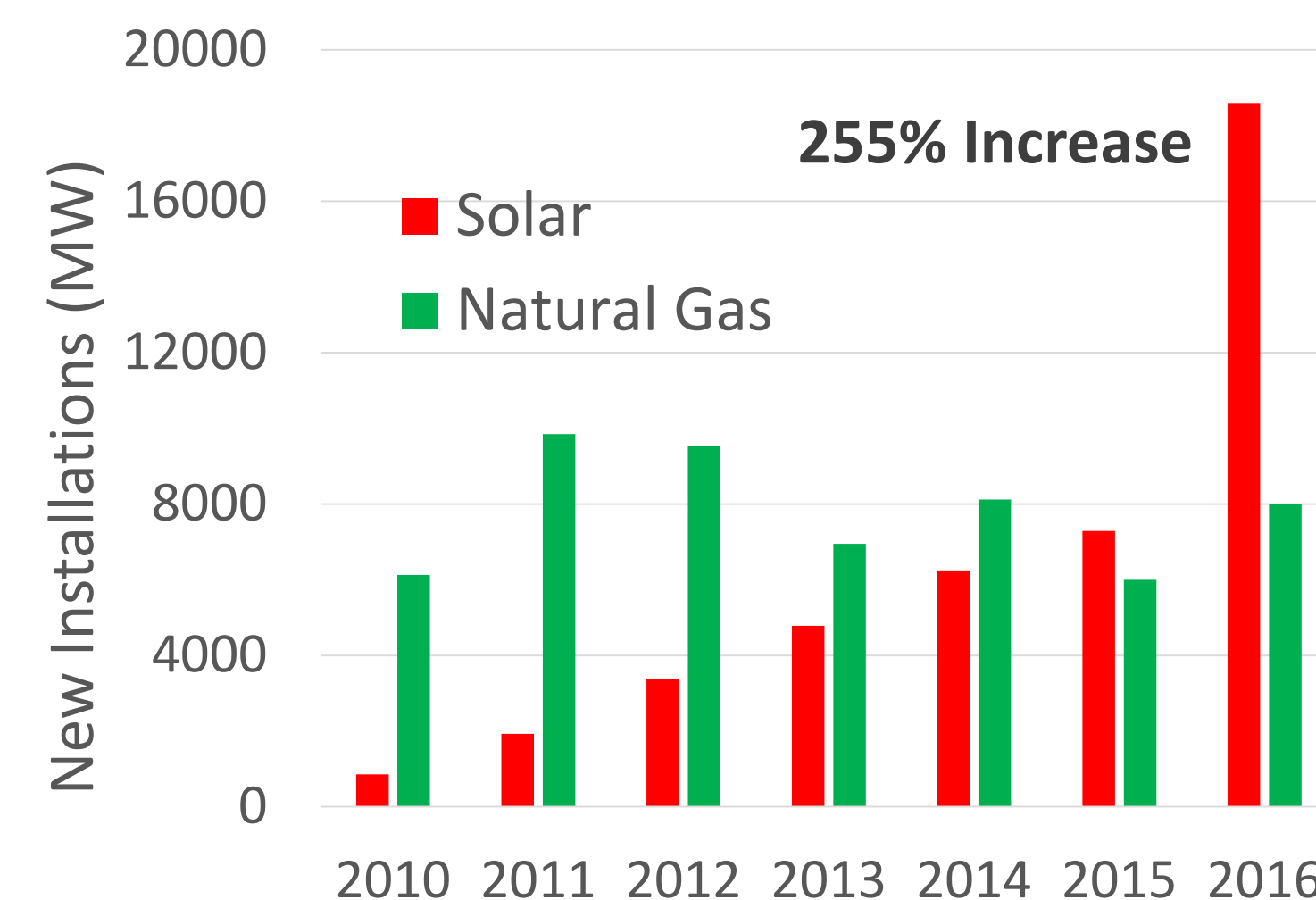
ECE 402 | **Team Members:** Jack Carli, Kapil Marahatta, Feras Kakish, Jason McAleese | **Faculty Advisers:** Dr. Ümit Özgür and Dr. Vitaliy Avrutin
Sponsor: Night Vision and Electronic Sensors Directorate | **Sponsor Advisers:** Dr. Randy Jacobs and Andre Slonopas

Solar Energy Potential

- Solar electrical generation: U.S 0.6% vs Germany 7.0%
- U.S. Consumes 4 trillion $kW \cdot hr/yr$
- VA potential- 1600 $kW \cdot hr / (m^2 \cdot yr)$
- Germany potential- 1050 $kW \cdot hr / (m^2 \cdot yr)$

