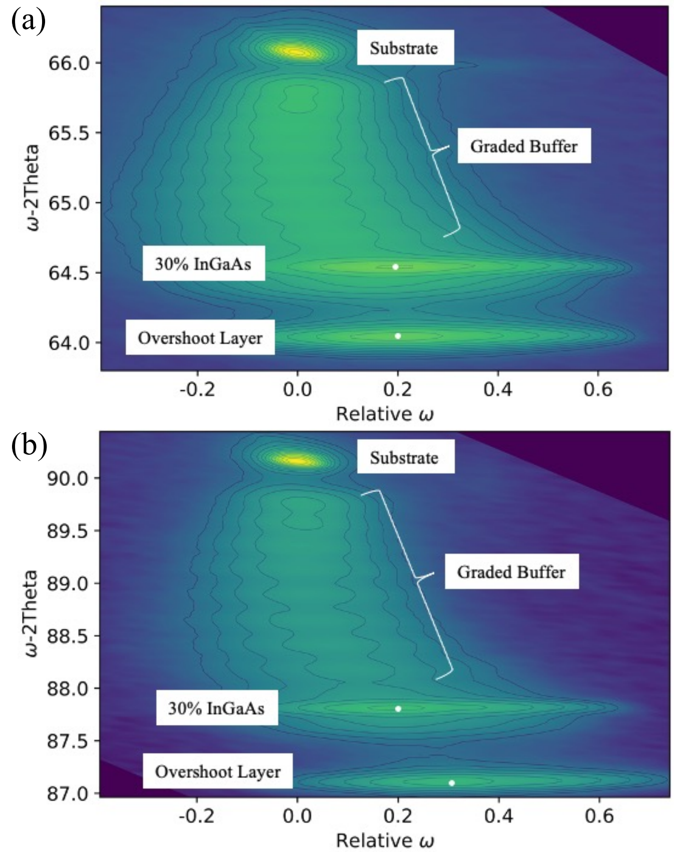


Figure 1: Reciprocal space maps (RSM) of the (a) 004 and (b) 115 lattice planes of the InGaAs graded buffer. A linear grade of 3% In composition intervals with a 0.7%/um grade rate and an overshoot layer of $In_{0.35}Ga_{0.65}As$ were used to realize 97.9% relaxation (-0.04% strain) in the $In_{0.30}Ga_{0.70}As$ cap. The change of relative omega in the graded buffer for both lattice planes is caused by epilayer tilt. ~100% relaxation is indicated by the vertical alignment of the $In_{0.30}Ga_{0.70}As$ cap and overshoot layer in the 004 RSM and an offset in omega between the $In_{0.30}Ga_{0.70}As$ cap and overshoot layer in the 115 RSM.

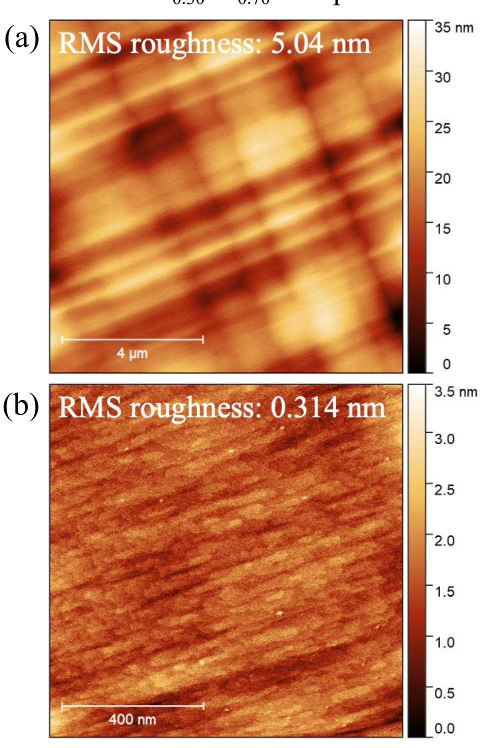


Fig 3: 10x10 µm² (a) and 1x1 µm² (b) atomic force microscopy of the $In_{0.30}Ga_{0.70}As$ graded buffer cap.

