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Type-II Interband cascade lasers grown on (100) GaAs substrates

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Introduction:

The production of **MIR gas sensors** on PICs requires **Sb-based light sources**. The growth on inexpensive and large-sized **mismatched substrates** ($\sim 8\%$ with GaAs) introduces dislocations. They create **deep levels** in the gap and act as trap defects, impacting laser performances. It's crucial to have an active zone **tolerant to dislocations**, which is achievable with interband cascade lasers (ICL).

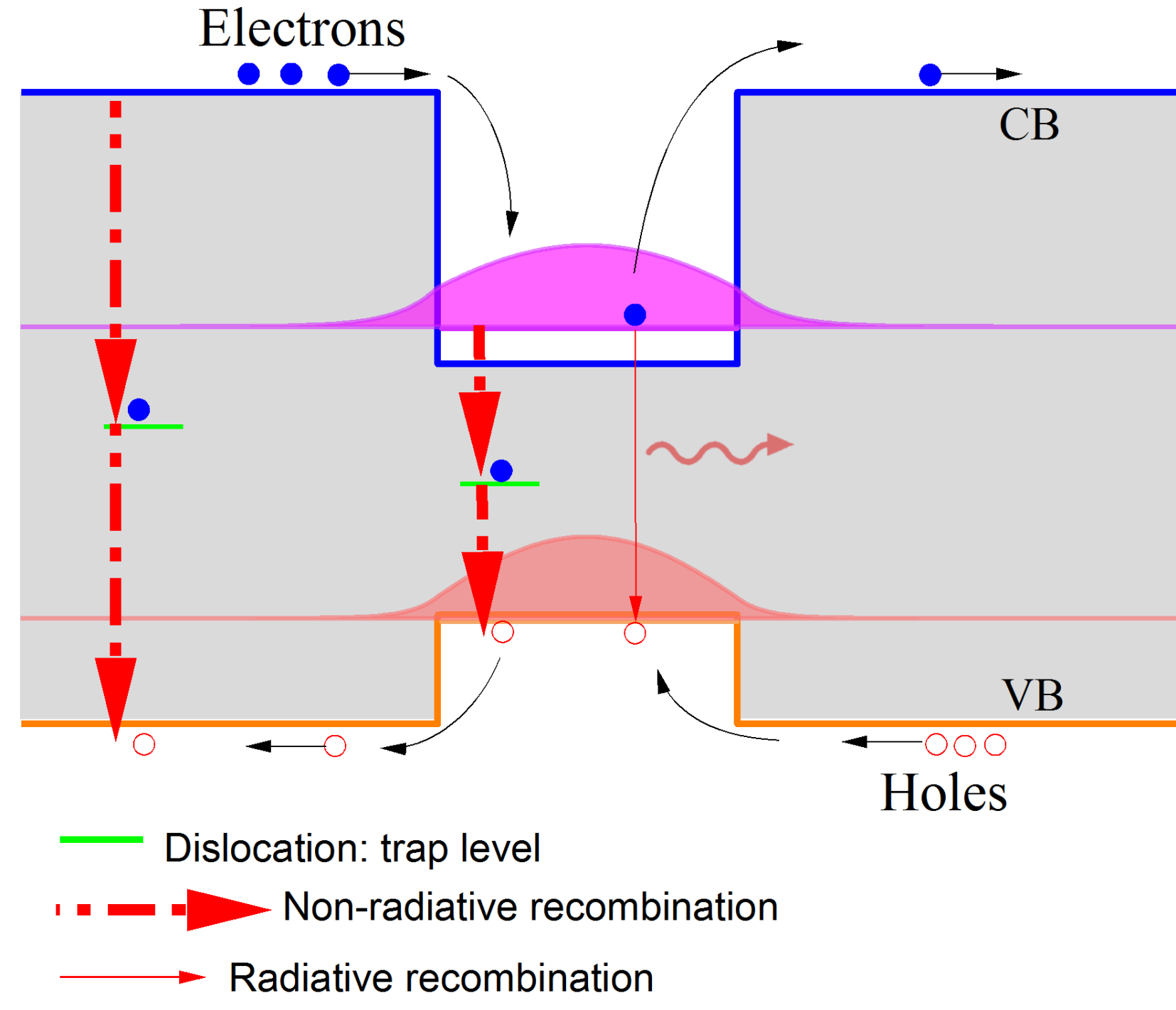
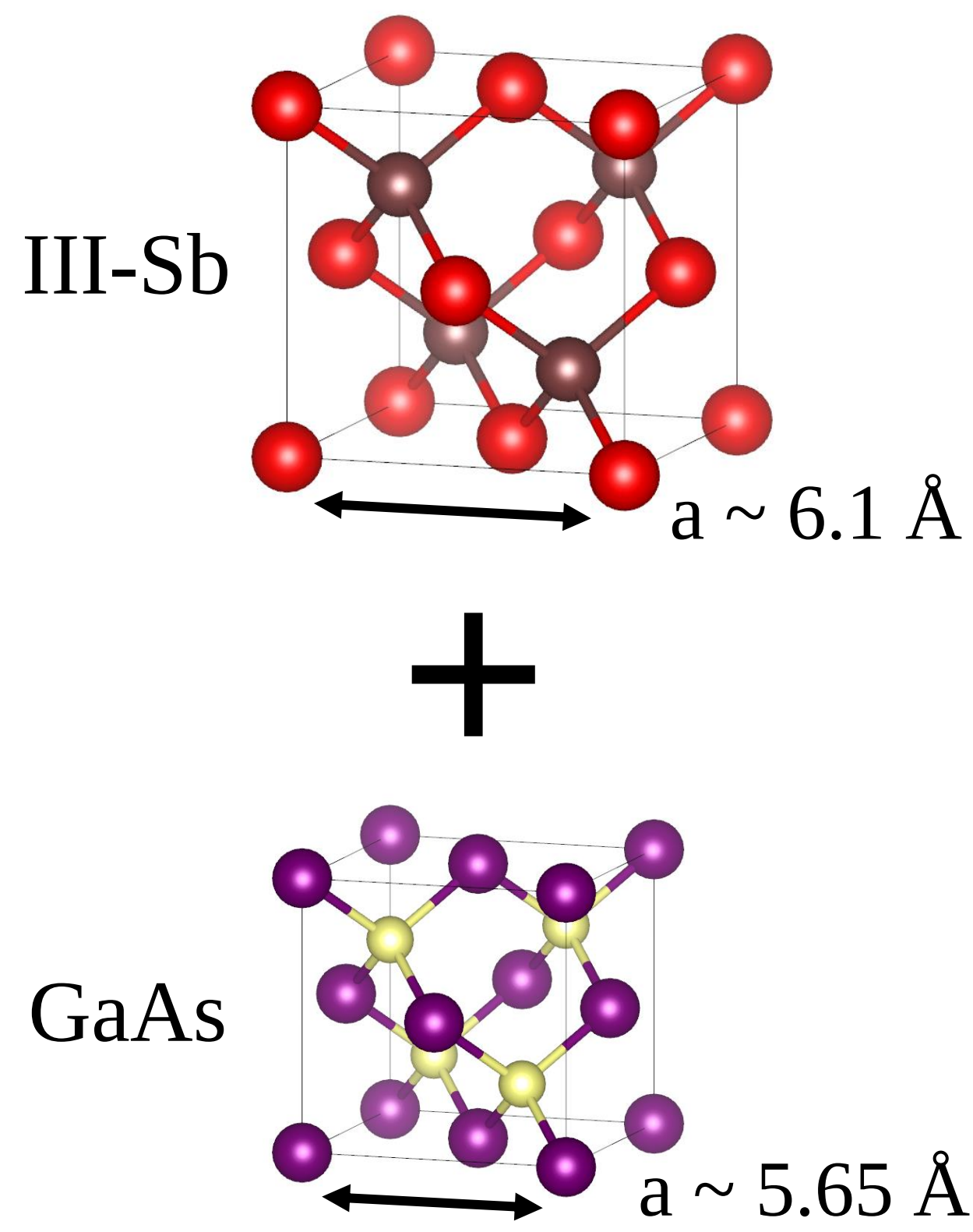


