

Accelerated Lifetime Testing of Thin Film CdTe Solar Cells

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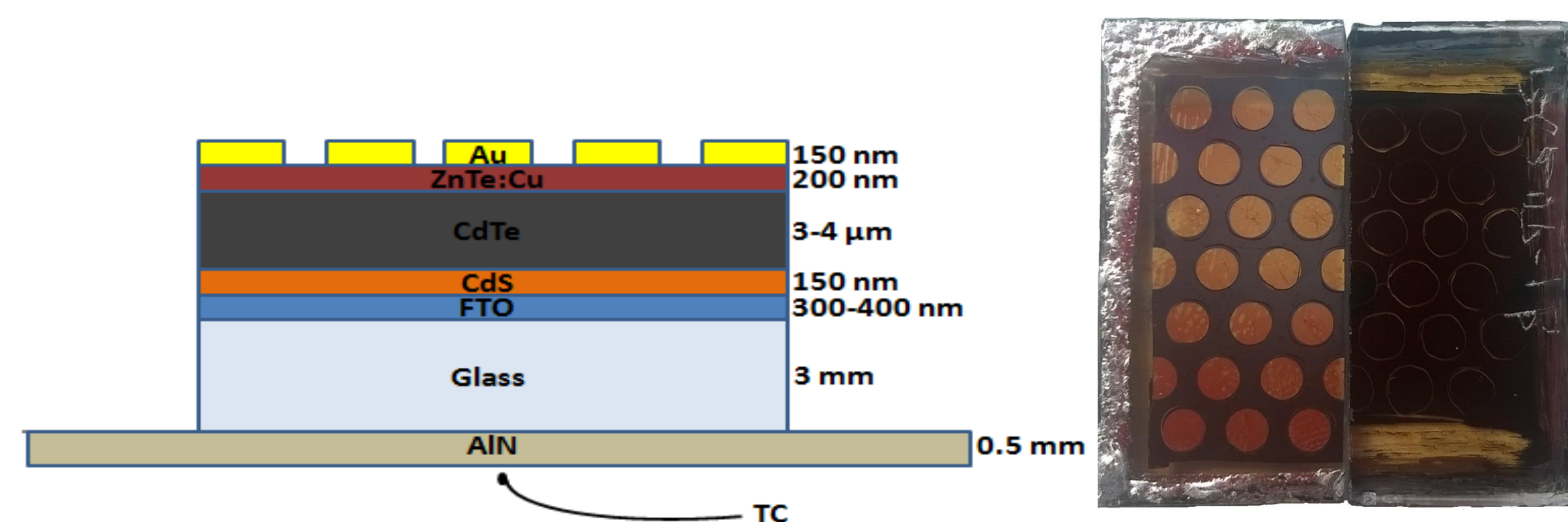


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Potential of CdTe Solar Cells

- Leading technology with 21.5% cells and 18.5% efficient modules [1]
- Low cost manufacturing (~\$0.6/W)
- Predicated on 30 year lifetimes
- Requires degradation rates of <0.2% per annum

