Effective surface passivation of c-Si by atomic layer deposited MoO_x layers for hole-selective contacts

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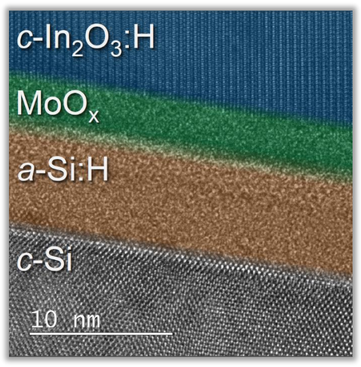
References:

1. Bivour et al,. presented SiliconPV 2017
2. Vos *et al.*, JVSTA 2016, **34 (1)**, 01A103
3. Macco *et al*, PSS – RRL 2015, **9 (7)**, 393–396
4. Bivour *et al*, Energy Procedia 2016, **92**, 443–449

Evaporated MoO_x :

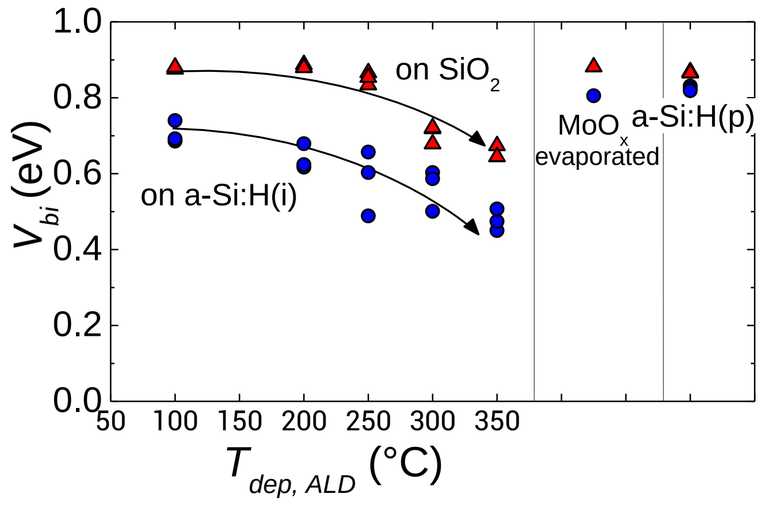
- replaces a-Si:H(p)
- efficiency of 22.6%[1]
- *a*-Si:H(i) absorptive
- not thermally stable
- industrial?



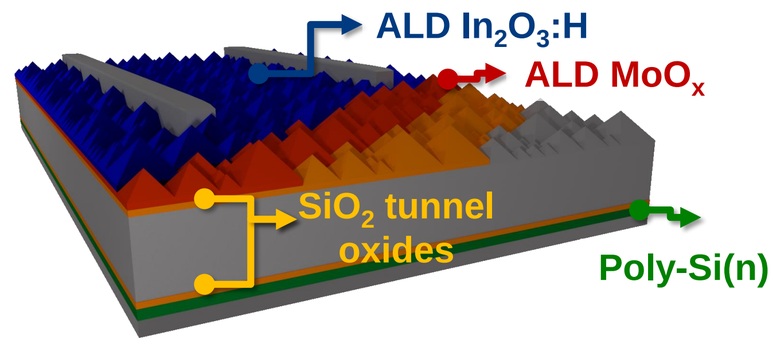
ALD MoO_x[2] :
Passivation/selectivity issues:

Passivation layer	Passivation quality	Selectivity (band bending)
a-Si:H	Good[3]	Poor[4]
Tunnel SiO_2	???	Good[4]

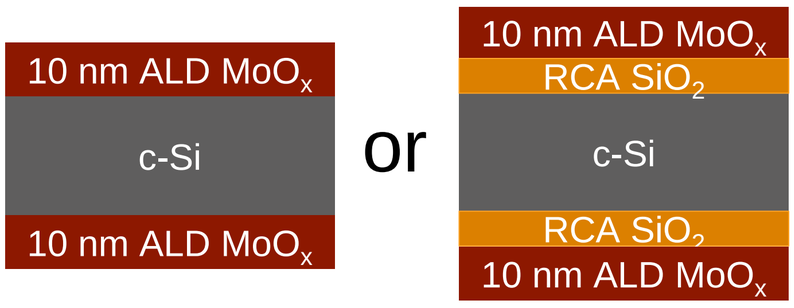
SPV: Band bending is measure of *h*-selectivity[4]



Research question:
Can ALD MoO_x **passivate** on a SiO_2 tunnel oxide?