Fig. 1. Impact of dislocations in a type-I QW¹

¹ L. Cerutti et al., Optica, vol. 8, no 11, p. 1397, nov. 2021

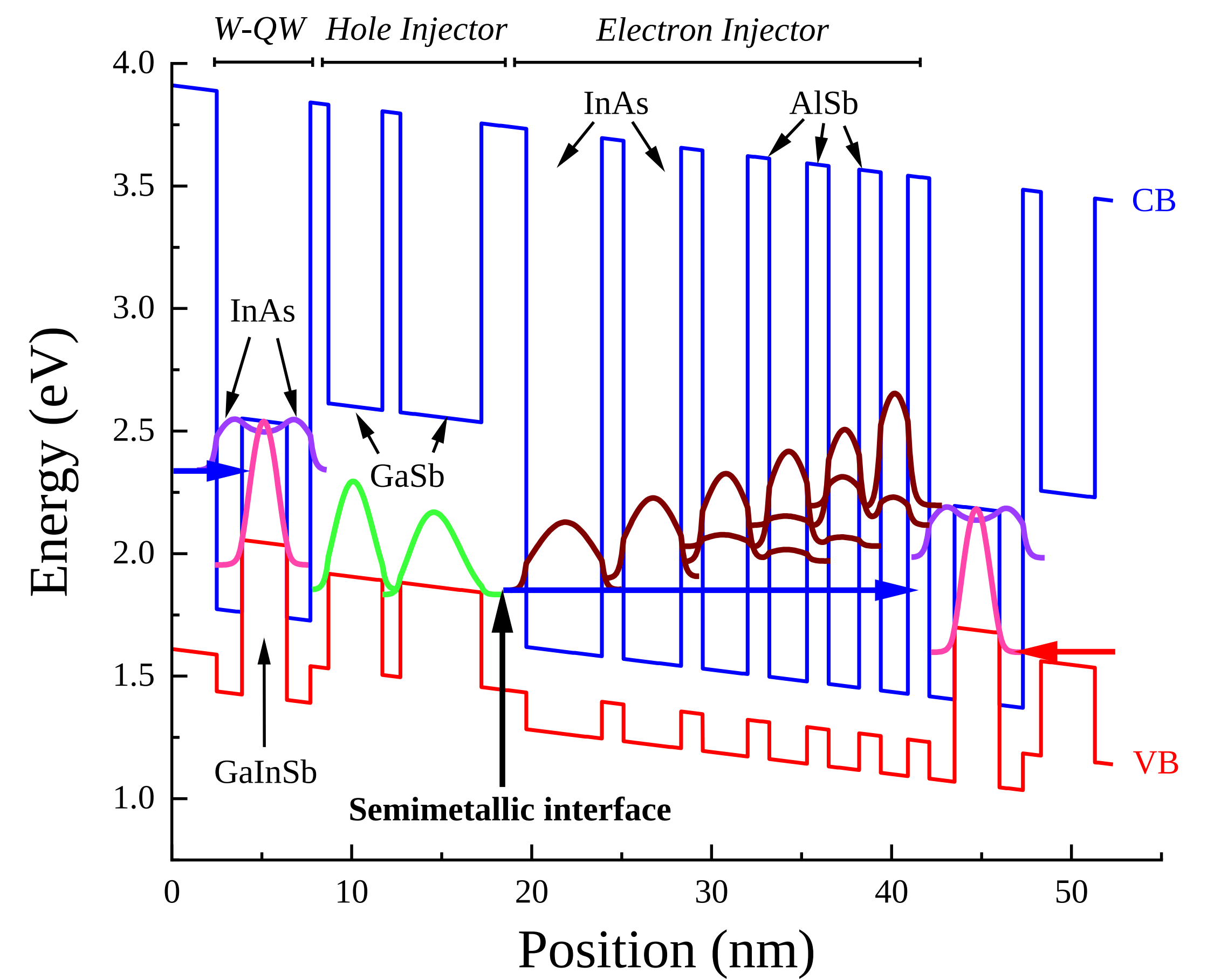


Fig. 2. Band structure of 1 stage of the ICL active zone

Surface and structural characterisations:

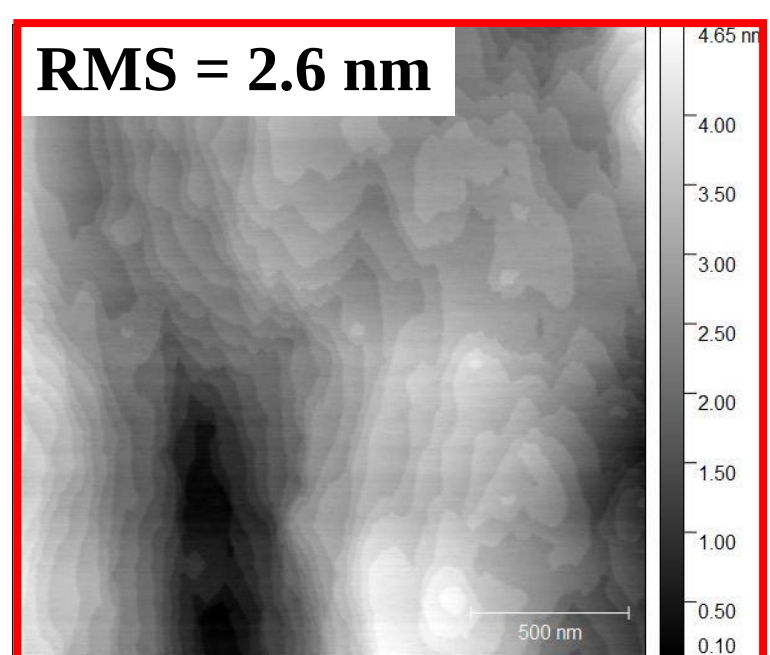
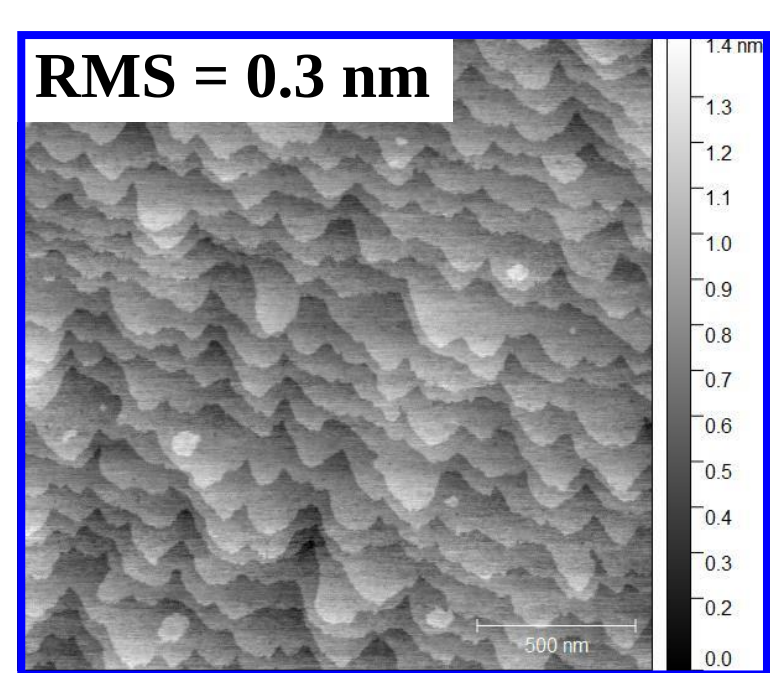


Fig. 3. $2 \mu\text{m} \times 2 \mu\text{m}$ AFM images for ICLs with SLs claddings