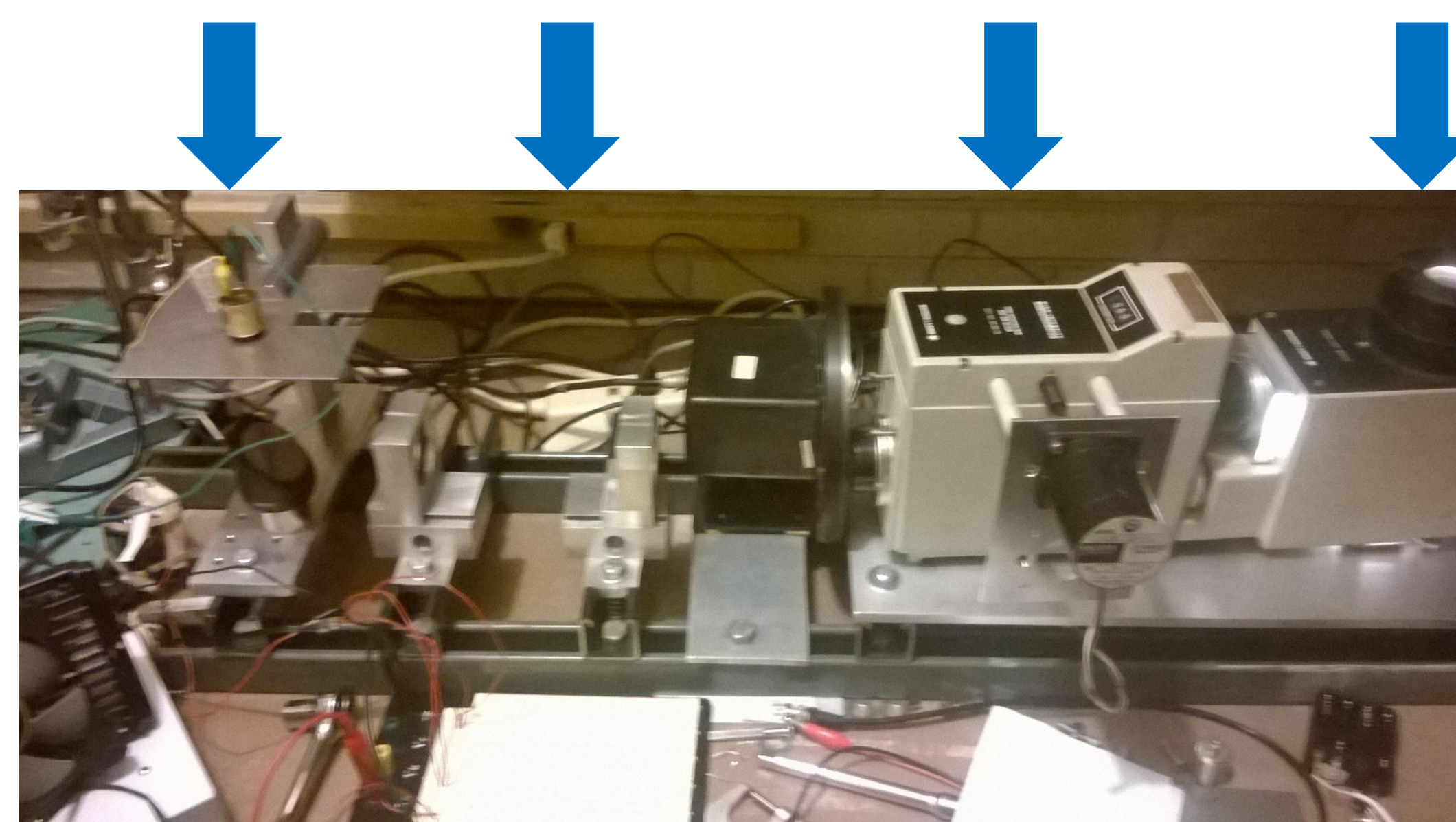


Stability of New Back Contact?

