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MIR Sb-based Interband cascade lasers on metamorphic 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** 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).

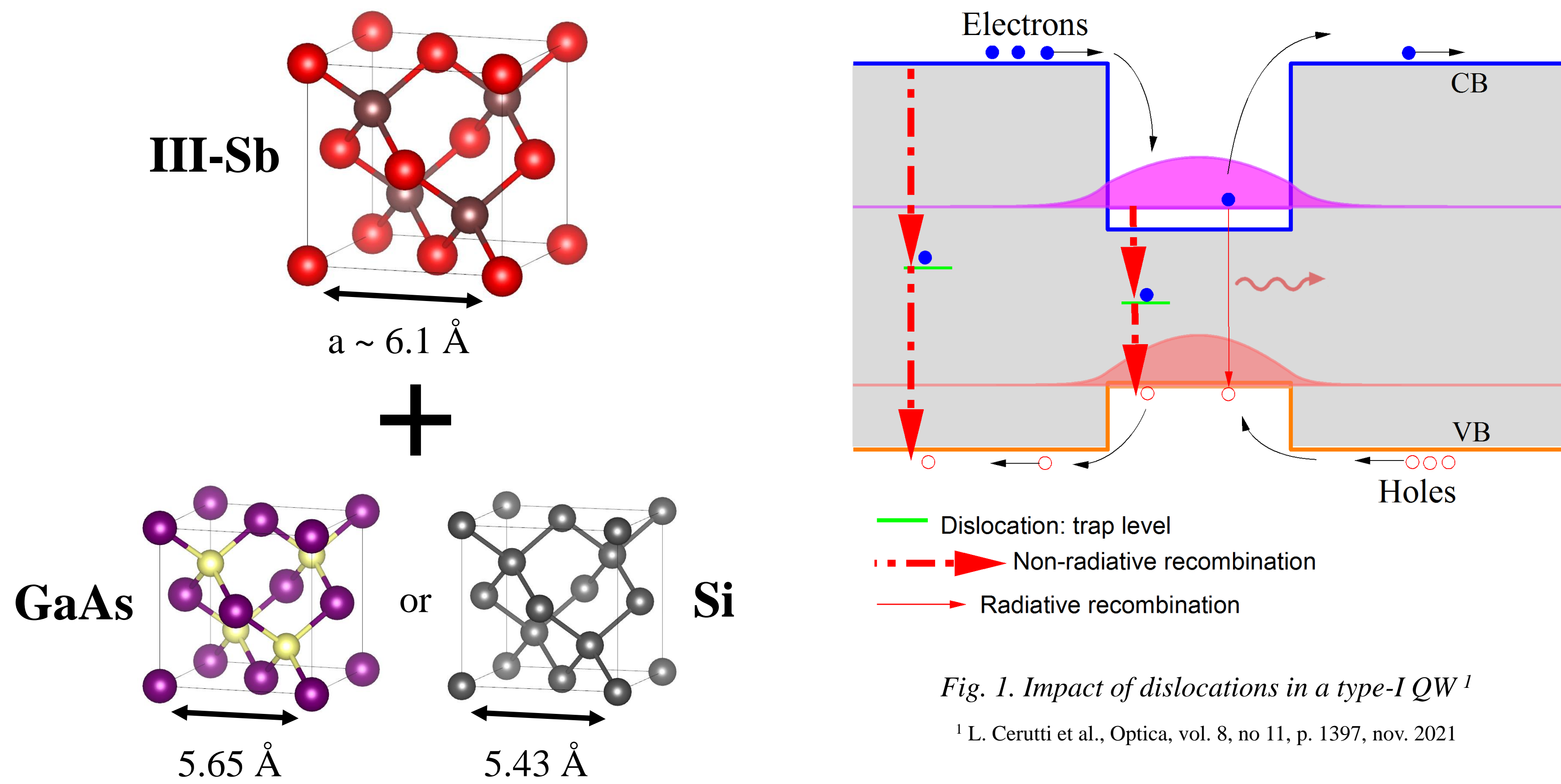


