Aluminium Doped TiO_x (TiO_x:Al): Improving Surface Passivation on Si by Supressing Crystal Phase Transformation

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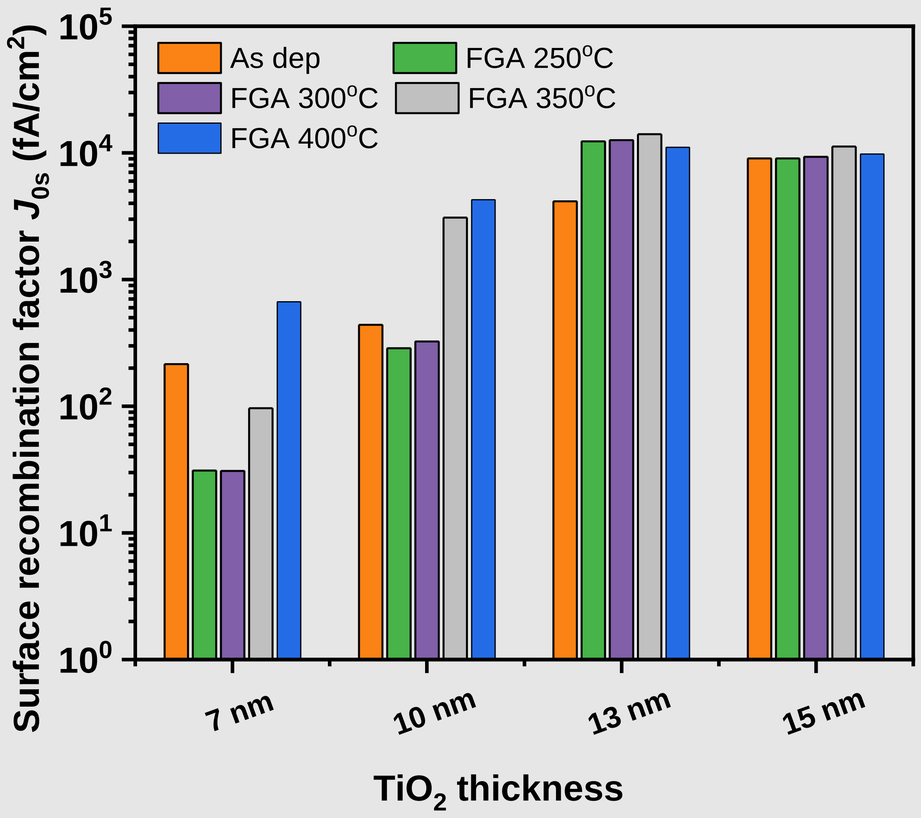
❑ Summary

✓ TiO_x is a possible alternative to the Al_2O_3/SiN_x:H stack for passivating p+ Si surfaces
✓ TiO_x provides both anti-reflection and surface passivation in a single package
✓ TiO_x is an excellent ARC for solar cells due to its high reflective index *n and lower* parasitic light absorption (below 600nm) than SiN_x:H due to its lower extinction coefficient *k*
✓ Surface passivation of TiO_x deteriorates when the layer is thick or being annealed at elevated temperatures, which is due to a phase transition from amorphous to anatase
✓ This work presents improved surface passivation and thermal stability of TiO_x via Al doping of the film which inhibits crystal phase transformation