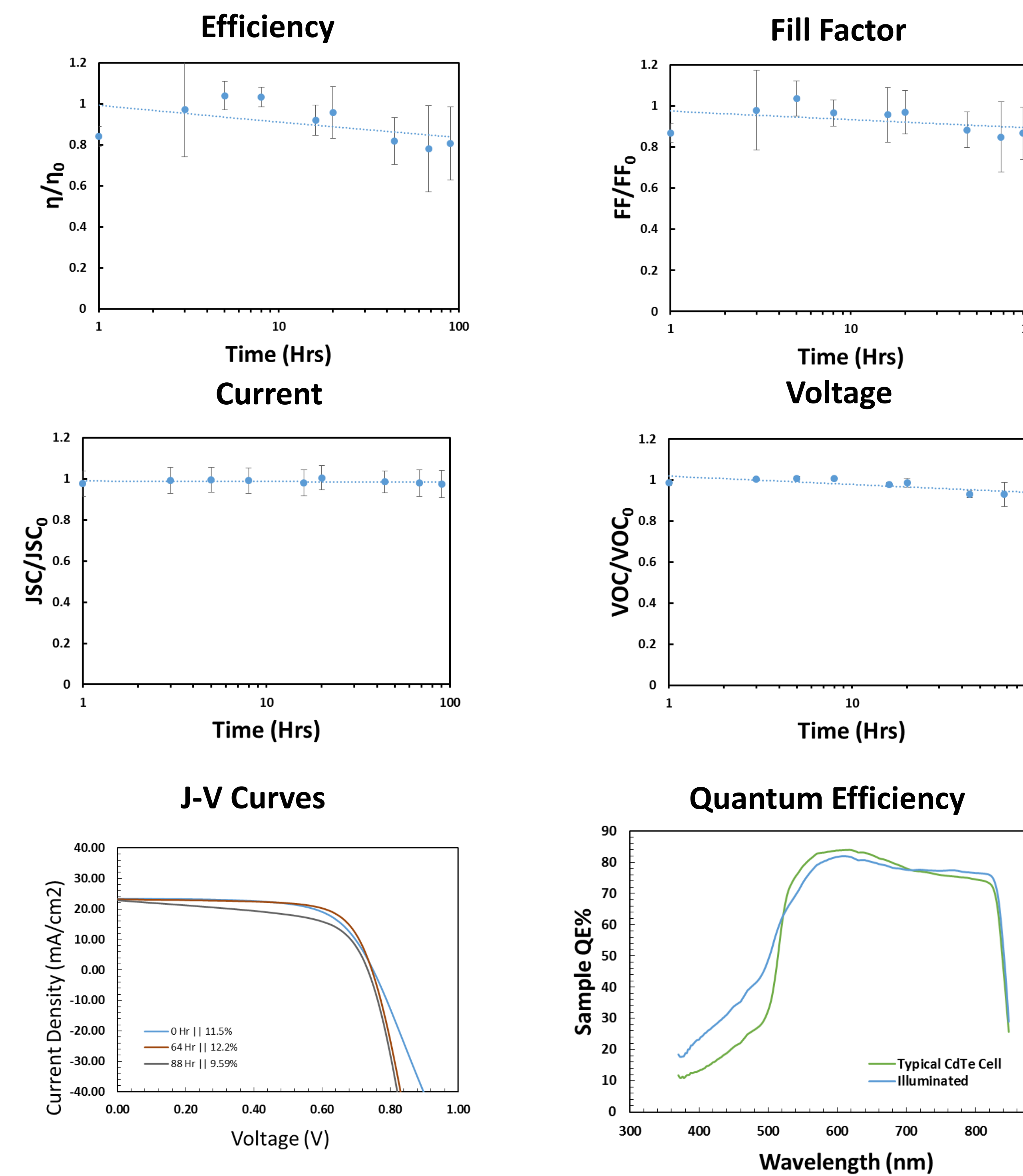
- CSM developed RTP activation of ZnTe:Cu back contact
- Copper migration detrimental to stability
- Accelerated lifetime testing (ALT) to assess stability
- ALT Parameters:
 - Temperature = 85 °C (hot)
 - Illumination: Induces open circuit bias
 - Dark: No bias
- Record J-V performance, quantum efficiency
- Using Eqn.1 [2] with parameters $T_u = 25^\circ\text{C}$, $T = 85^\circ\text{C}$, $E_A = 1\text{ eV}$, to estimate ALT.
- Illuminated: 8 Yrs
- Dark: 16 Yrs

$$F(T, T_u, E_A) = \text{Exp}\left[E_A \left(\frac{11605}{T_u} - \frac{11605}{T}\right)\right] \quad (\text{Eqn.1})$$

