Temperature and Radiation Tolerance Studies of CdSe/CdTe Bilayer Solar cells on Space-Qualified Coverglass

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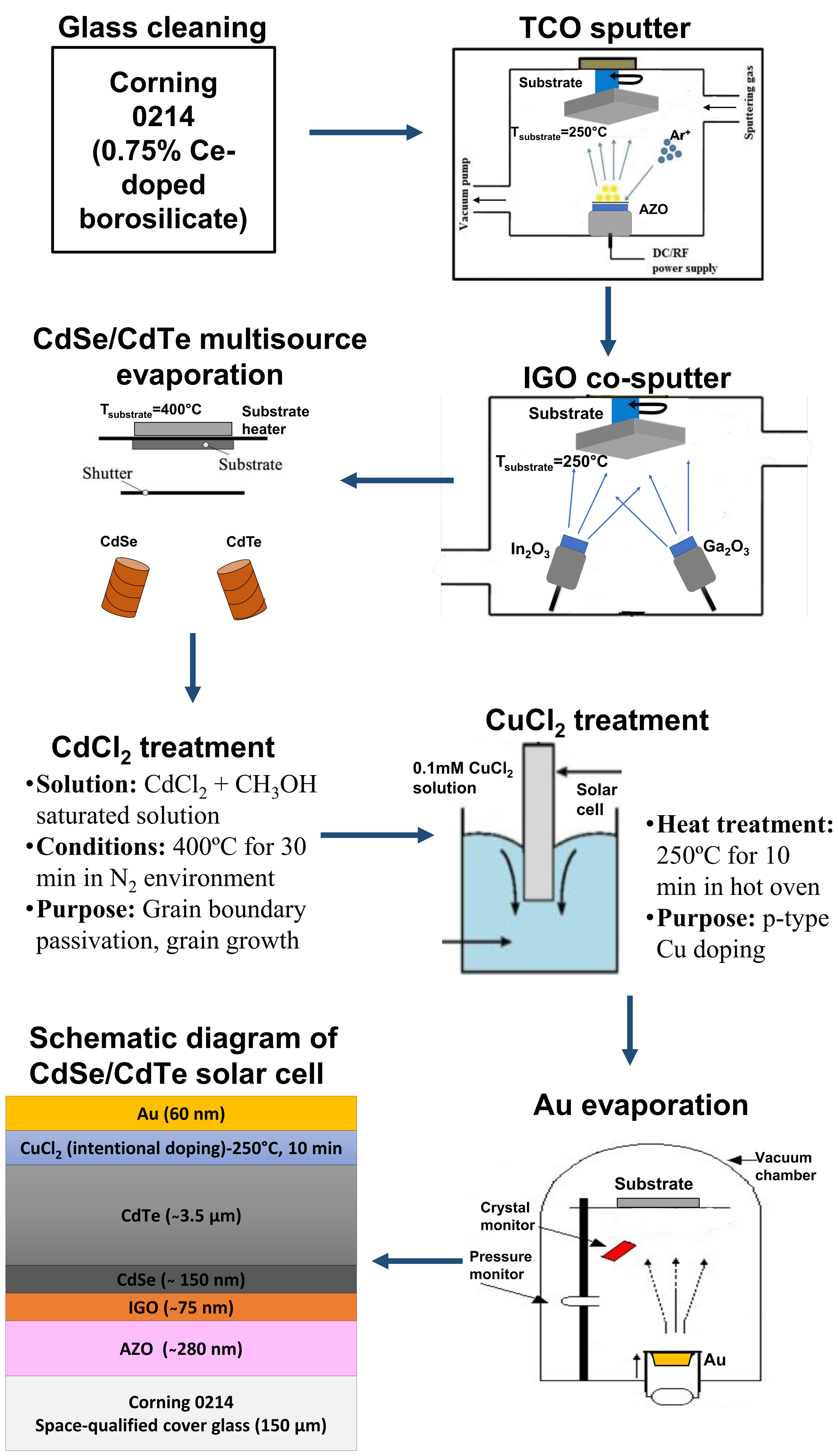
Motivation and Background

- II-VI thin film solar cells are expected to show superior high energy radiation tolerance and achieve higher specific power with lower manufacturing costs than Si or III-V solar cells [1]
- Highest recorded efficiency for CdS/CdTe solar cell on flexible and ultra-thin glass superstrate has been 16.4% [2]
- Replacing CdS with CdSe significantly improves current collection at lower wavelength region in visible spectrum [3]
- Incorporation of novel Indium Gallium Oxide (IGO) as an emitter in CdSe/CdTe solar cell improves device efficiency under AM1.5G condition [4]
- Here, we demonstrate fabrication of CdSe/CdTe bilayer solar cell directly onto space coverglass and report preliminary results of thermal cycling and proton radiation tolerance on a 15% efficient CdSe/CdTe device