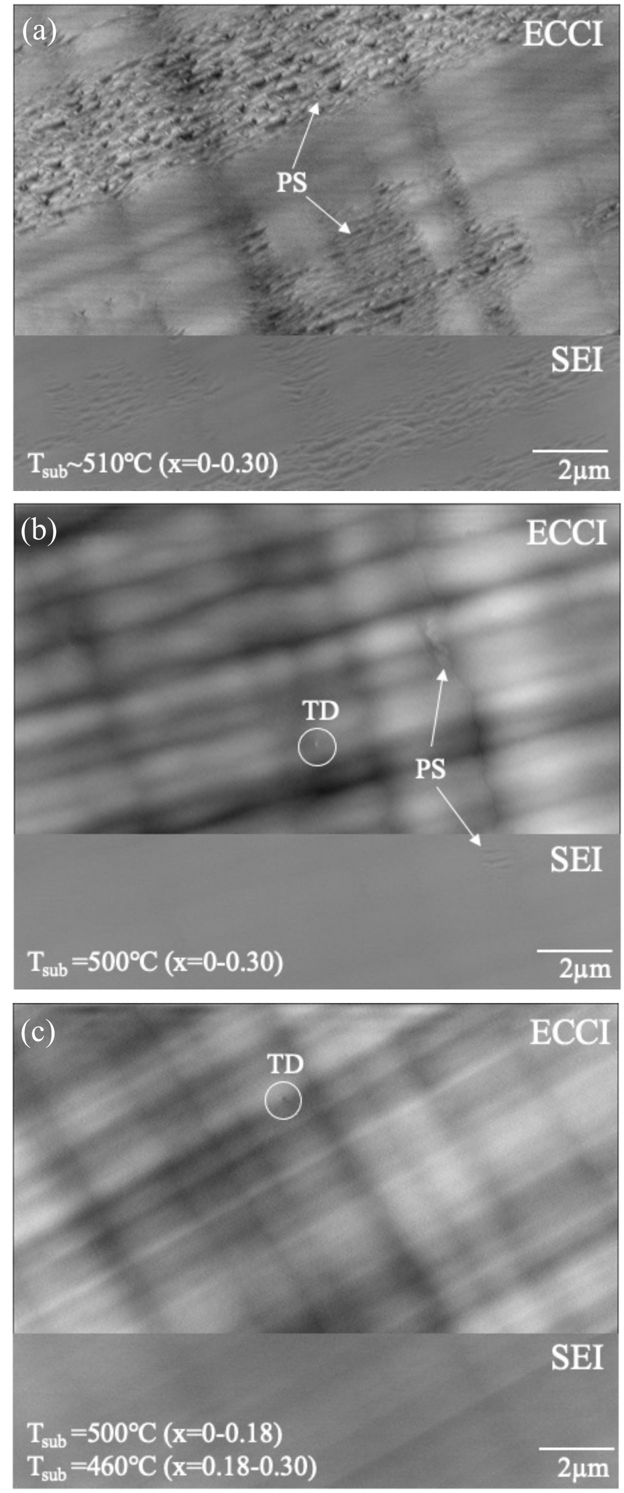


Figure 2: ECCI (top) and SEI (bottom) micrographs of $In_xGa_{1-x}As$ graded buffers grown at various temperatures. At ~510°C (a), rampant PS causes large-scale dislocation nucleation. At 500°C (b), dislocation nucleation is suppressed, but small patches of PS are present. Finally, when growing at 500°C for x=0-0.18 and 460°C for x=0.18-0.30 (c), PS is eliminated and the TDD of 7.0x10⁵ cm⁻³ is comparable to the lowest reported values for $In_{0.30}Ga_{0.70}As$.

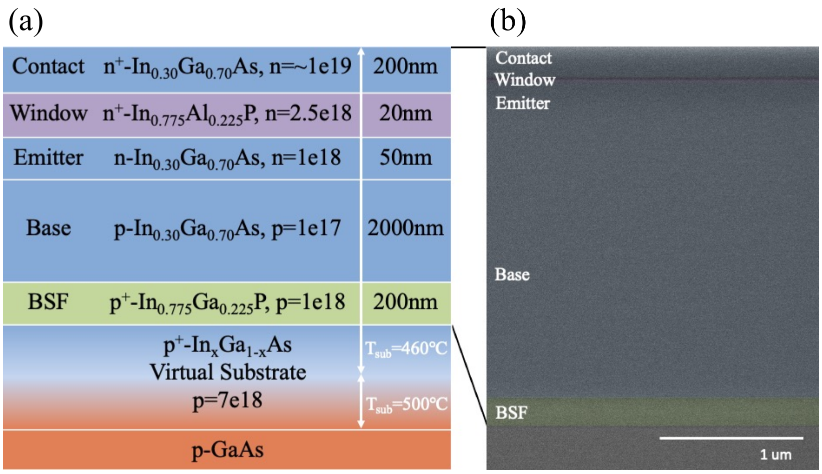


Figure 4: (a) Layer structure of 1 eV InGaAs solar cell grown on a two-step graded buffer. All layers of the device were grown at 460°C. (b) Cross-sectional SEM micrograph of the as-grown solar cell.