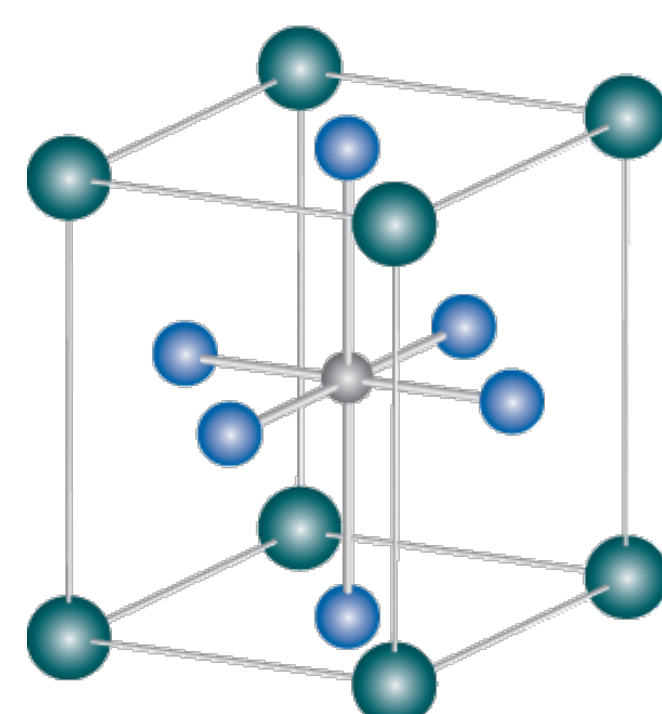
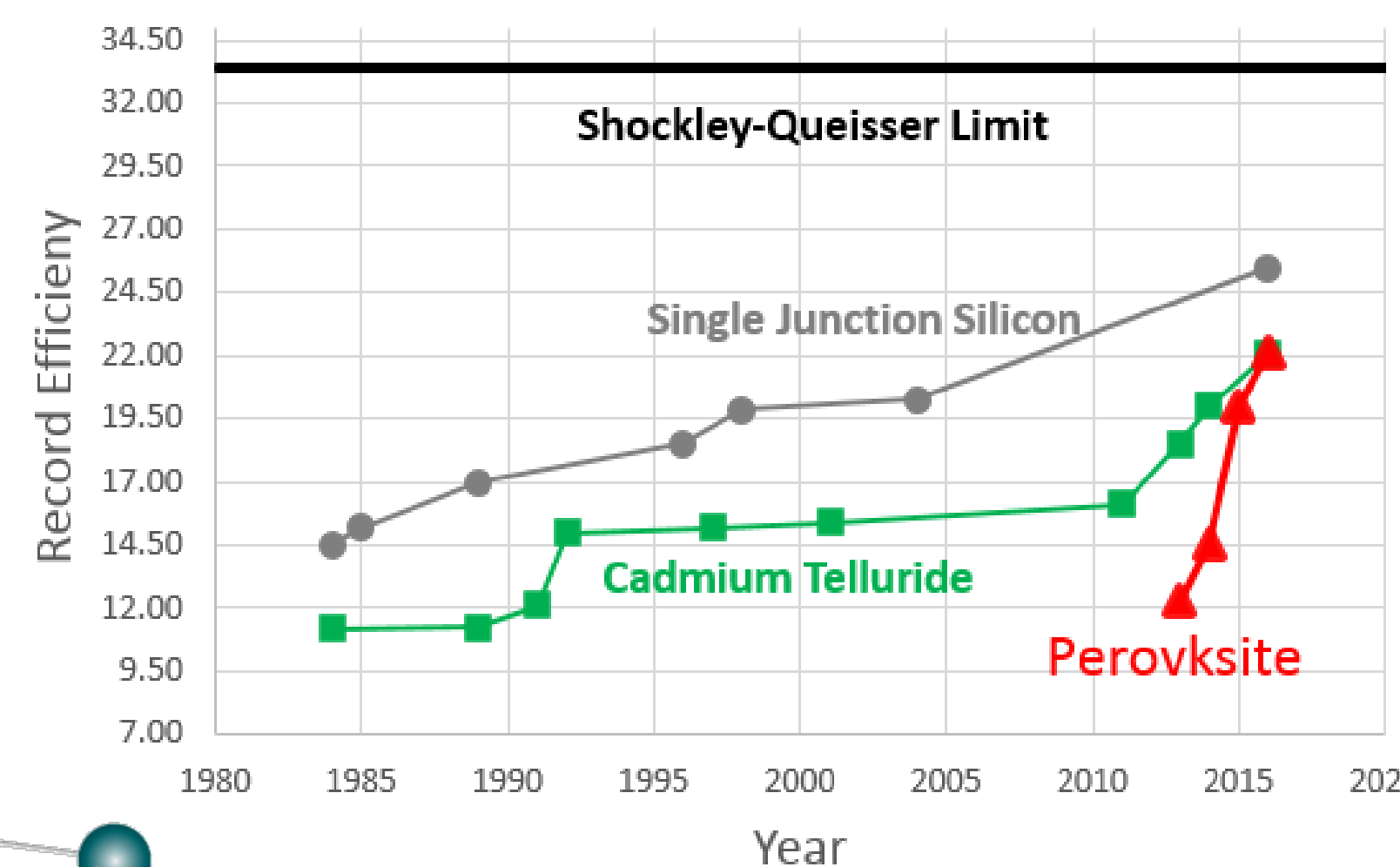


Solar Installations in US



Why Perovskite Solar Cells

- Rapid increase in efficiency
- Low production cost
- Simple & scalable fabrication
- Light weight & flexible substrates