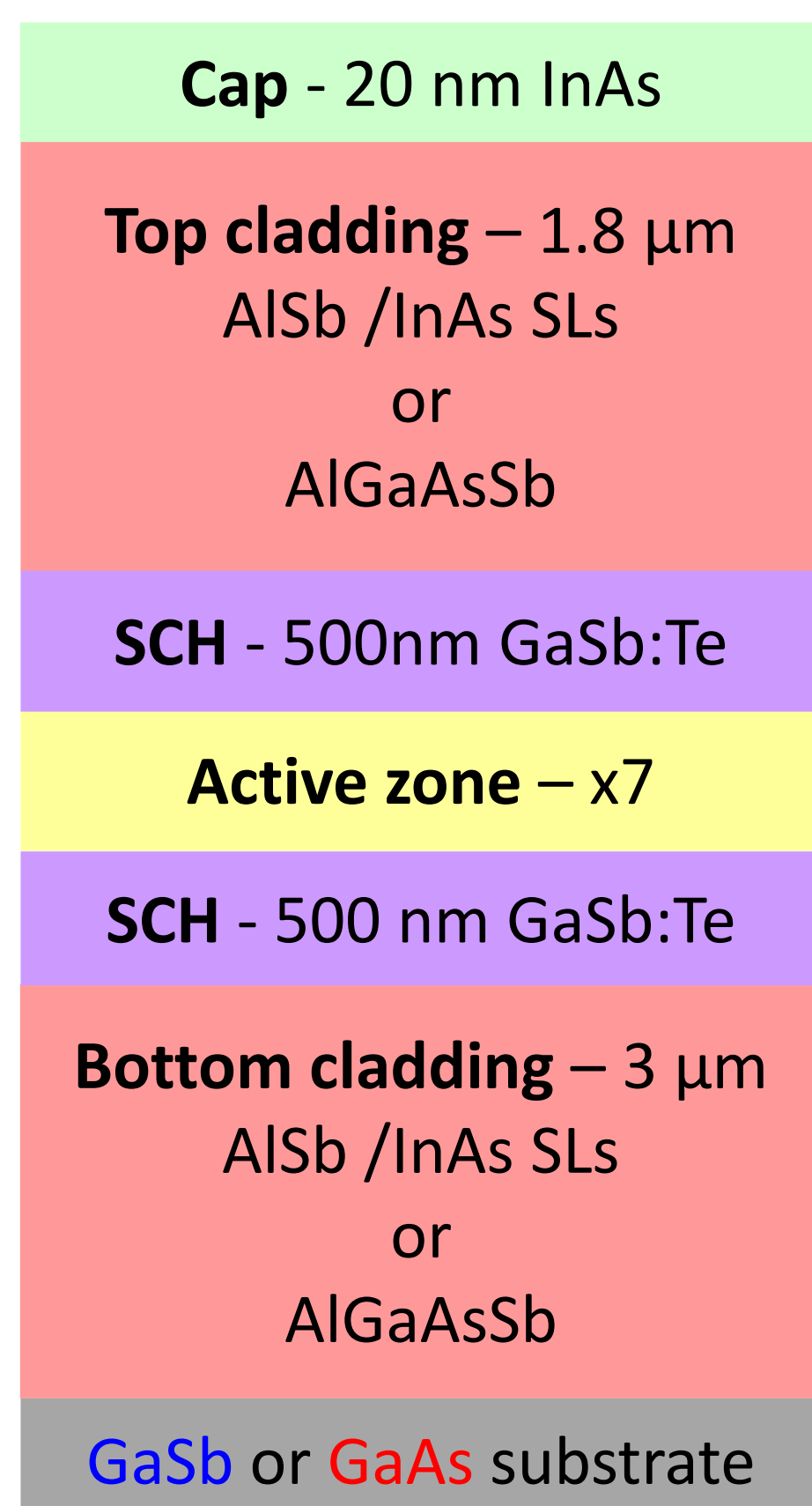


Fig. 4. ICL structure

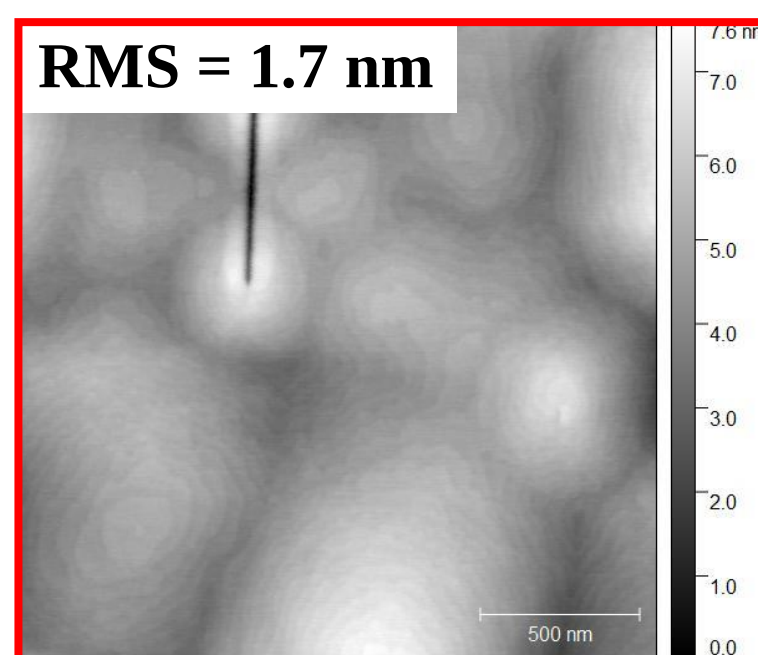
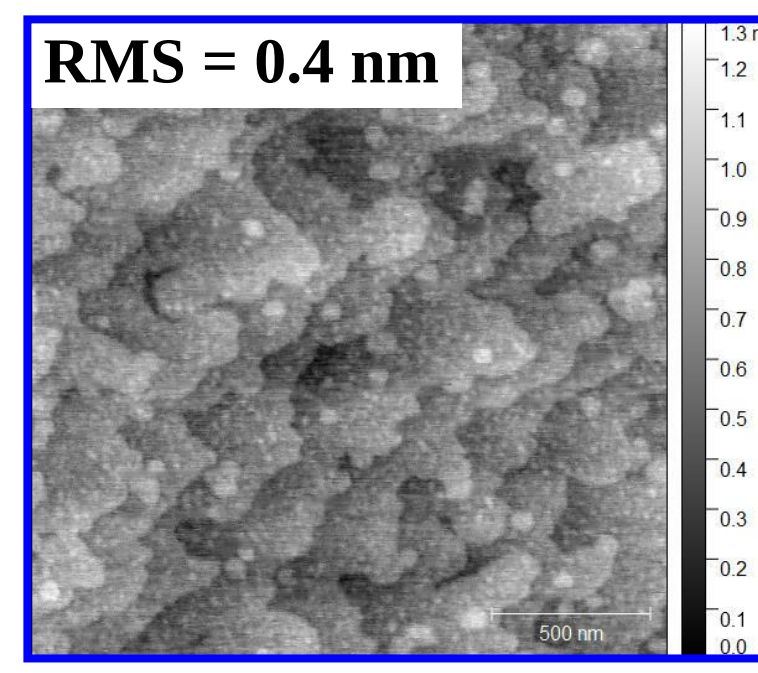


Fig. 5. $2 \mu\text{m} \times 2 \mu\text{m}$ AFM images for ICLs with AlGaAsSb claddings

Higher RMS on GaAs $\rightarrow$ Spiral growth mode (TDD $\sim 10^8 \text{ cm}^{-2}$)