❑ Experiments and results

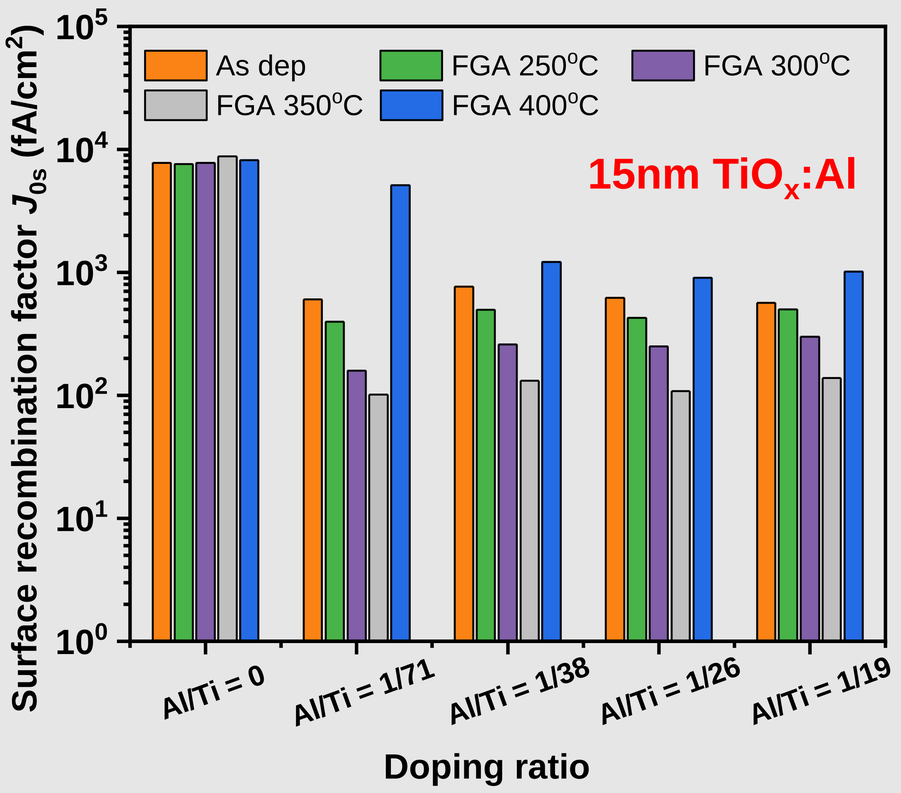
➢ Undoped TiO_x



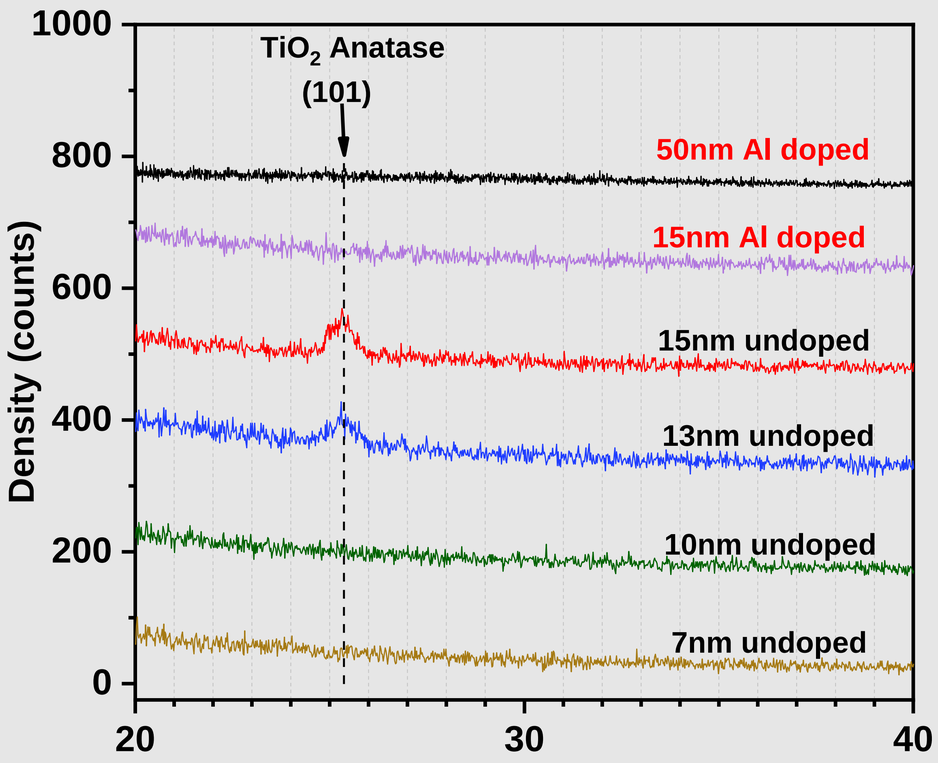
- ✓ Thickness sensitive
  more than 10nm: no passivation
- ✓ Unstable up to annealing
  @ 250°C where J_{0s} increases
  Incompatible with cell fabrication