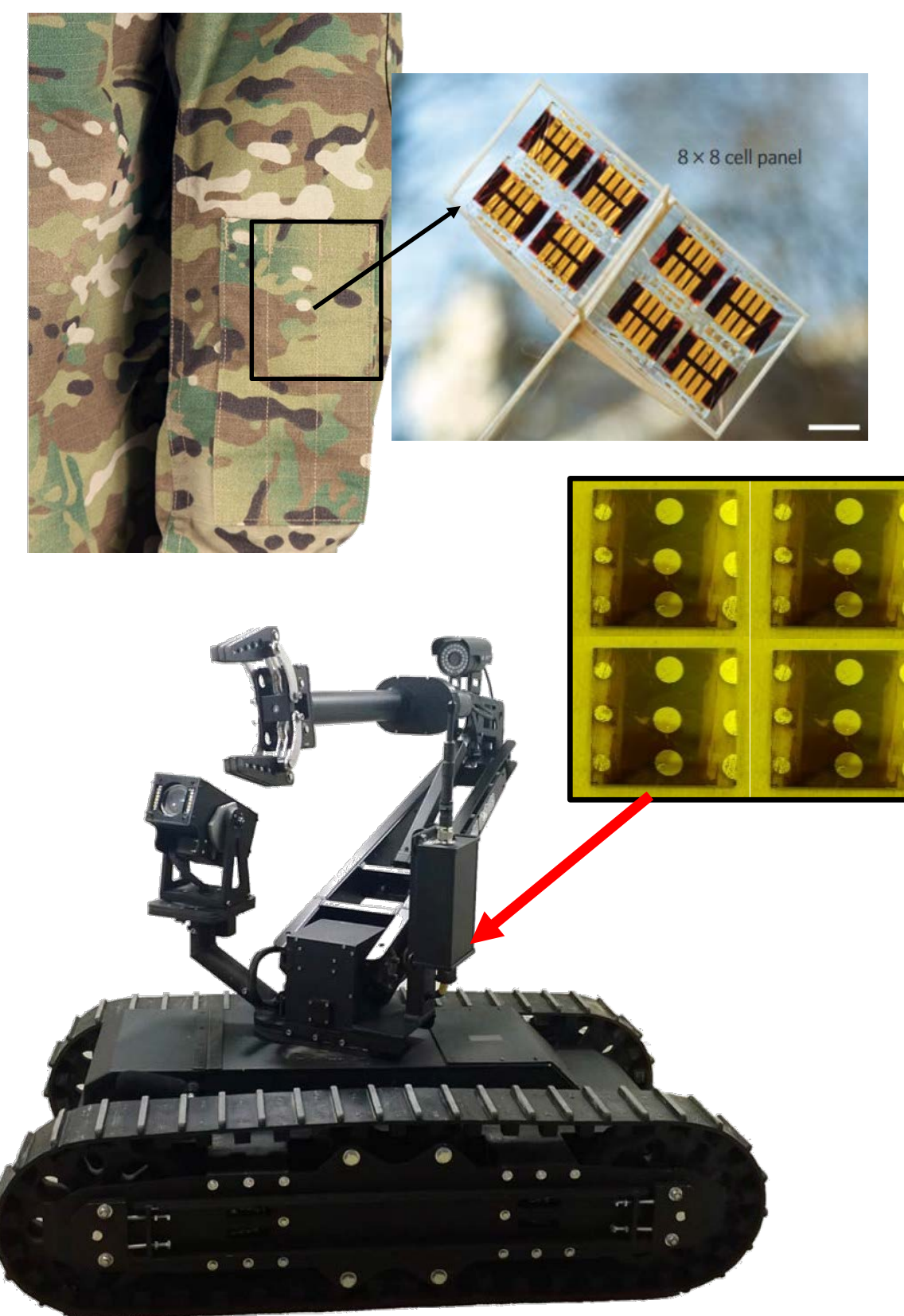


- Methylammonium ion
- Halogen ion
- Lead ion

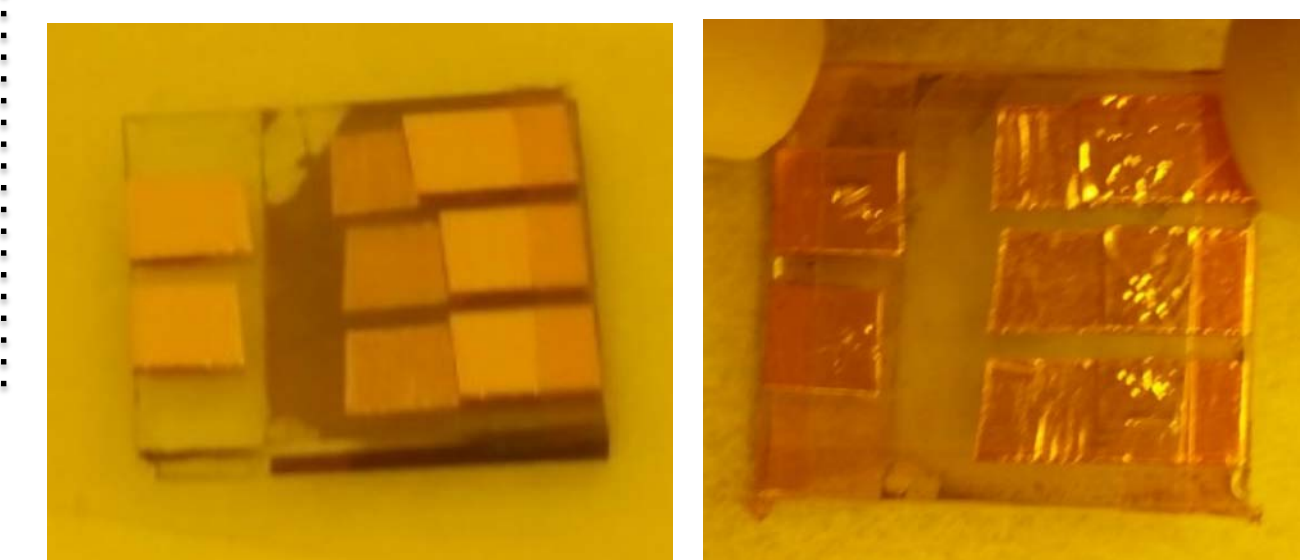
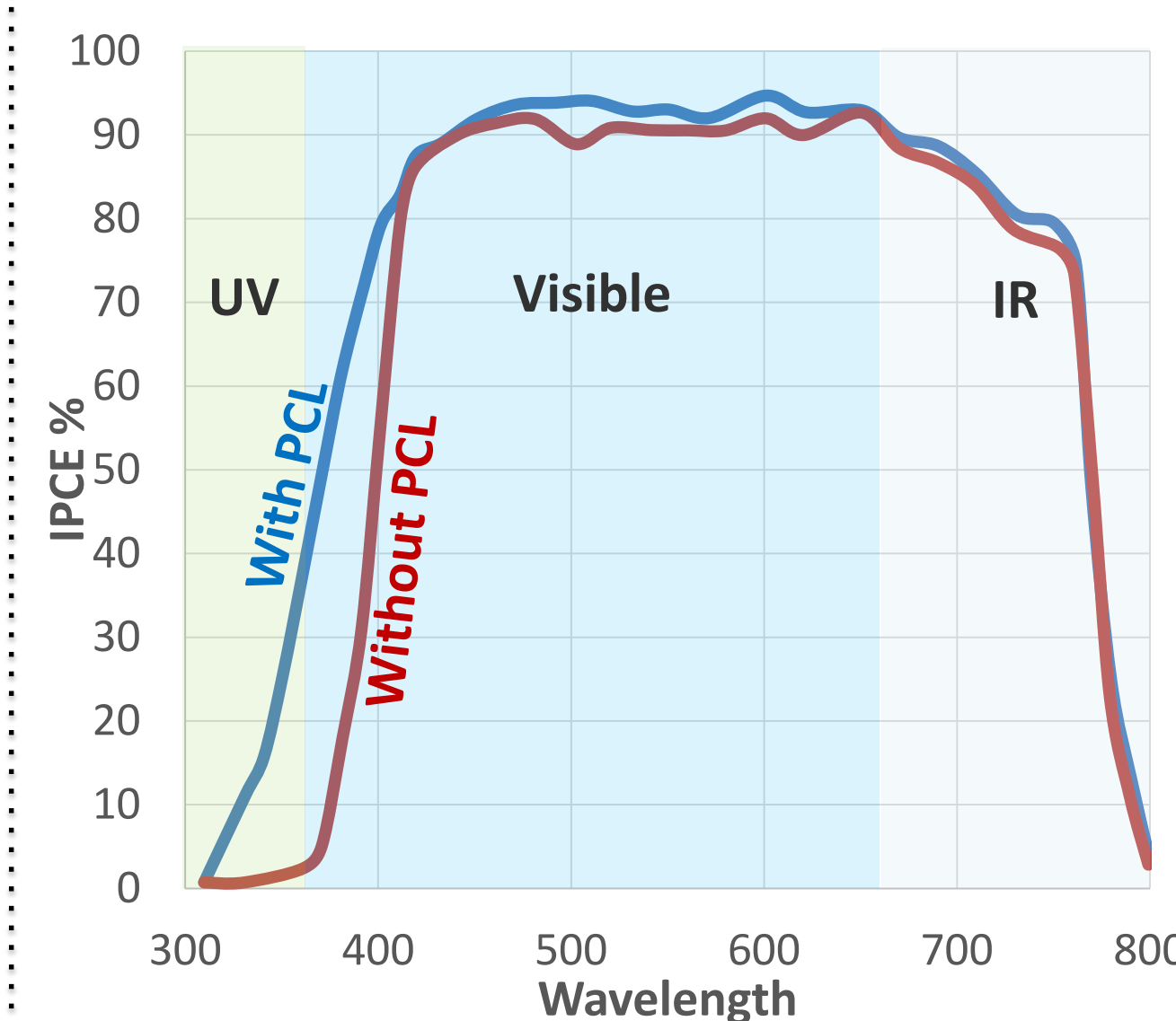
Potential Military Application



- Small Recon UAV for covert missions
- Providing power to sensors that help protect the warfighter
- Powering motor and sensors for land or sea autonomous vehicles