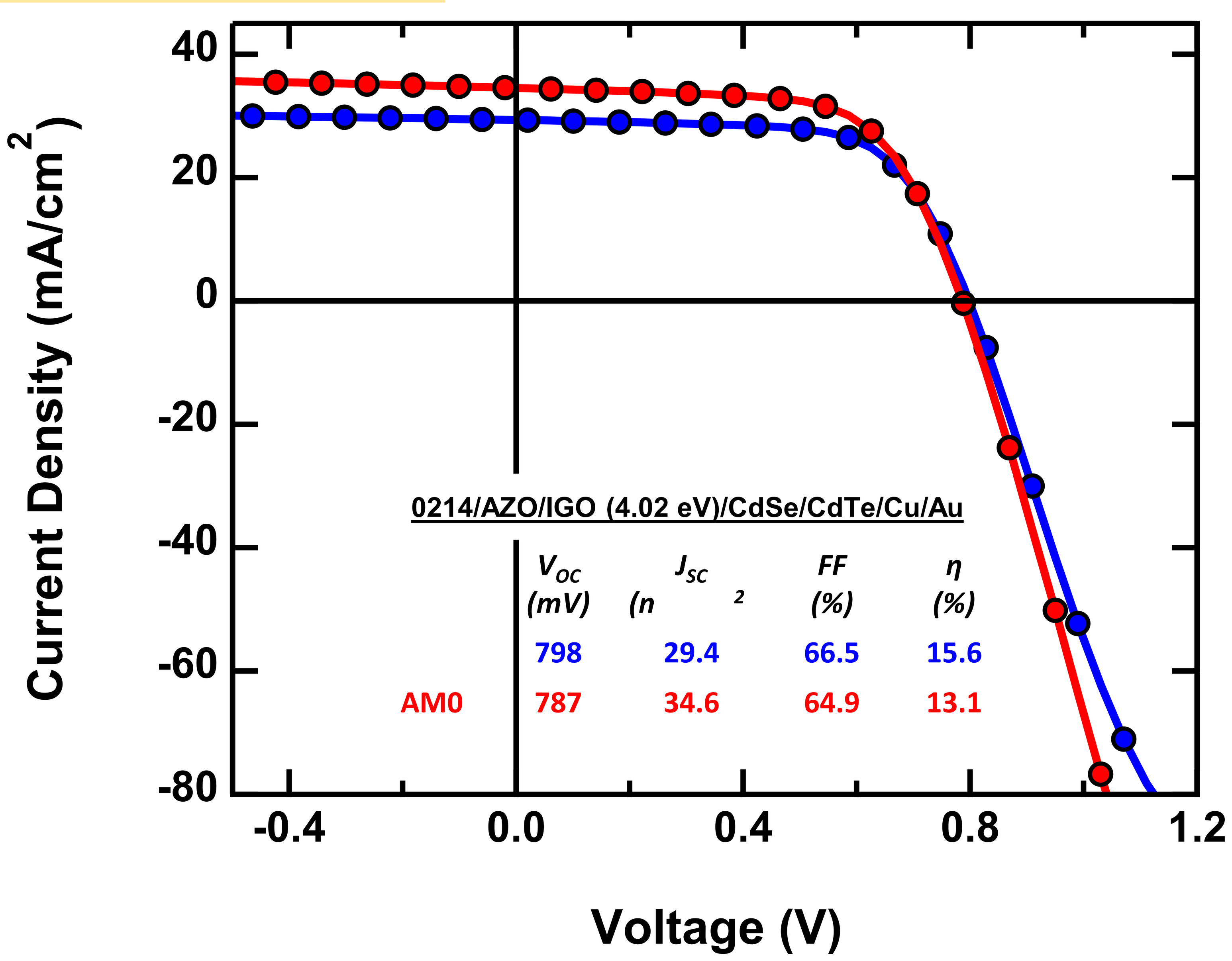
Methodology

Device fabrication



Results and Discussion

Device Performance



	V_{OC} (mV)	J_{SC} (mA/cm²)	FF (%)	η (%)
	798	29.4	66.5	15.6
AM0	787	34.6	64.9	13.1