- ✓ Improved passivation
  J_{0s}: 110 fA/cm², SRV:15 cm/s
- ✓ Improved thermal robustness
  @350°C showing the lowest J_{0s}
  Compatible with cell fabrication

➢ Al doped TiO_x (TiO_x:Al)

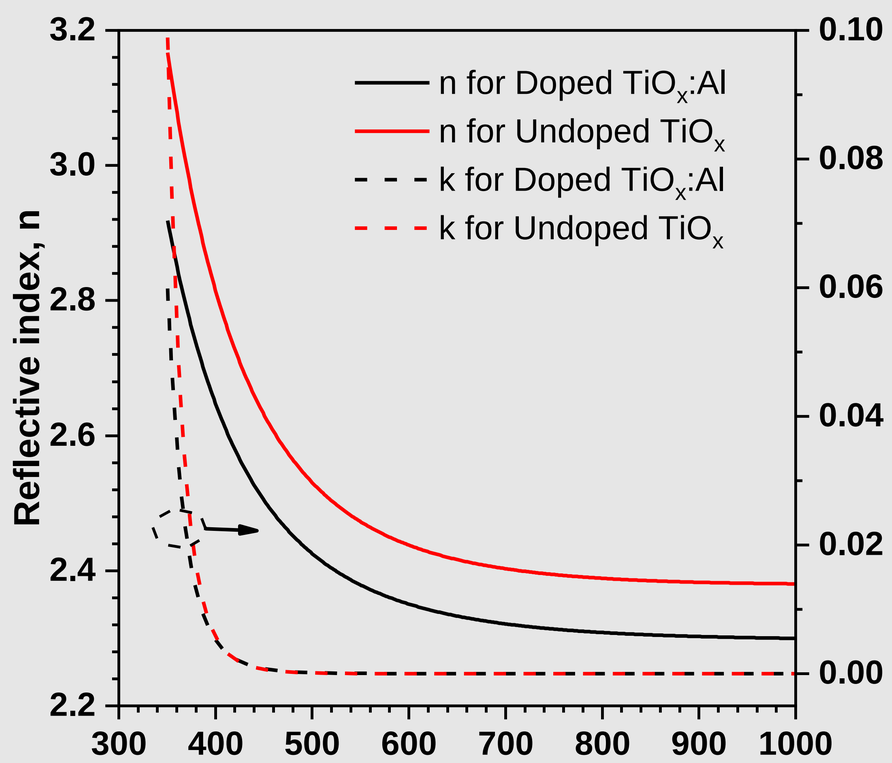


➢ GIXRD crystal phase



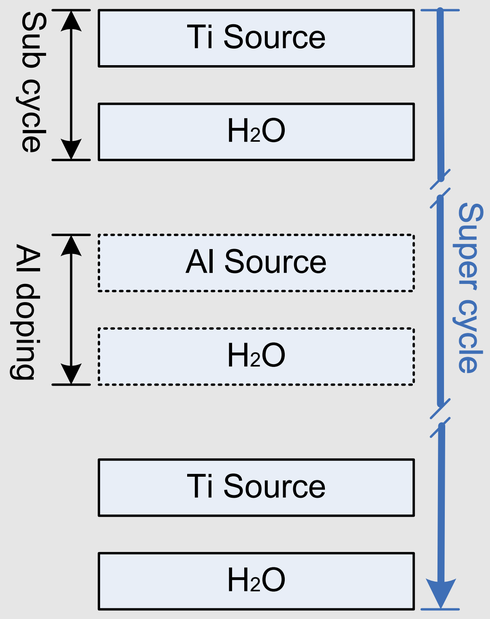
- ✓ A small increase in TiO_x thickness can trigger a phase change from amorphous TiO_x into anatase
- ✓ Al doping into the TiO_x films inhibits crystallization
- ✓ Doping could be a promising strategy to improve the surface passivation quality and the thermal stability of TiO_x

➢ Optical properties



- ✓ n and k were modelled using the Caushy model with ellipsometry test
- ✓ Very low k value (< 0.1) measured for undoped and doped TiO_x
- ✓ n value decreases with doping, but also maintains n = 2.33 @ 632 nm

➢ ALD Super cycle



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