Design Considerations



Before Humidity Exposure

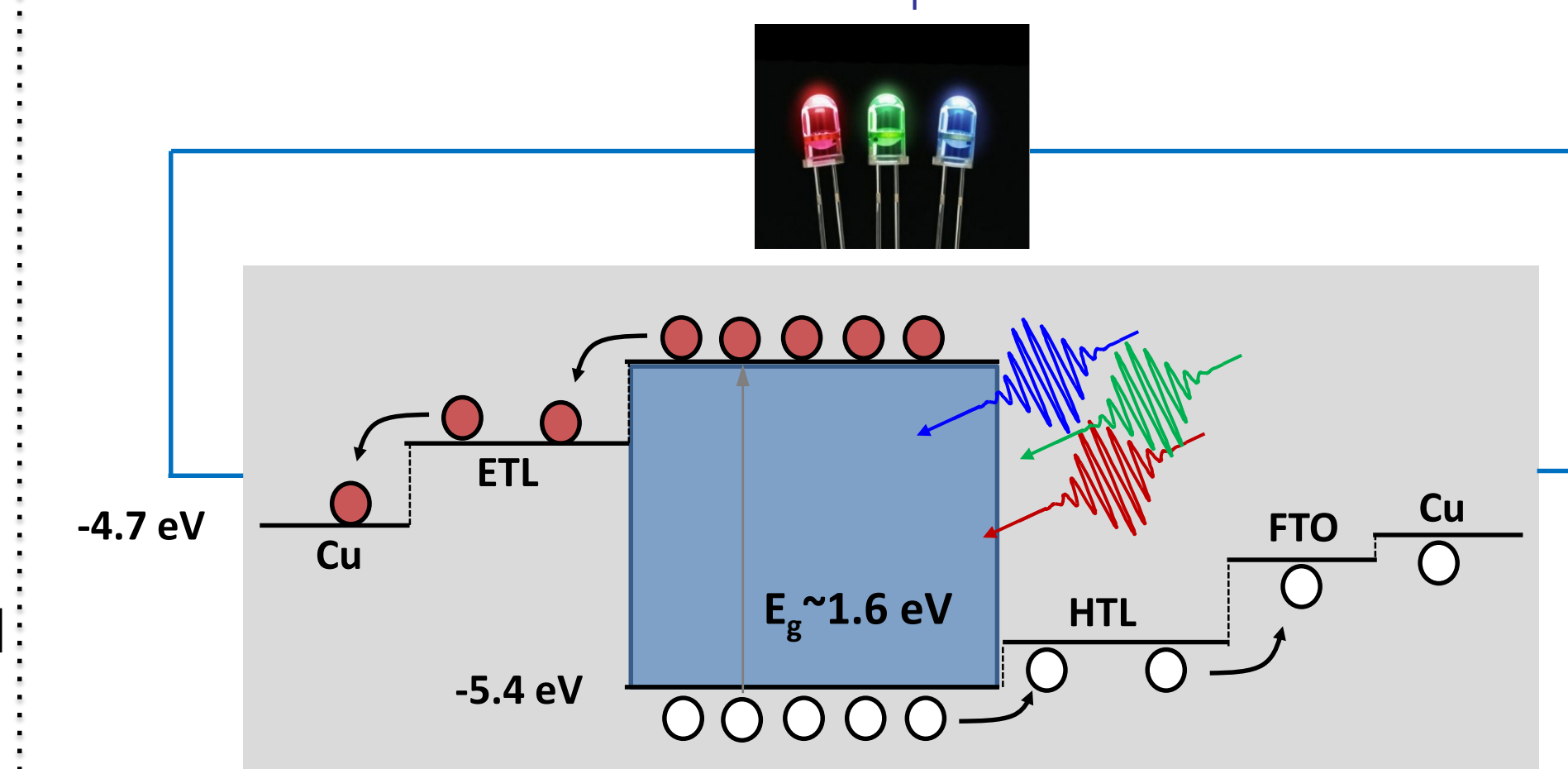
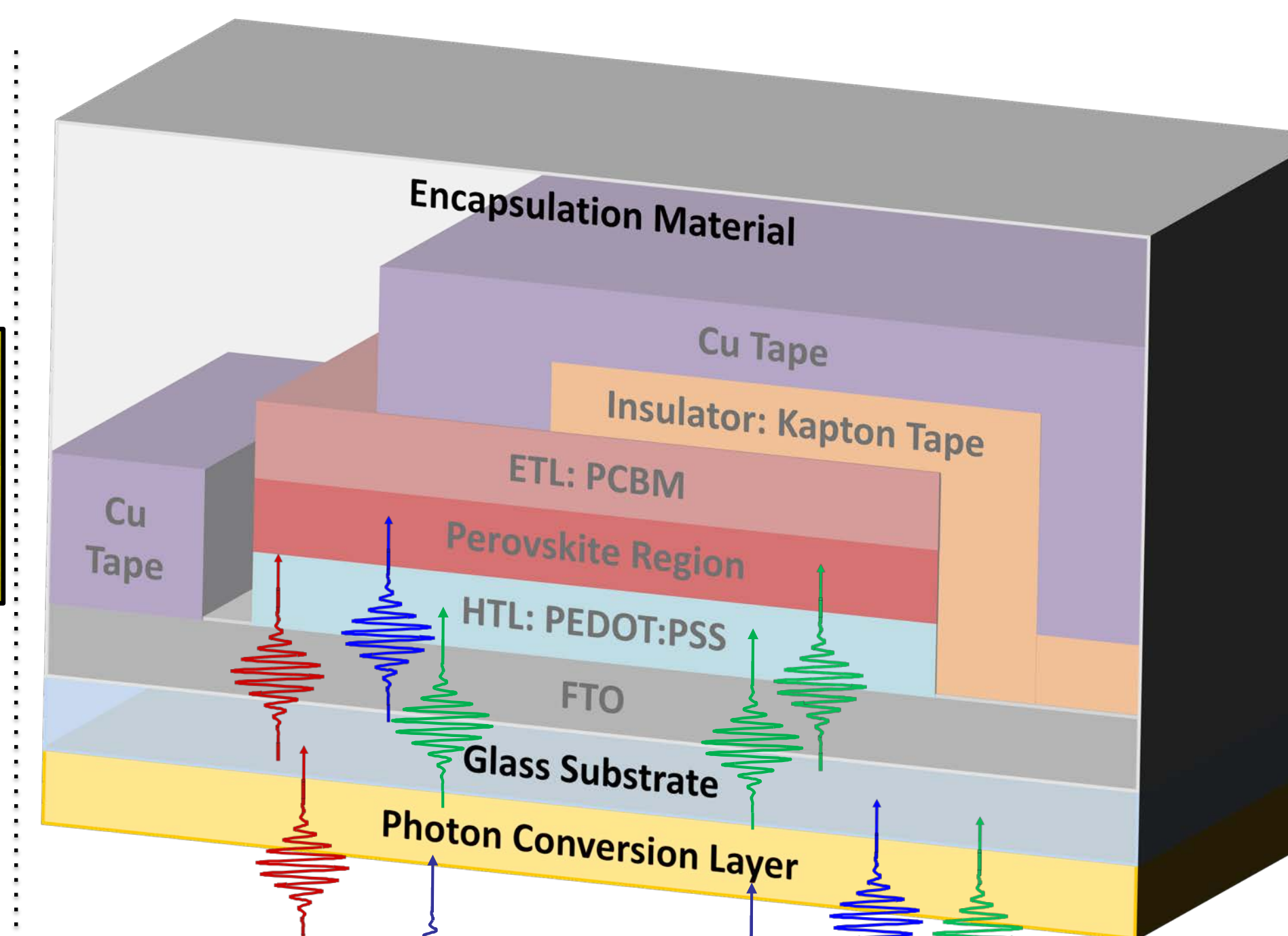
After Humidity Exposure