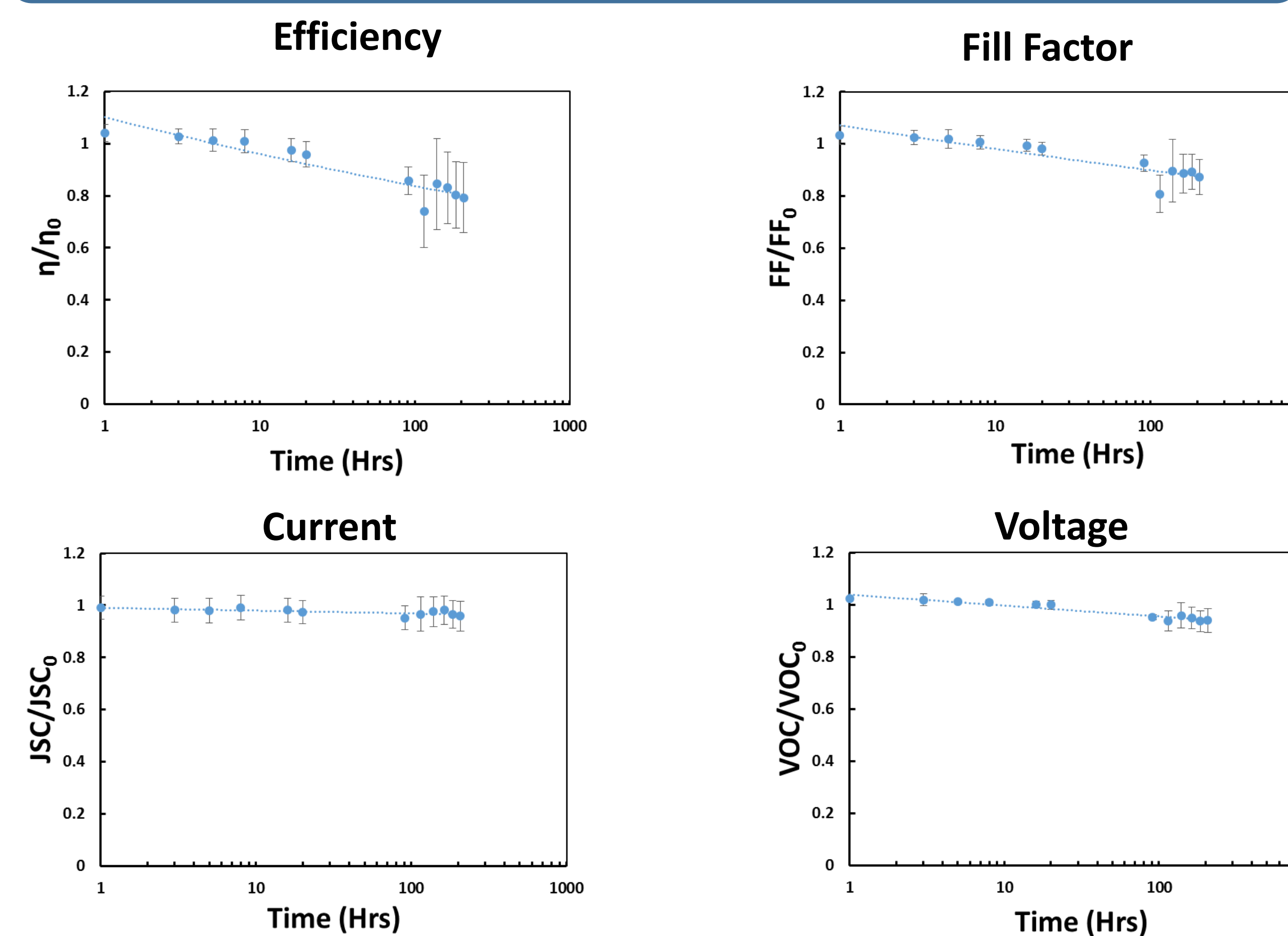
Stage Lenses Monochromator Xenon Lamp



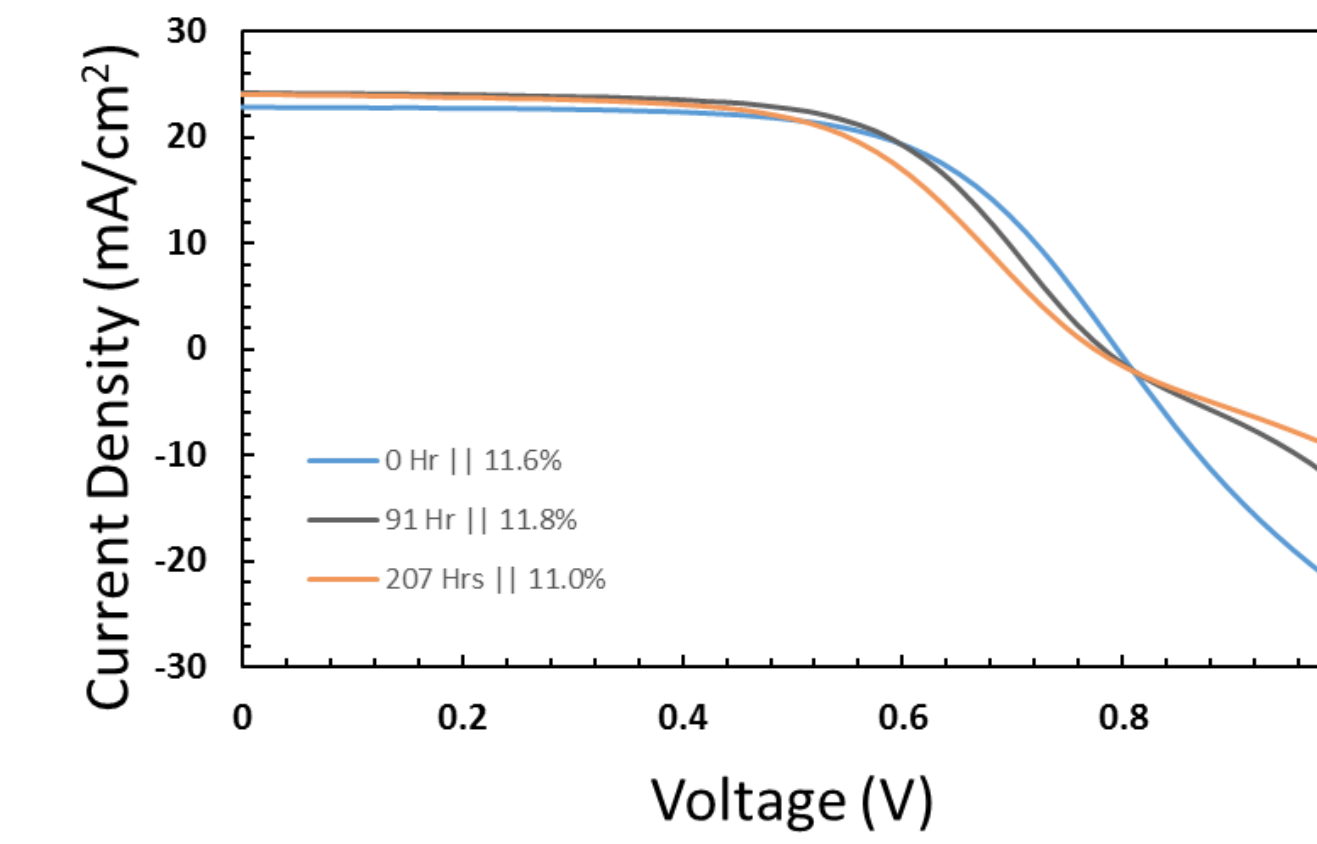
Illumination



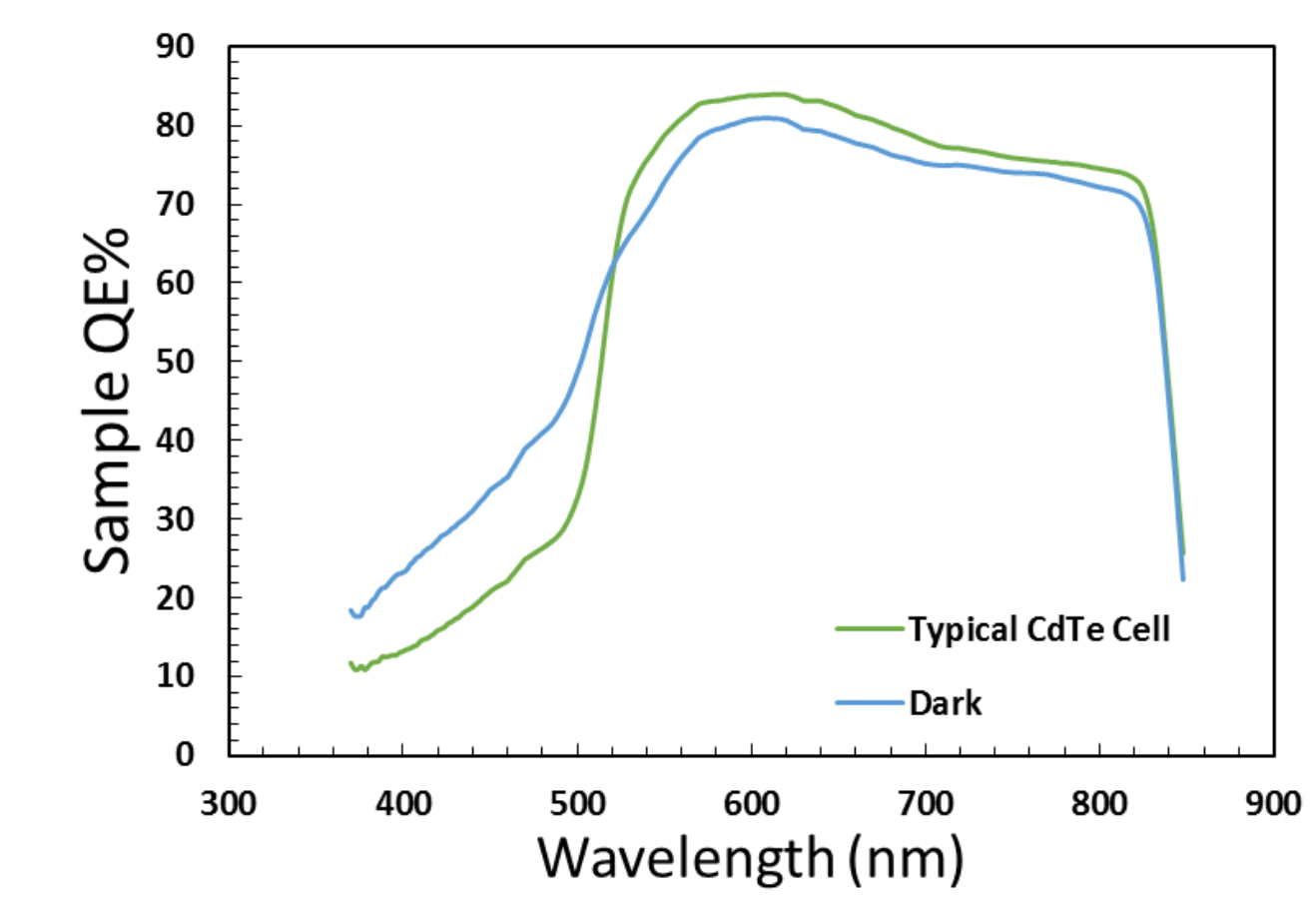
Dark



J-V Curves



Quantum Efficiency



CdTe can take the Heat!

- J_{SC} and V_{OC} remain unchanged during ALT
- Decreasing Fill Factor main cause for reduced Efficiency
- An initial increase in efficiency (up to 10 Hrs) for both tests indicates a possible self healing property.
- Rollover observed in J-V in dark, not in light
- Differences attributed to electromigration
- No significant changes in quantum efficiency
- The estimated efficiency lost per annum is ~0.15% Dark, ~0.26% Illuminated.

References & Acknowledgements

- [1] First Solar, (2015). *First Solar Achieves Efficiency, Durability Milestones*. <http://investor.firstsolar.com/releasedetail.cfm?ReleaseID=895118>
- [2] Albin, D. S., Demtsu, S. H. & McMahon, T. J., "Film thickness and chemical processing effects on the stability of cadmium telluride solar cells" *Thin Solid Films* **515**, 2659 (2006).



- UCD School of Chemical and Bioprocess Engineering
- The Pat McAdam Scholarship in Chemical and Bioprocess Engineering
- Research funding from BAPVC

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