Experiment:

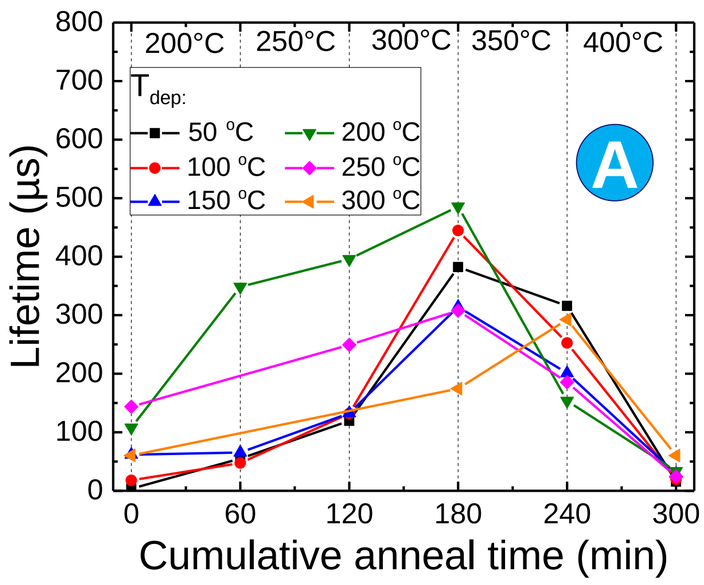


+ forming gas annealing (FGA)

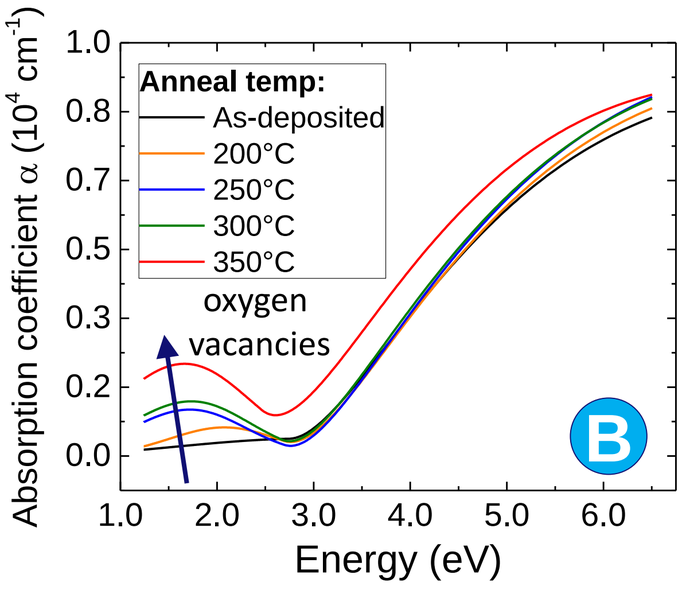
Results:

Passivation achieved only when using RCA oxide + FGA (O_2, N_2 results not shown)