- Methylammonium Lead Iodide - $CH_3NH_3PbI_3$
- Major problem: rapid degradation under moisture and UV irradiation
- Degradation caused by organic components

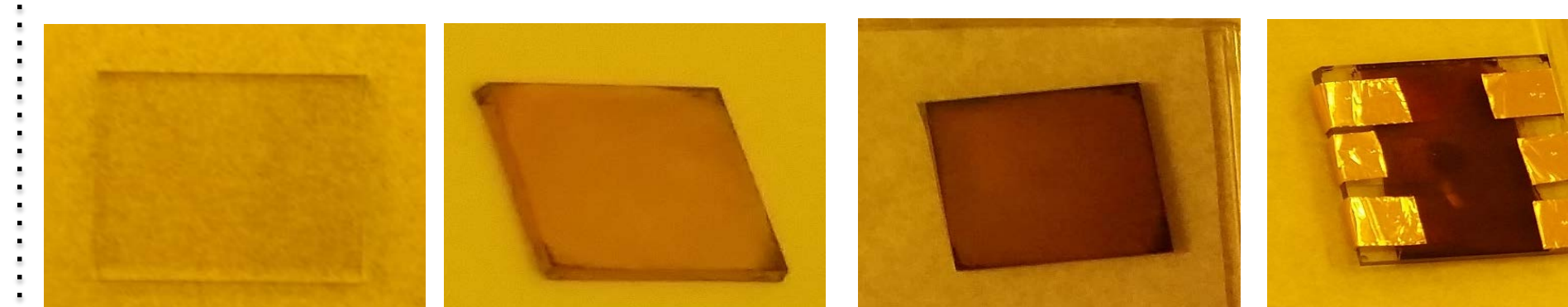
Proposed Solution

- Photon conversion layer (PCL):
 - Efficiency increased by harvesting UV light
- Provides encapsulation from humidity

