UT AUSTIN PORTUGAL ANNUAL CONFERENCE 2023
MODELLING THE FUTURE

UTAustin Portugal

Solution processed Na-doped and Ag-alloyed Cu_2ZnSnS_4 thin film based photovoltaic devices

NANOTECHNOLOGIES
Neha Kumari, Research Fellow, neha.kumari@inl.int
Jitendra Kumar, Sarang Ingole

MOTIVATION

- Cu_2ZnSnS_4 (CZTS) has earth-abundant constituent elements.
- Direct and tunable band gap (1.5 eV).
- High absorption coefficient ($\alpha > 10^4$ cm^{-1}).
- Large grains and defect passivation is needed for high solar cell efficiency.
- This can be achieved via sodium (Na) and silver (Ag) incorporation into CZTS.

OBJECTIVE

To establish a facile and low-cost non-vacuum solution-based approach for Na and Ag incorporation into CZTS films.

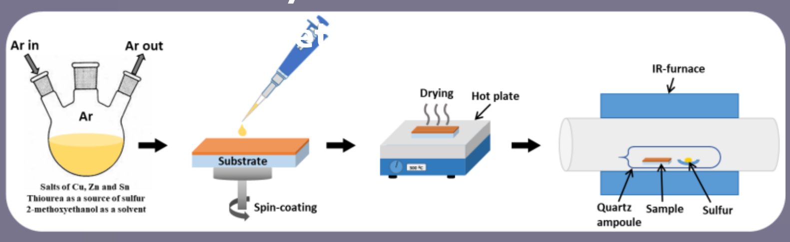
METHODOLOGIES

- Precursor CZTS films were obtained by solution route. Metal salts of Cu, Zn, Sn and thiourea were dissolved in 2-methoxyethanol. The solution was spin-coated on the substrate and dried on a hot plate.
- The precursor films were sealed in quartz ampoules and sulfurized in tube furnace at 550 $_0$C for 15 minutes at different sulfur-vapor pressures (P_s).
- For Na incorporation, Na_2S solution was coated on glass and placed on top of the CZTS precursor film while sulfurization, with Na_2S coating facing the CZTS film.
- For Ag alloying, $AgNO_3$ was introduced into the precursor solution and ACZTS film was obtained.
- The effect of Na-doping and Ag-alloying on the morphology and optoelectronic properties of CZTS films were studied.

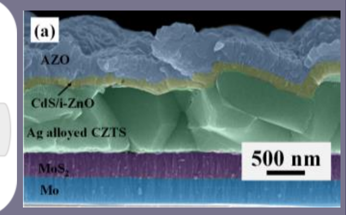
RESULTS

- CZTS films sulfurized at 22.3 kPa P_s shows better morphology and optoelectronic properties.[1]
- Na-doping led to increased grain size, reduced resistivity and decreased bandgap to ~1.2 eV.[2]
- Ag-alloying led to increased grain size, reduced Cu-Zn disorder and increased bandgap.[3,4]

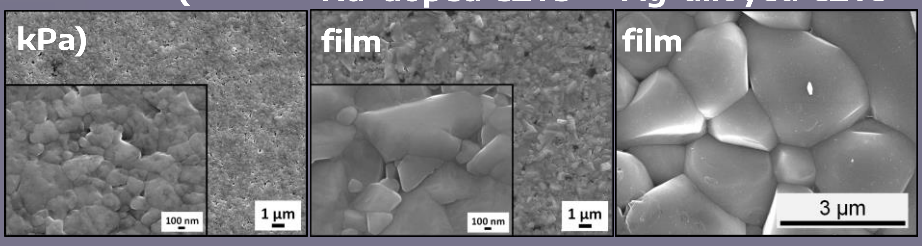
Synthesis



Solar cell



CZTS film (22.3 kPa) | **Na-doped CZTS film** | **Ag-alloyed CZTS film**



REFERENCES

1. Kumari, N. *et al. Sol. Energy* 231, 484-495 (2022)
2. Kumari, N. *et al. Mater. Sci. Semicond. Process.* 146, 106660 (2022)
3. Kumar, J. *et al. J. Alloys Compd.* 727, 1089-1094 (2017)
4. Kumar, J. *et al. J. Alloys Compd.* 865, 158113 (2021)

INL International Iberian Nanotechnology Laboratory
fct Fundação para a Ciência e a Tecnologia
TEXAS The University of Texas at Austin