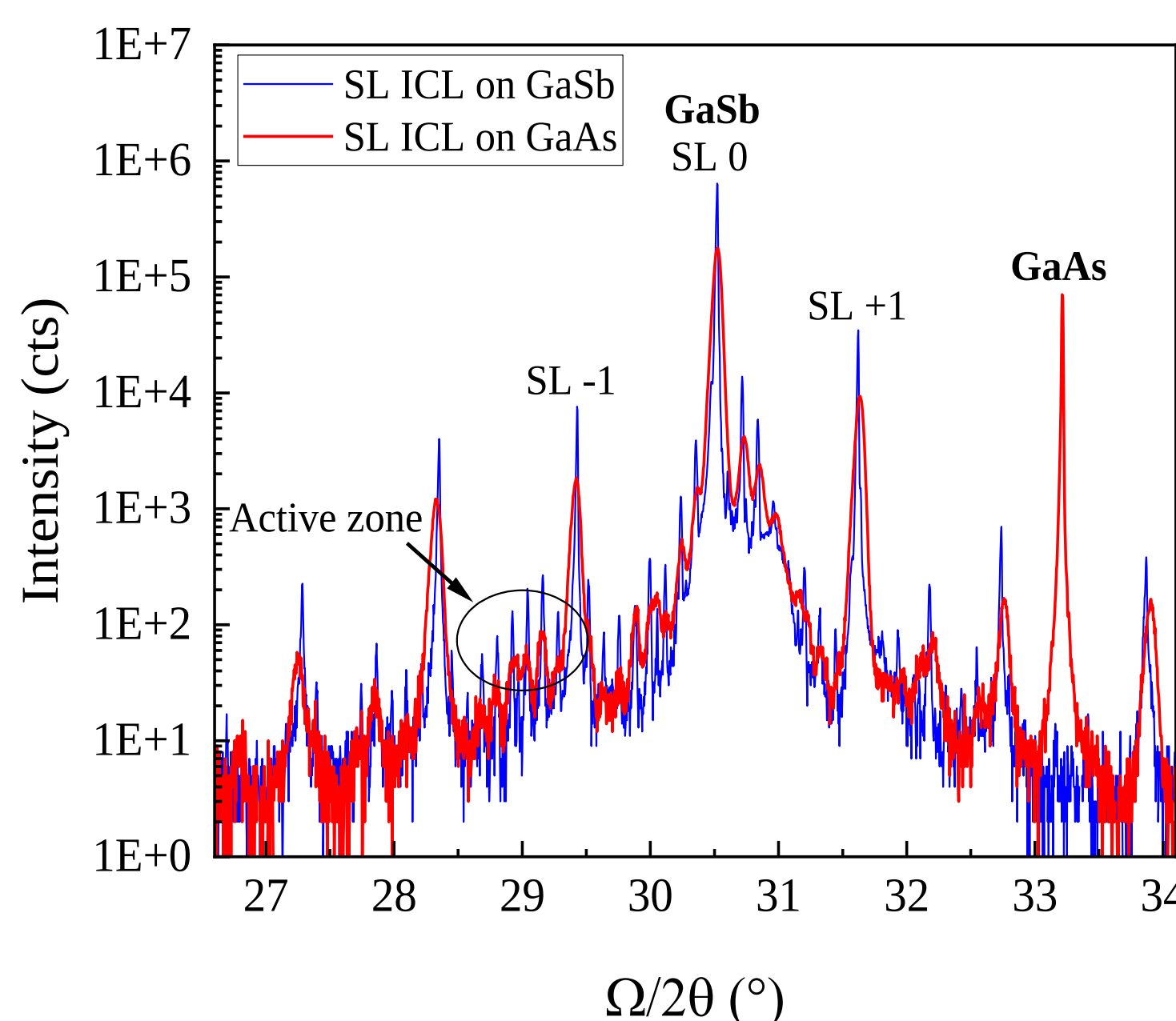


Fig. 6. XRD pattern for ICLs with SLs claddings

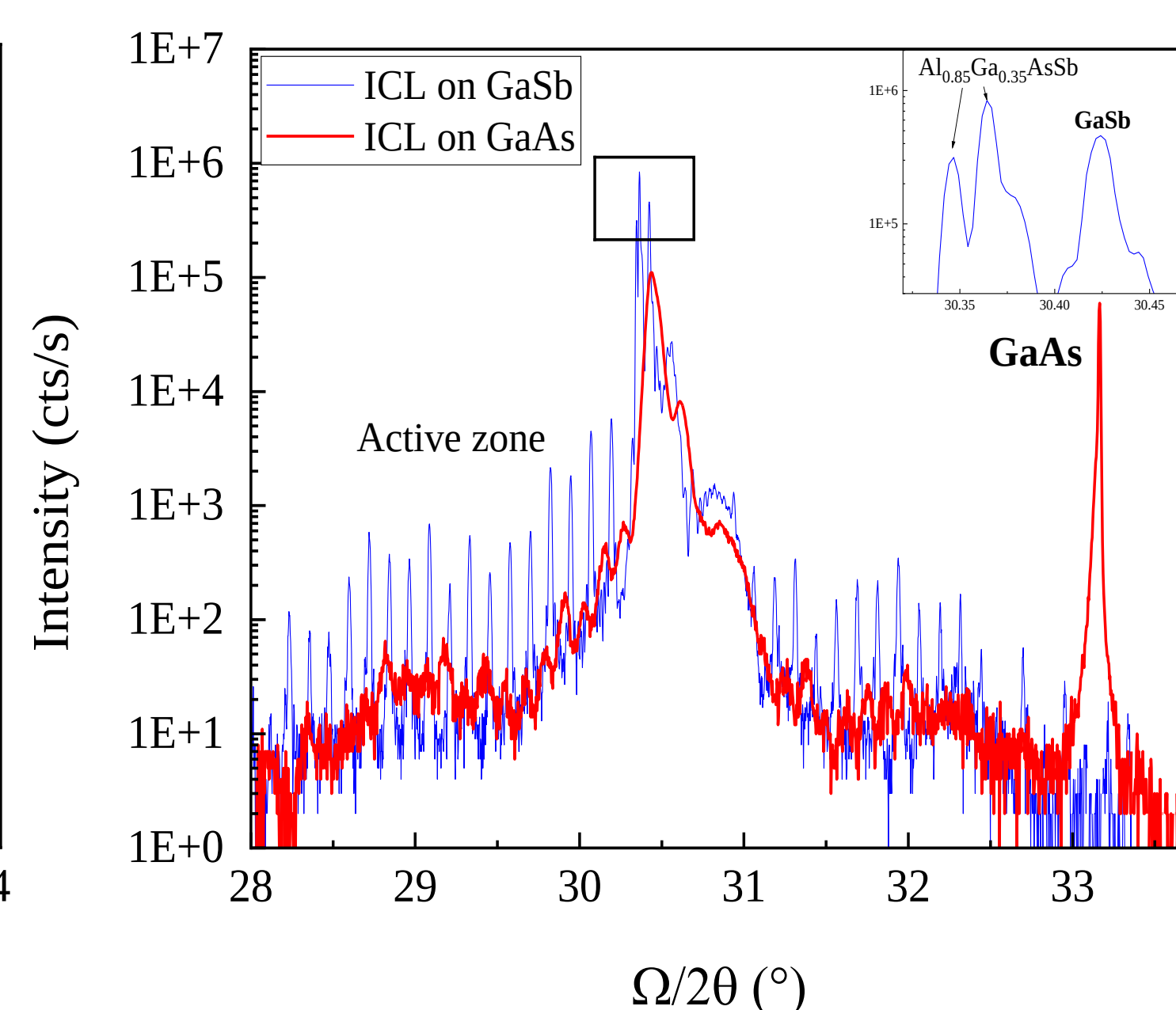


Fig. 7. XRD pattern for ICLs with AlGaAsSb claddings

Broad the satellites peaks on GaAs $\rightarrow$ dislocations

Results:

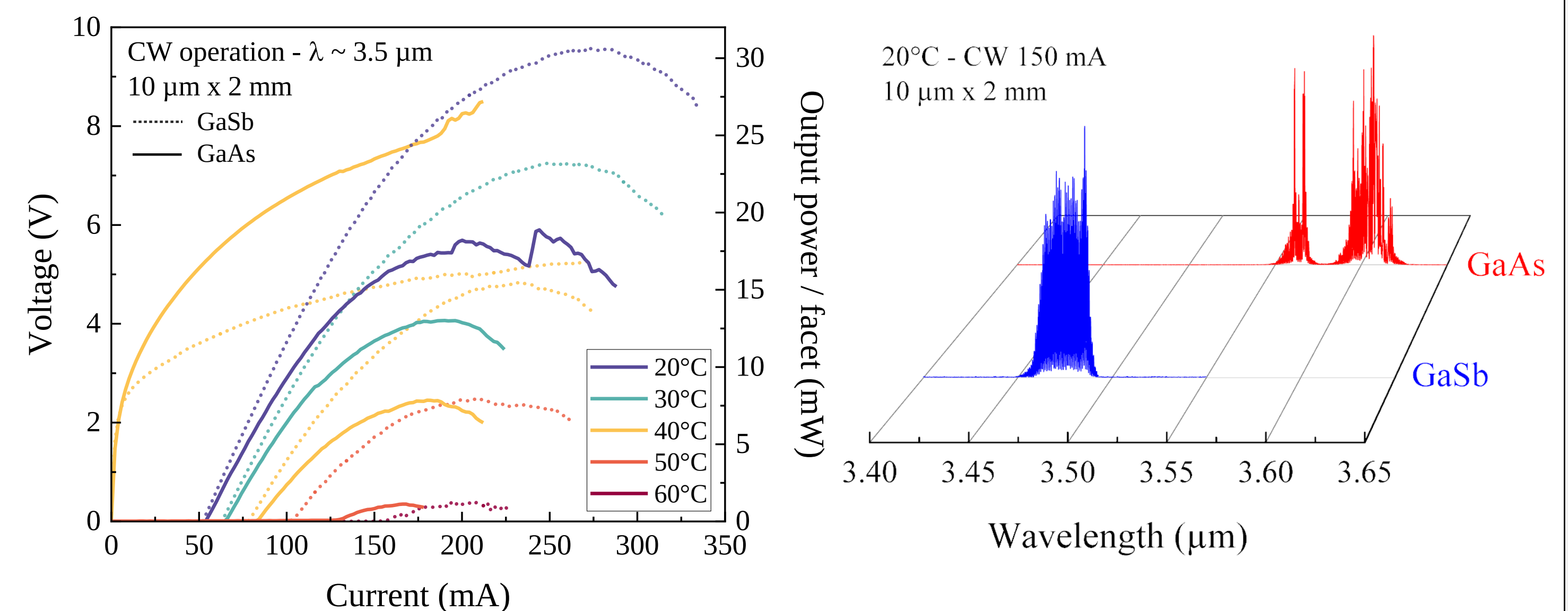


Fig. 8. (a) LIV curves of a $10 \mu\text{m} \times 2 \text{ mm}$ AlGaAsSb ICL on GaSb and GaAs (b) Spectra