Device Schematic & Band Structure



Fabrication Procedure



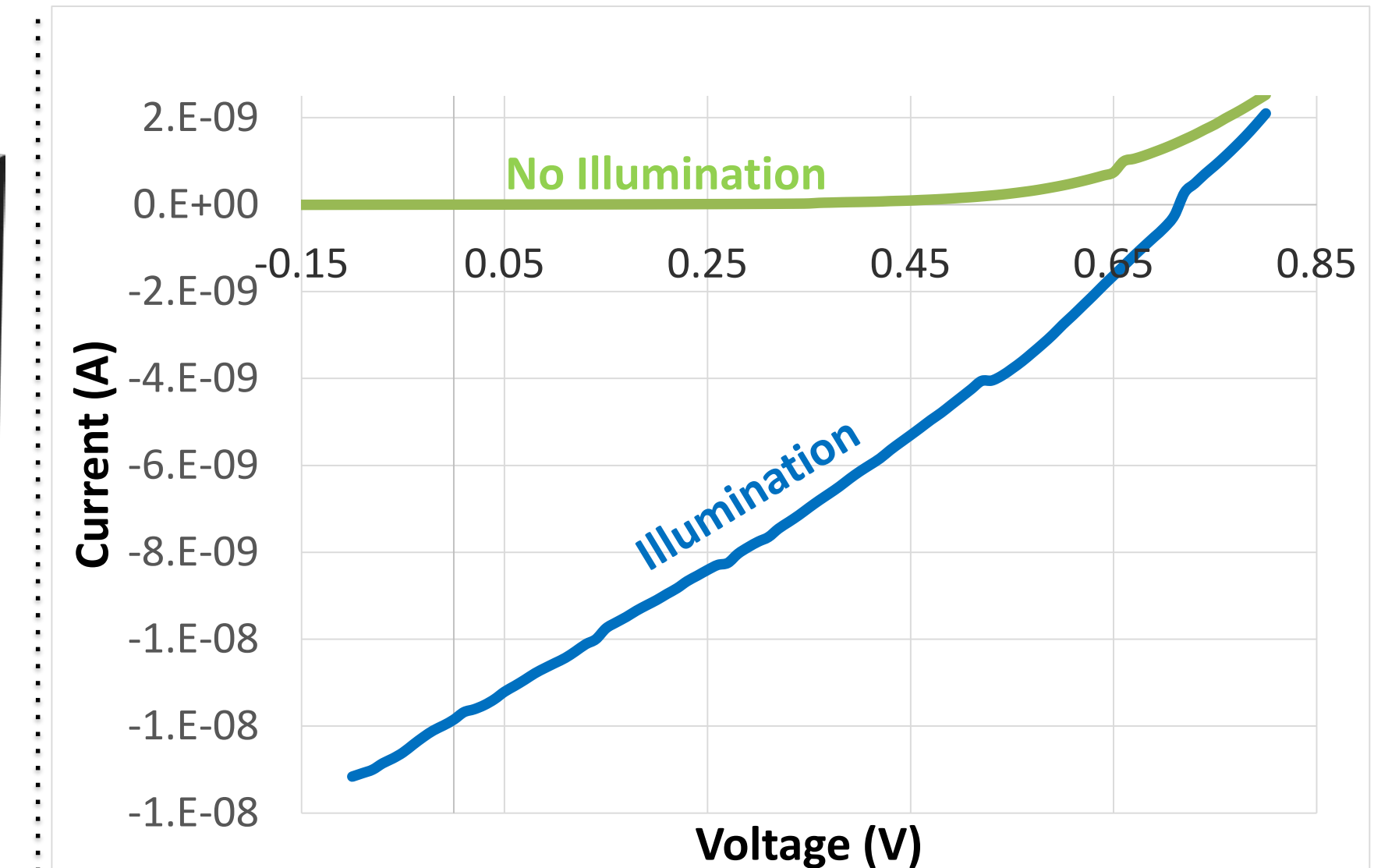
Deposition of PEDOT:PSS

Deposition of Perovskite

Deposition of PCBM

Applying contacts

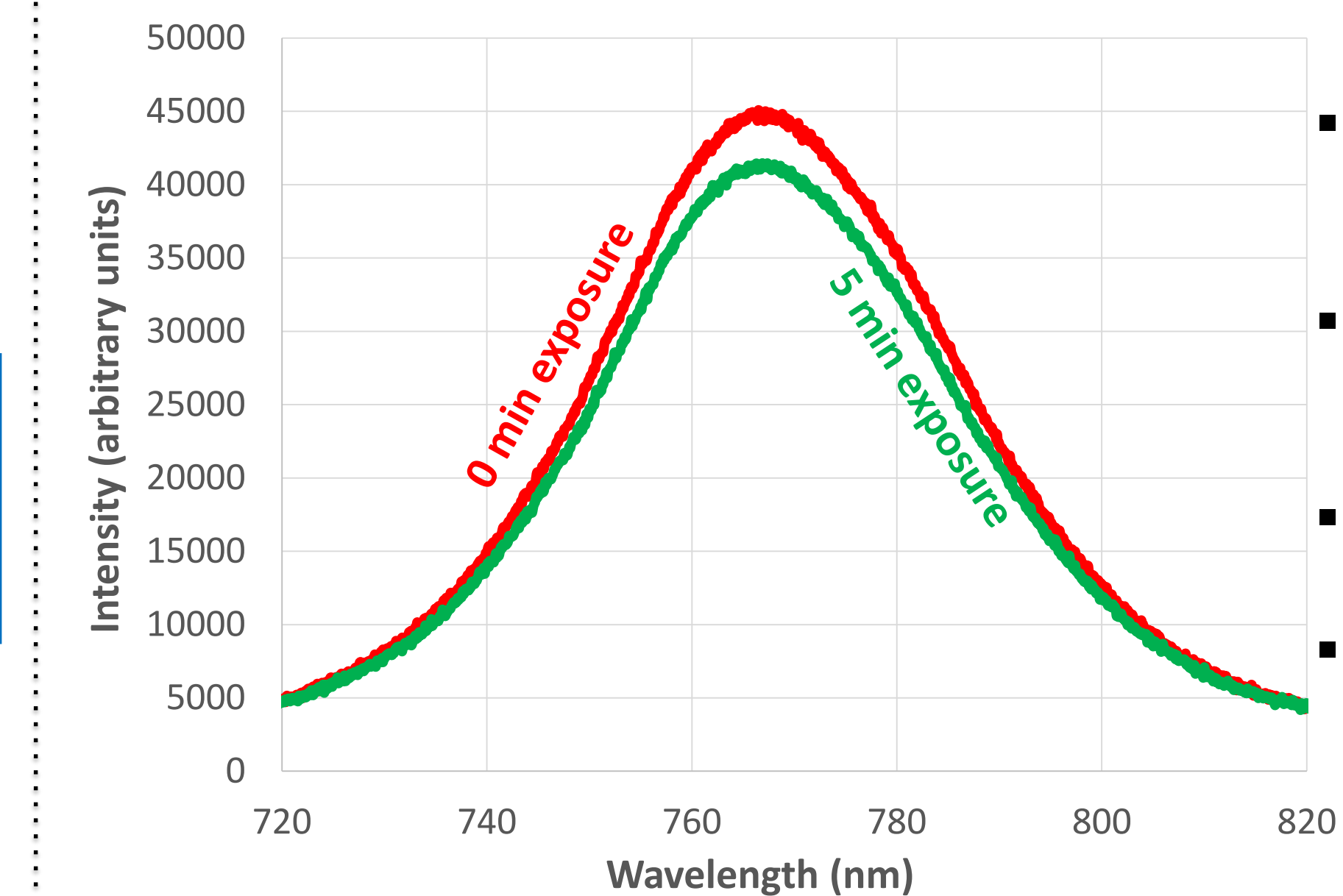
I-V Characteristic



Measured:
(small area devices)
 $V_{oc} = 0.715 V$
 $I_{sc} = 1.25 \times 10^{-8} A$