Fig. 1: Current density (J)-voltage (V) curves for AM1.5G and AM0 conditions

Thermal Cycling: -20ºC to 80ºC under AM1.5G

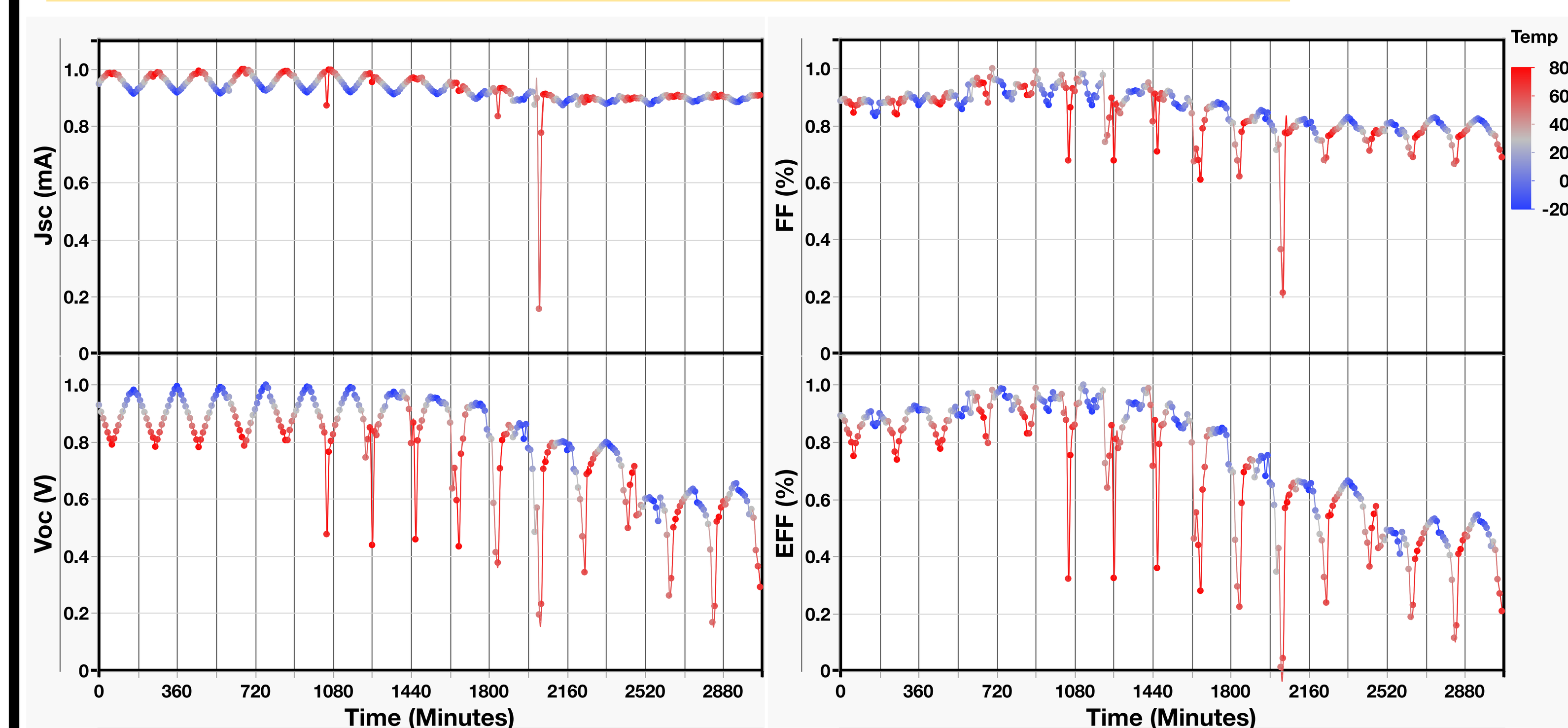


Fig. 2: Thermal cycling from -20ºC to 80ºC under AM1.5G

- ~16 cycles were performed over +3000 minutes
- Within first few cycles, no degradation observed in J_{SC} and V_{OC}