- Similar I_{th} up to 40°C
- CW operation up to 50°C

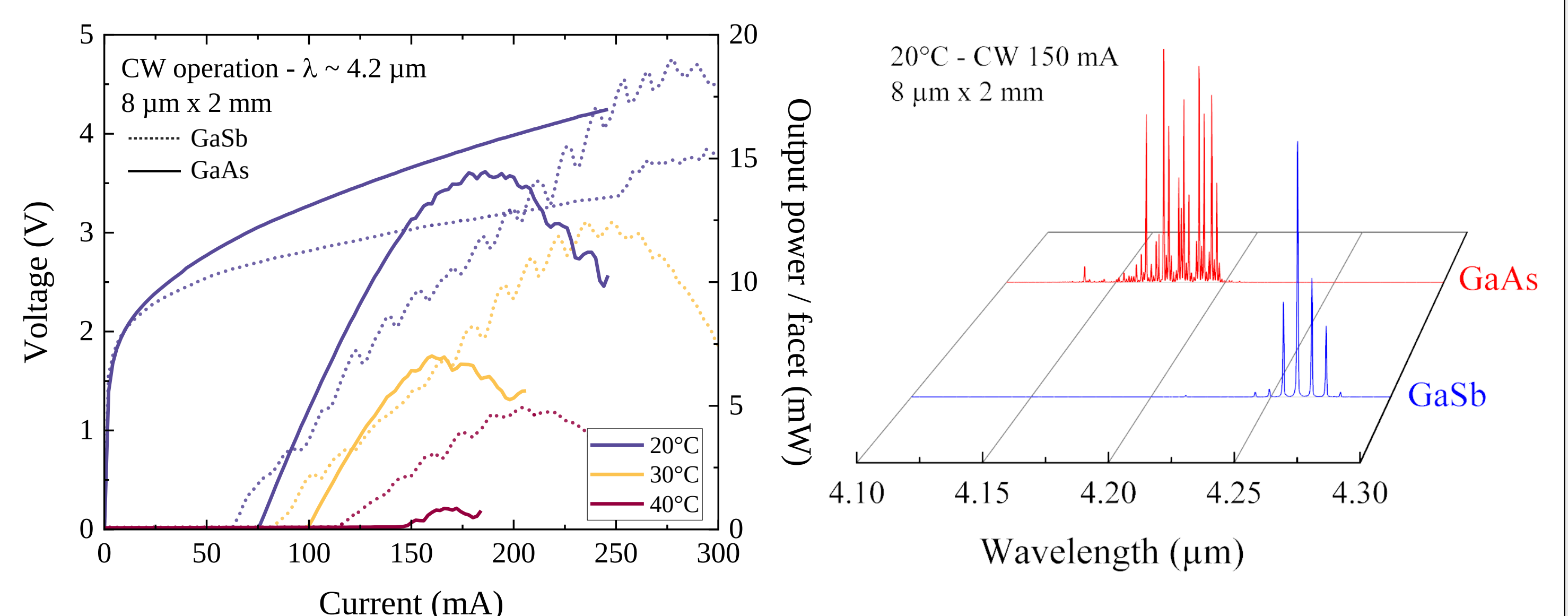


Fig. 9. (a) LIV curves of a $8 \mu\text{m} \times 2 \text{ mm}$ SLs ICL on GaSb and GaAs (b) Spectra

- $I_{th}(\text{GaAs}) \sim I_{th}(\text{GaSb})$
- CW operation up to 40°C

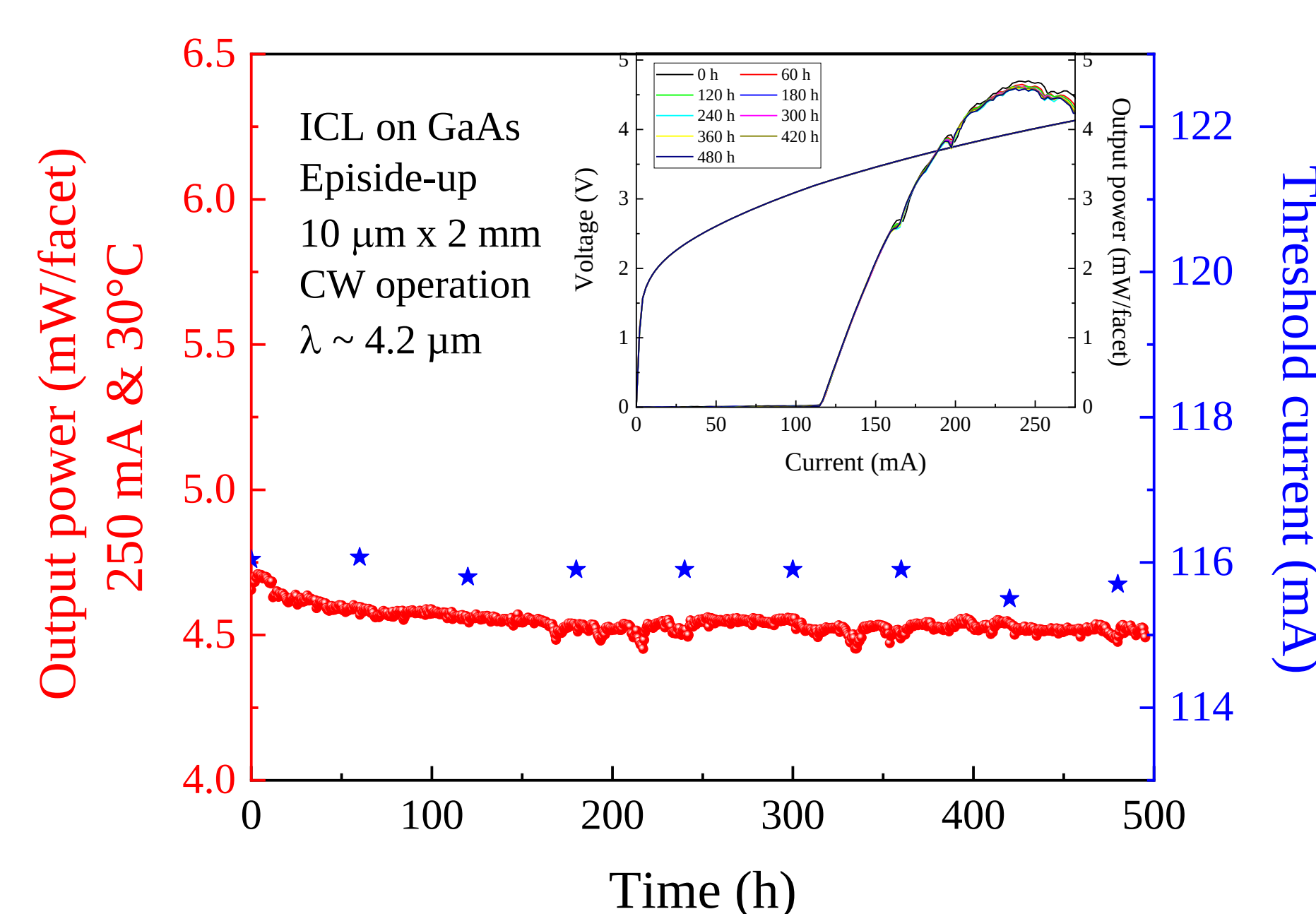


Fig. 10. Ageing of an ICL on GaAs

No degradation during ageing
 $\downarrow$
TOLERANCE to dislocations
 $\downarrow$
Towards integration on Si

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