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Pure-sulfide CZTS solar cells by pulsed laser deposition

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Pure-sulfide CZTS solar cells by pulsed laser deposition

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Deposition parameters	Target	Annealed in	Device structure
• Temperature: 25°C • Base pressure: 10^{-7} mbar • Laser: Excimer KrF • 248 nm, 20 ns pulse @10Hz	Compound Cu_2ZnSnS_4 **(Cu/Zn = 1.8)**	100 mbar N2 200 mg S 570°C 10 min	**Mo** – 600 nm - DC sputtering **CZTS** – 800 nm - pulsed laser deposition **CdS** – 70 nm - chemical bath deposition **ZnO/AZO** – 70/250 nm - RF sputtering

??? Why pulsed laser deposition ???

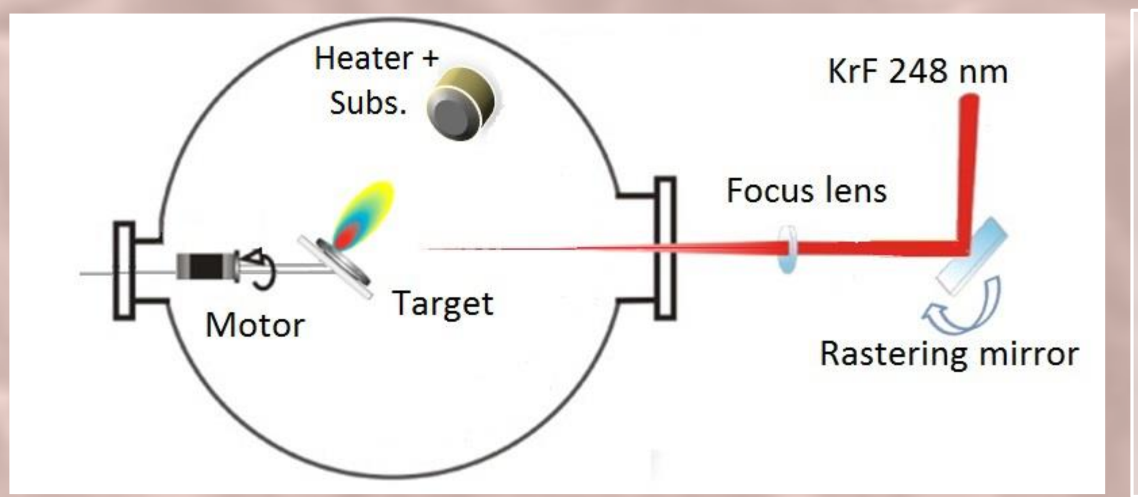
PROS	CONS
1. Many tunable parameters 2. Kinetic energy of ablated species promotes surface mobility at the substrate 3. Non-equilibrium deposition conditions → **control over defect formation?**	1. Complex physics 2. Expensive production method 3. Radially inhomogeneous flux of species 4. Ejection of micro-particulate **(solved after annealing!)**

Pulsed laser deposition setup

Laser fluence = pulse energy / beam area

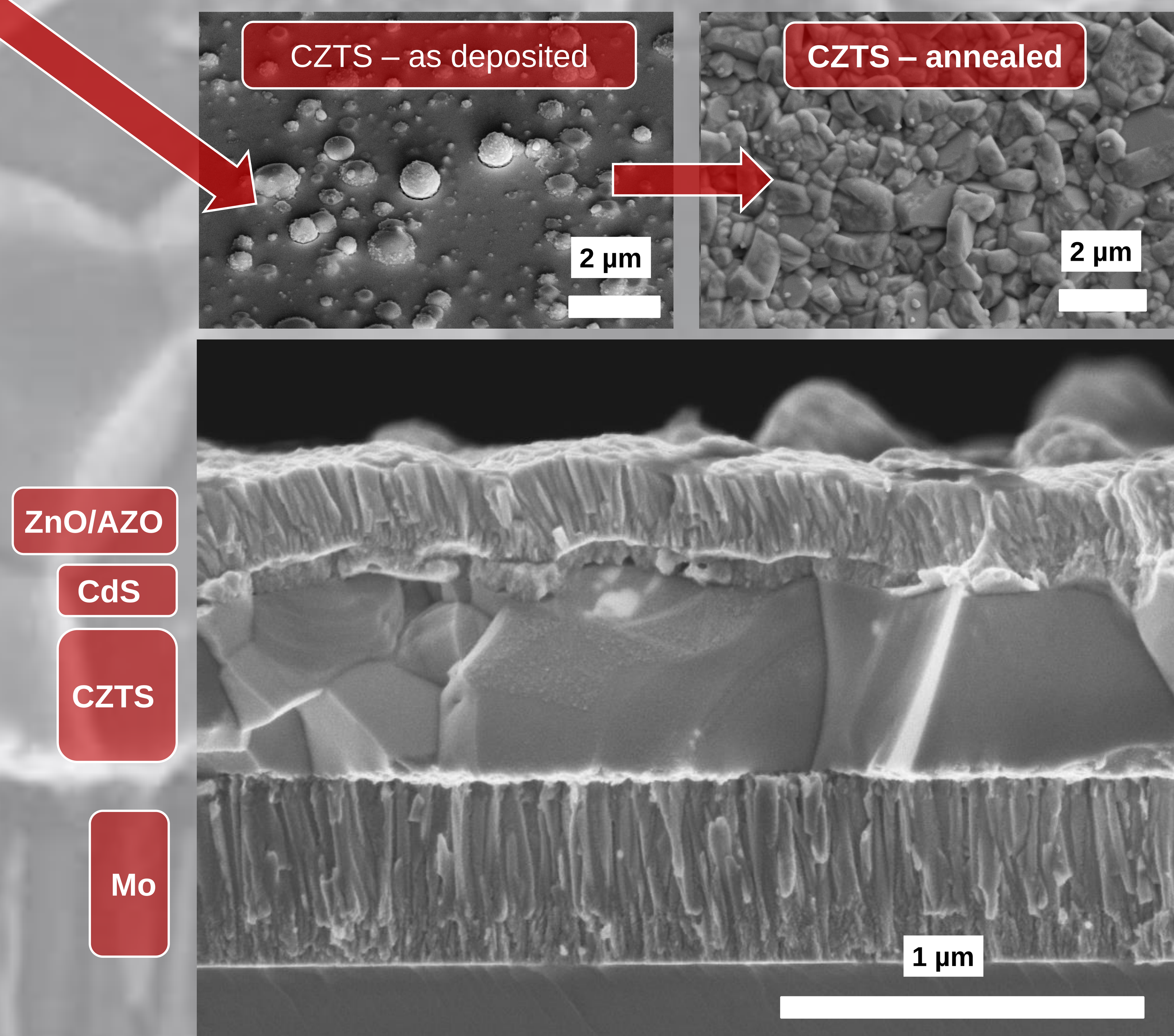
Pulse energy: constant over 1 hour deposition time