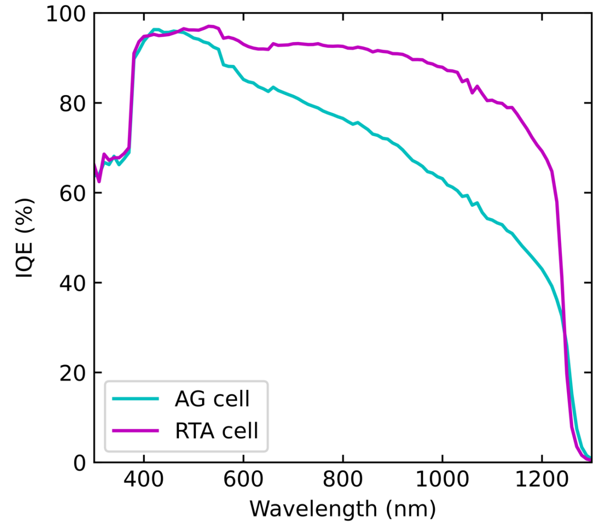
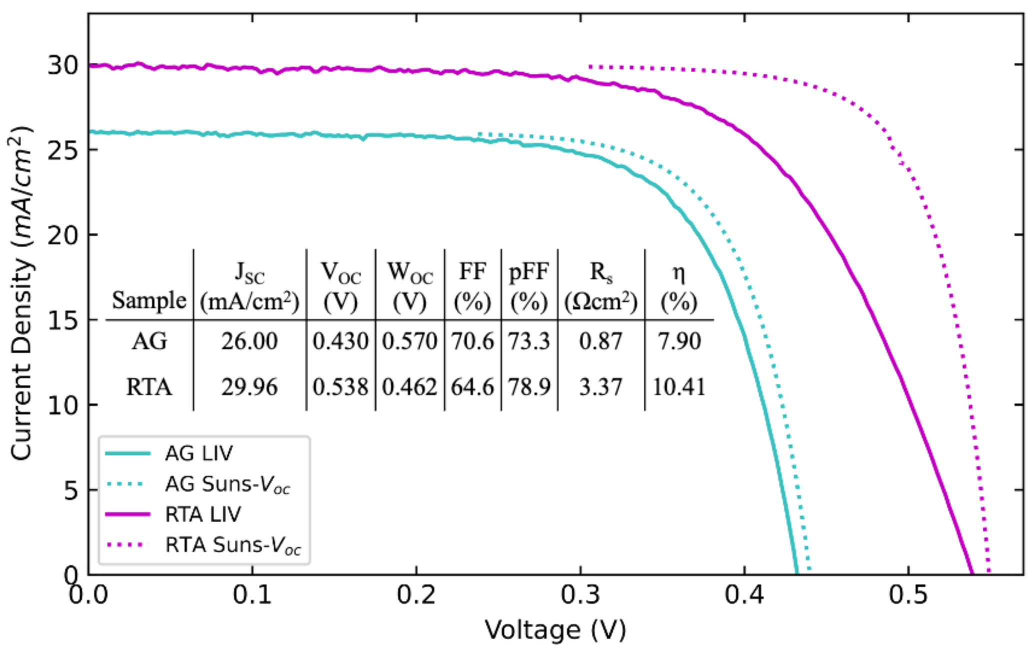


Figure 5: IQE spectra of AG and RTA'd cells. IQE of the RTA'd cell is significantly higher than the AG cell at longer wavelengths due to improved minority electron diffusion length in the base.



Sample	J_{SC} (mA/cm^2)	V_{OC} (V)	W_{OC} (V)	FF (%)	pFF (%)	R_s (Ωcm^2)	η (%)
AG	26.00	0.430	0.570	70.6	73.3	0.87	7.90
RTA	29.96	0.538	0.462	64.6	78.9	3.37	10.41

Figure 6: LIV curves under 1-sun AM1.5 and Suns-V_{oc} curves of the AG and RTA'd cells; the Suns-V_{OC} method allows a 'pseudo IV' curve to be collected without series resistance (R_S). No anti-reflection coatings were used. The RTA'd cell has similar J_{SC} and V_{OC} to other MBE-grown 1eV solar cells[6], but series resistance hinders its FF. However, the pFF extracted from Suns-V_{oc} measurements indicates potential for improvement of the cell if series resistance can be reduced.

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