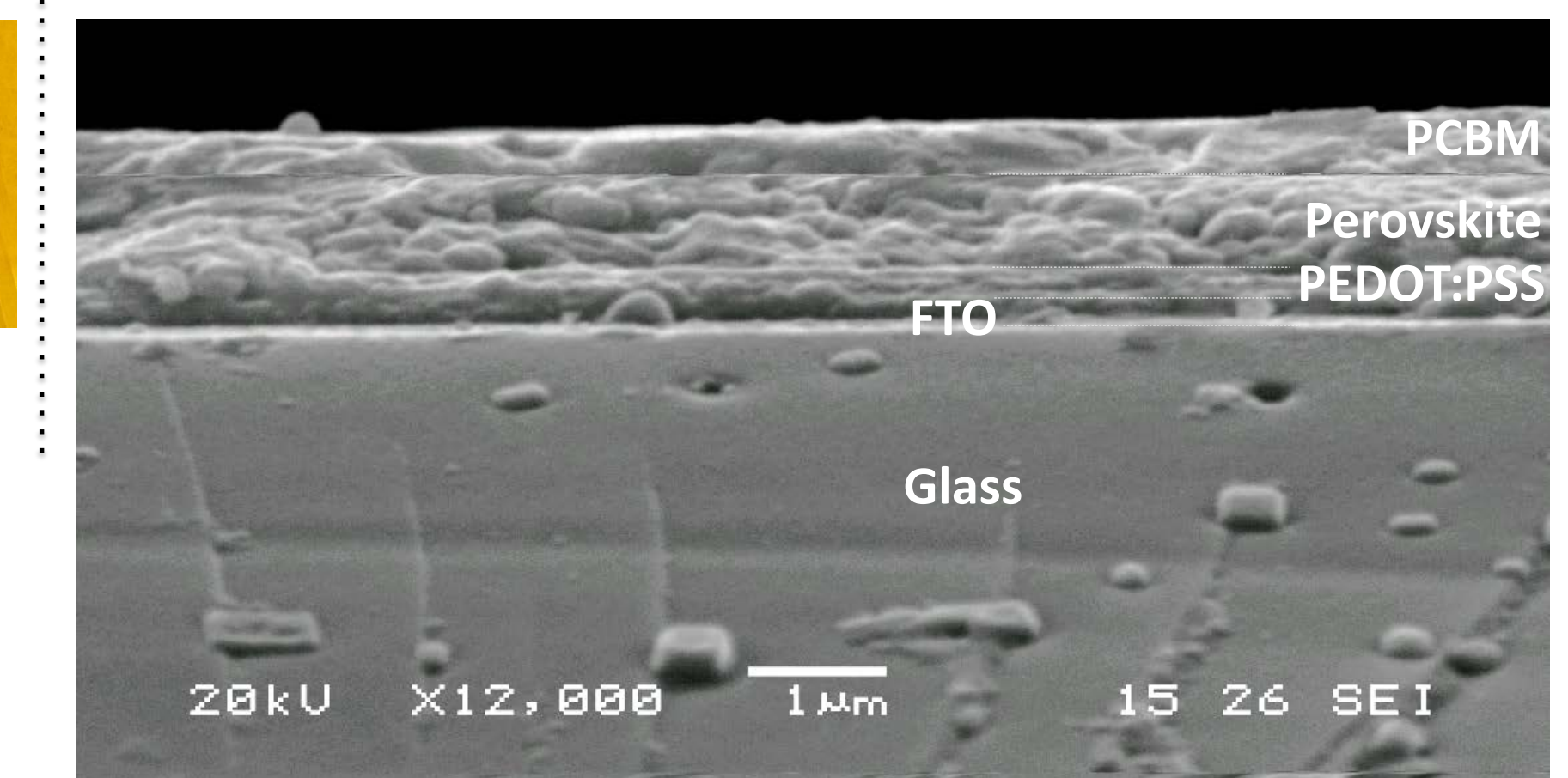
Potential:
 $V_{oc} = 0.96 V$
 $I_{sc} = 18.8 mA \cdot cm^{-2}$
 $FF = 72 \%$

Photoluminescence



- 532 nm excitation- 150 mW/cm^2
- Sun- AM1.5 Global 100 mW/cm^2
- Peak $\lambda \sim 770 nm$
- $E_g = 1.61 eV$

SEM Cross Sectional Images



Actual Thicknesses

- HTL~ 100 nm
- Active ~ 1000nm
- ETL~ 500 nm

Desired Thicknesses

- HTL ~ 150 nm
- Active~ 350 nm
- ETL ~ 100 nm

Acknowledgements

Our team would like to thank Barkat Ullah for his guidance in device fabrication and Ramendra Pal for helping with processes involving conducting polymers.