Beam area: tuned by changing the **lens-target distance**



Very low fluence: **evaporation**

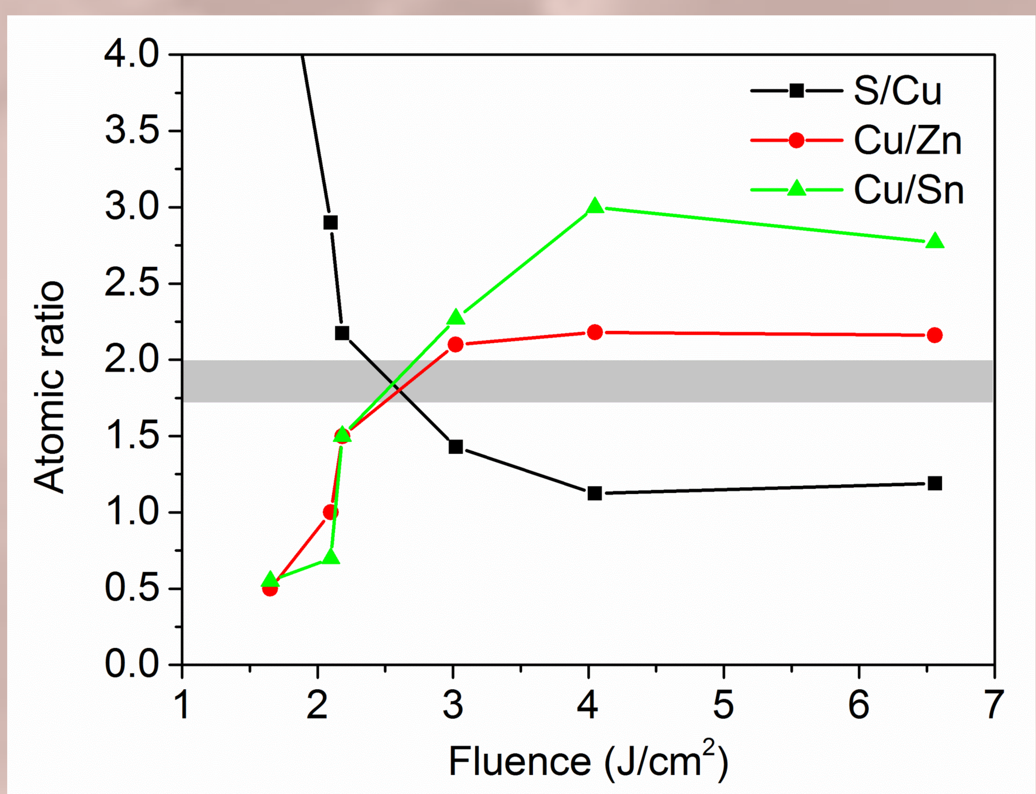
Very high fluence: **ablation**



Influence of laser fluence on composition

Copper has the lowest vapour pressure among the 4 elements

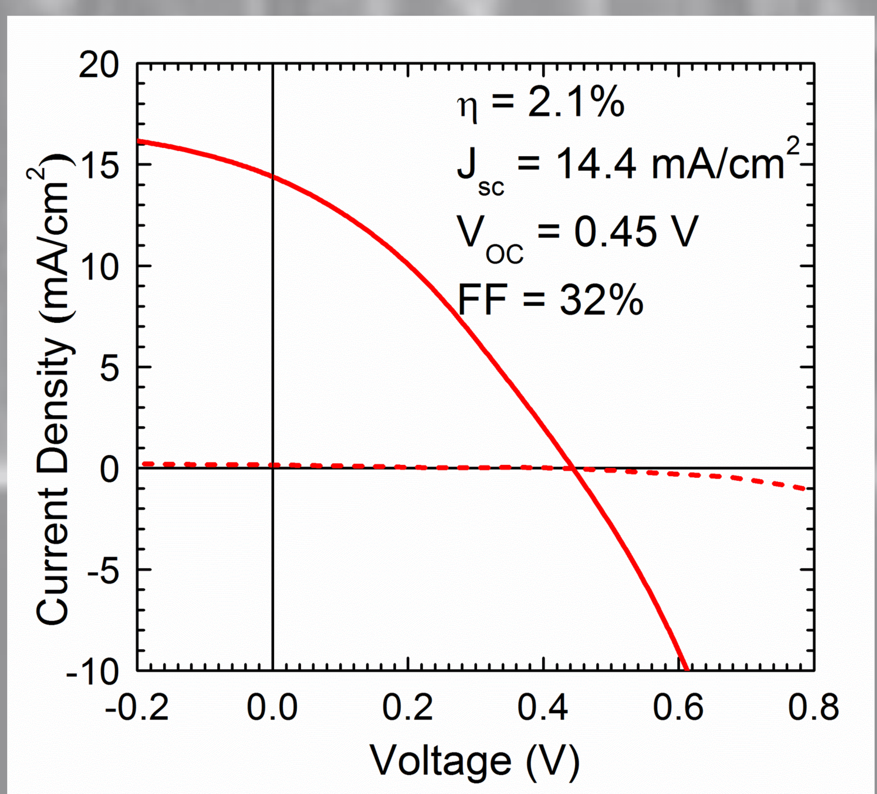
Tuning laser fluence = tuning %Cu

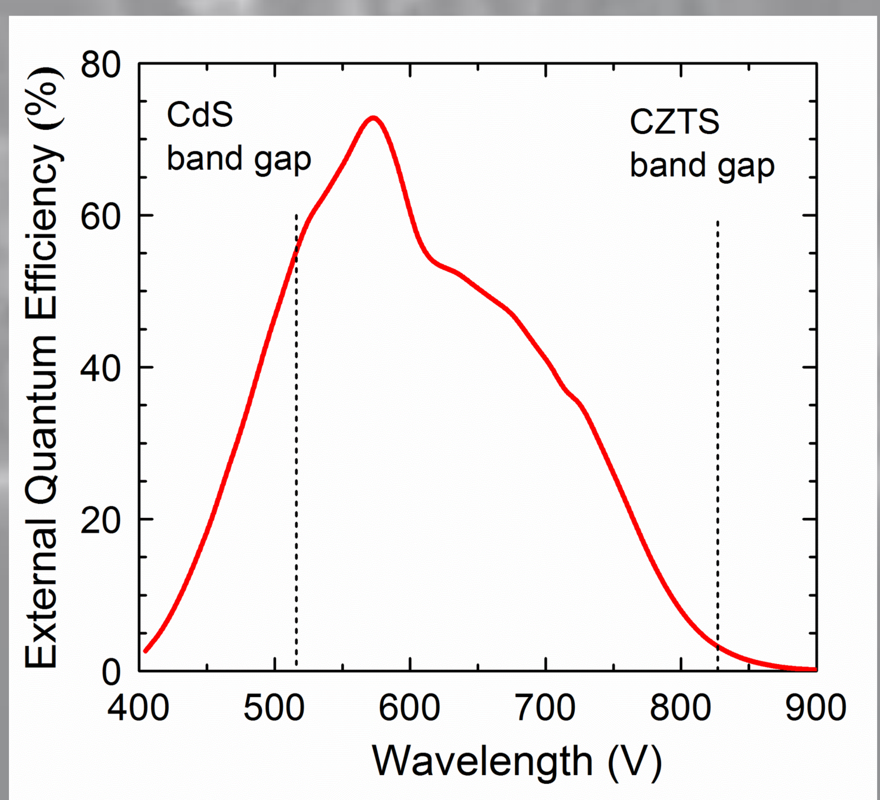


At optimal lens position:

Cu: **22.6%**; Zn: **14.7%**; Sn: **12.2%**; S: **50.5%**

Cu /(Zn+Sn) = **0.84**; Zn/Sn = **1.20**; Cu/Sn = **1.85**





Conclusions

Solar cell devices	CZTS processing
1. J_{sc} and V_{oc} are relatively close to best devices 2. Fill factor is very low 3. Extreme light-dark crossover	1. Compact morphology with large grains 2. Micro-particulate disappears after annealing 3. Radial compositional inhomogeneities

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