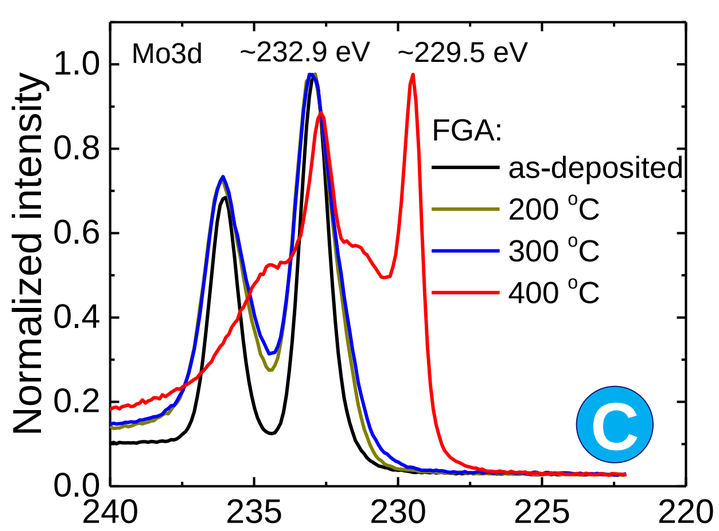
A **Best** passivation: FGA @ 300 °C



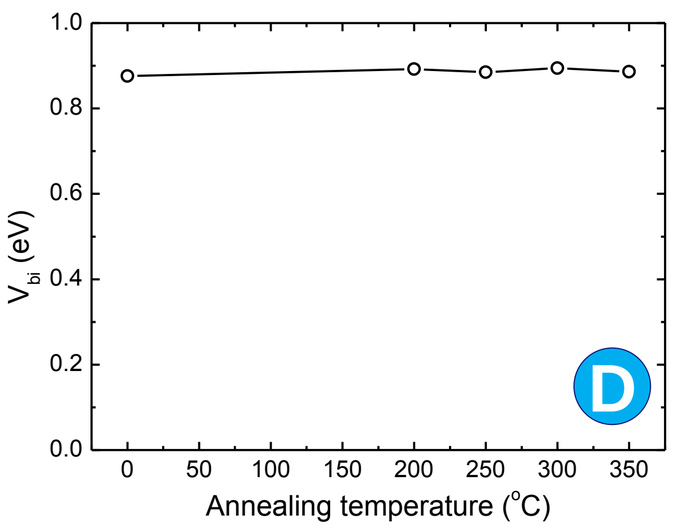
B FGA ➔ subgap absorption
➔ oxygen vacancies



C XPS: Oxide reduction
➔MoO_2 upon FGA @400 °C

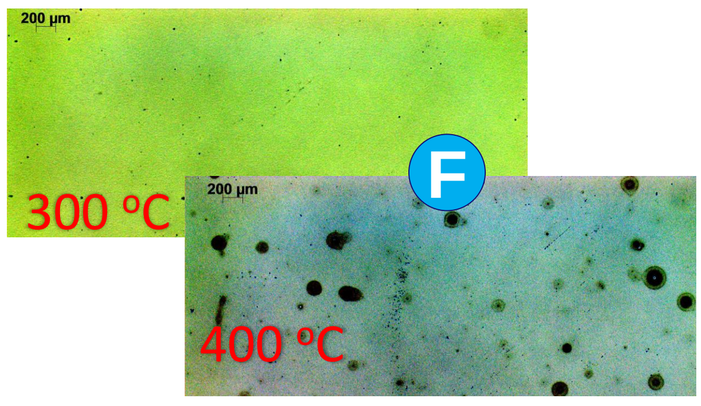


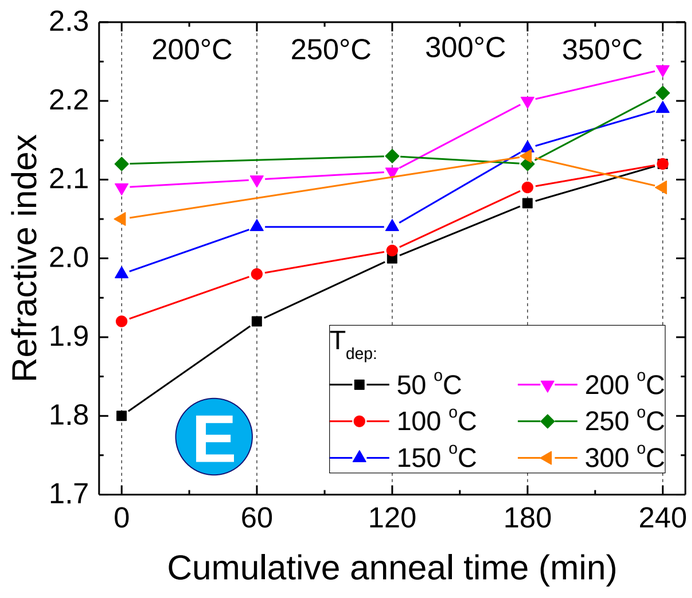
D Band bending is preserved upon FGA!
Should be sufficient for h-contact!



E Refractive index increase
➔ densification

F Etch pit/blister formation at high T_{ann}





Conclusions:

- Fair passivation (74 fA/cm²) obtained using RCA oxide and FGA
- At T_{ann}>300 °C reduction and blistering/etching
- **Next steps**: Check selectivity: Band bending? Contact resistance?

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