Proton Radiation (film-side):~50-240 keV, low & high fluence

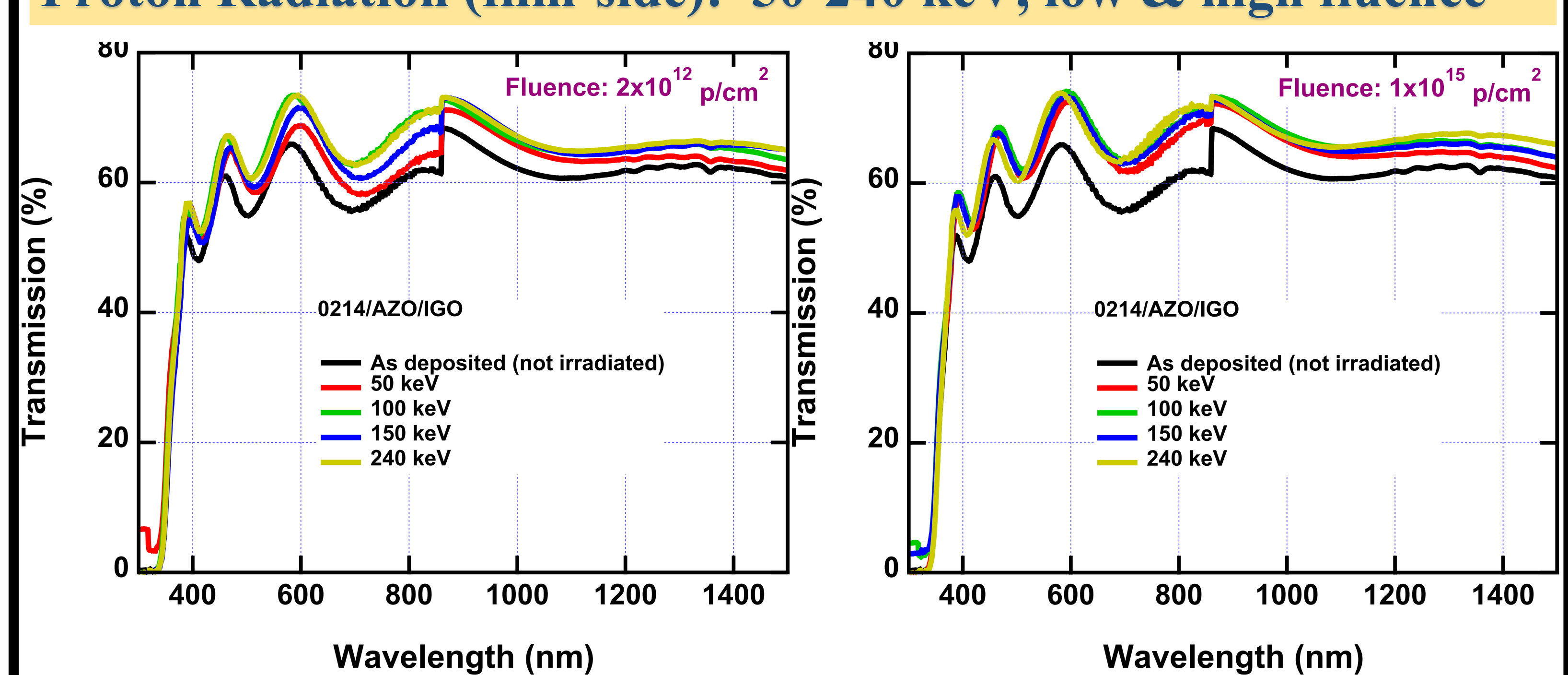


Fig. 3: T(%) measurements for pre- and post-proton irradiated AZO/IGO films on space coverglass for low ($2x10^{12}$) and high ($1x10^{15}$) p/cm² fluences

- Films irradiated from film-side (no encapsulation). Higher T(%) for all irradiated samples. Minor increment in transmission with increase in energy

Conclusion

- Highest achieved device efficiency for multisource evaporated CdSe/CdTe bilayer solar cells, deposited directly onto 150 µm space coverglass is 15.6% and 13.1% under AM1.5G and AM0 conditions, respectively
- From thermal cycling results under AM1.5G, higher fluctuations observed in fill factor (*FF*) and V_{OC}, thereby lowering efficiency post 8-10 cycles
- Film-side proton irradiated 0214/AZO/IGO films showed higher transmission (%) than film that did not undergo irradiation
- Transmission(%) increased with increase in energy dosage and fluence

Next Steps

- Further experiments will be conducted to optimize IGO bandgap, $CdCl_2$ and $CuCl_2$ treatment conditions to improve bilayer device efficiency
- Thermal cycling to understand degradation mechanisms of CdSe/CdTe solar cells under AM0 condition
- Au stability must be determined
- Looking to collaborate for electron and higher energy proton irradiation experiments

References

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Acknowledgements

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