Fig. 1. Impact of dislocations in a type-I QW¹

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

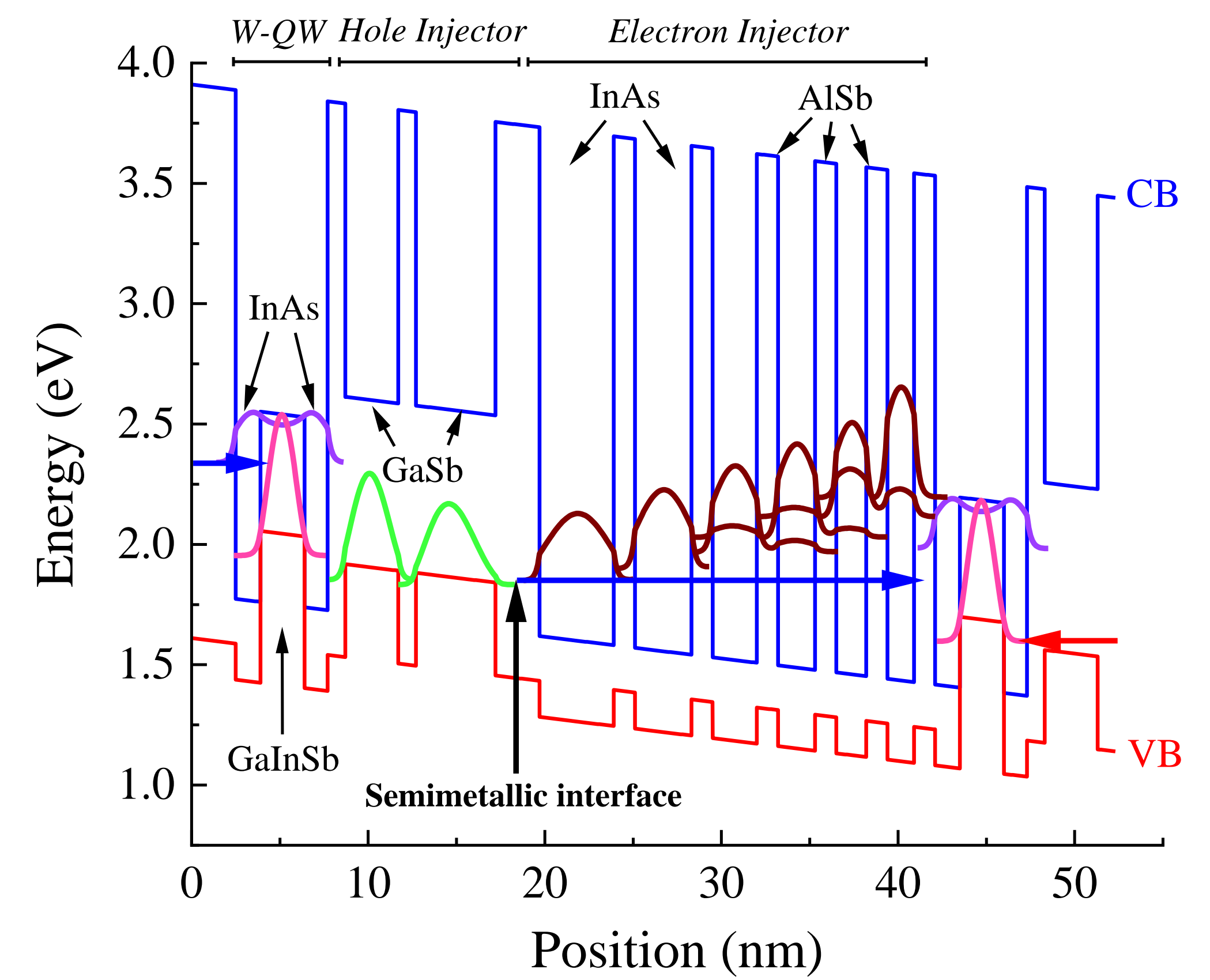


Fig. 2. Band structure of 1 stage of the ICL active zone

Structural characterizations:

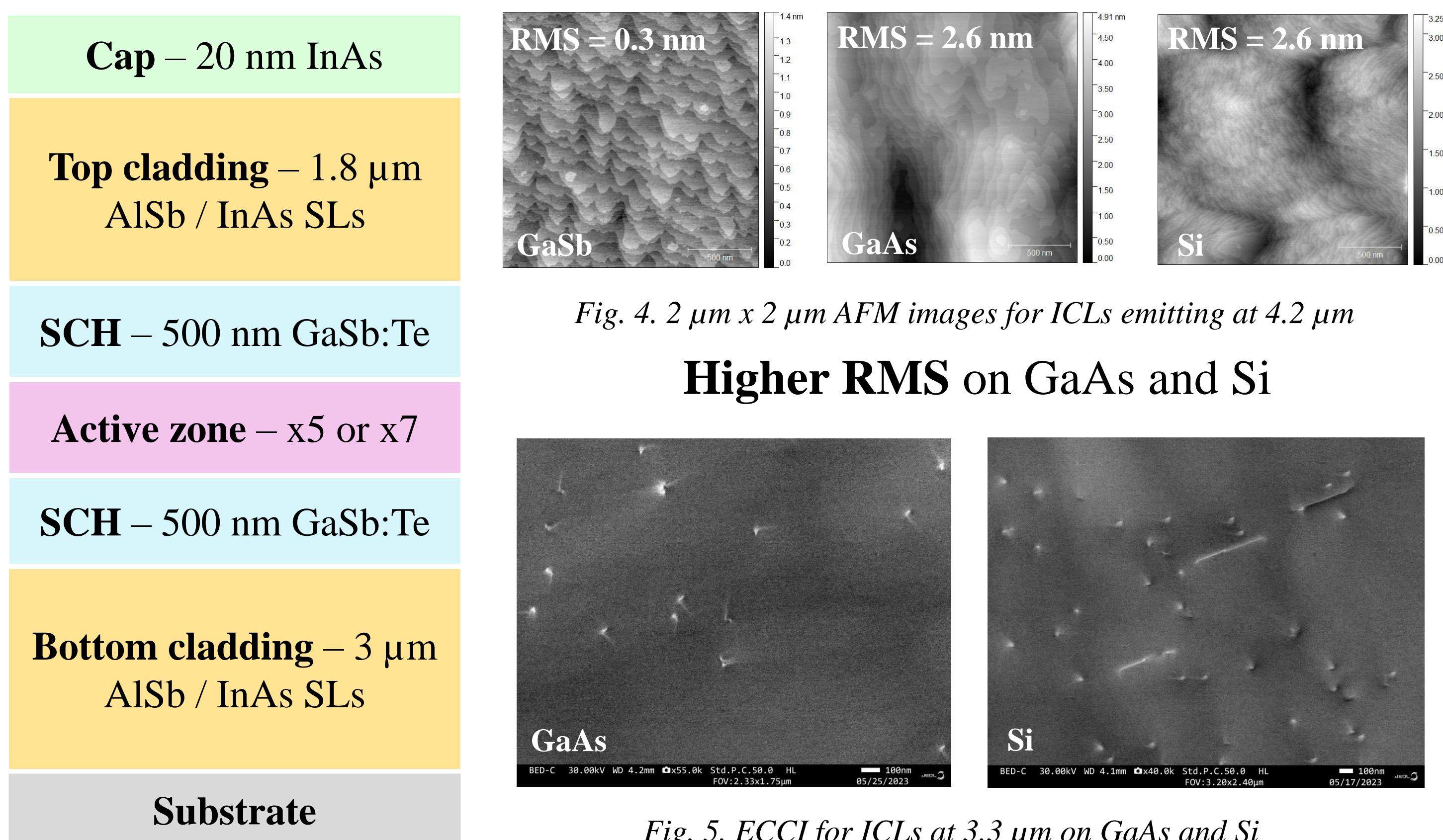


Fig. 4. 2 μm x 2 μm AFM images for ICLs emitting at 4.2 μm

Higher RMS on GaAs and Si

Fig. 5. EDCI for ICLs at 3.3 μm on GaAs and Si

TDD ~ 5.10⁸ cm⁻²

Fig. 3. ICL structure

Growth on **mismatched** substrates → **High** dislocation density (>10⁸ cm⁻²)

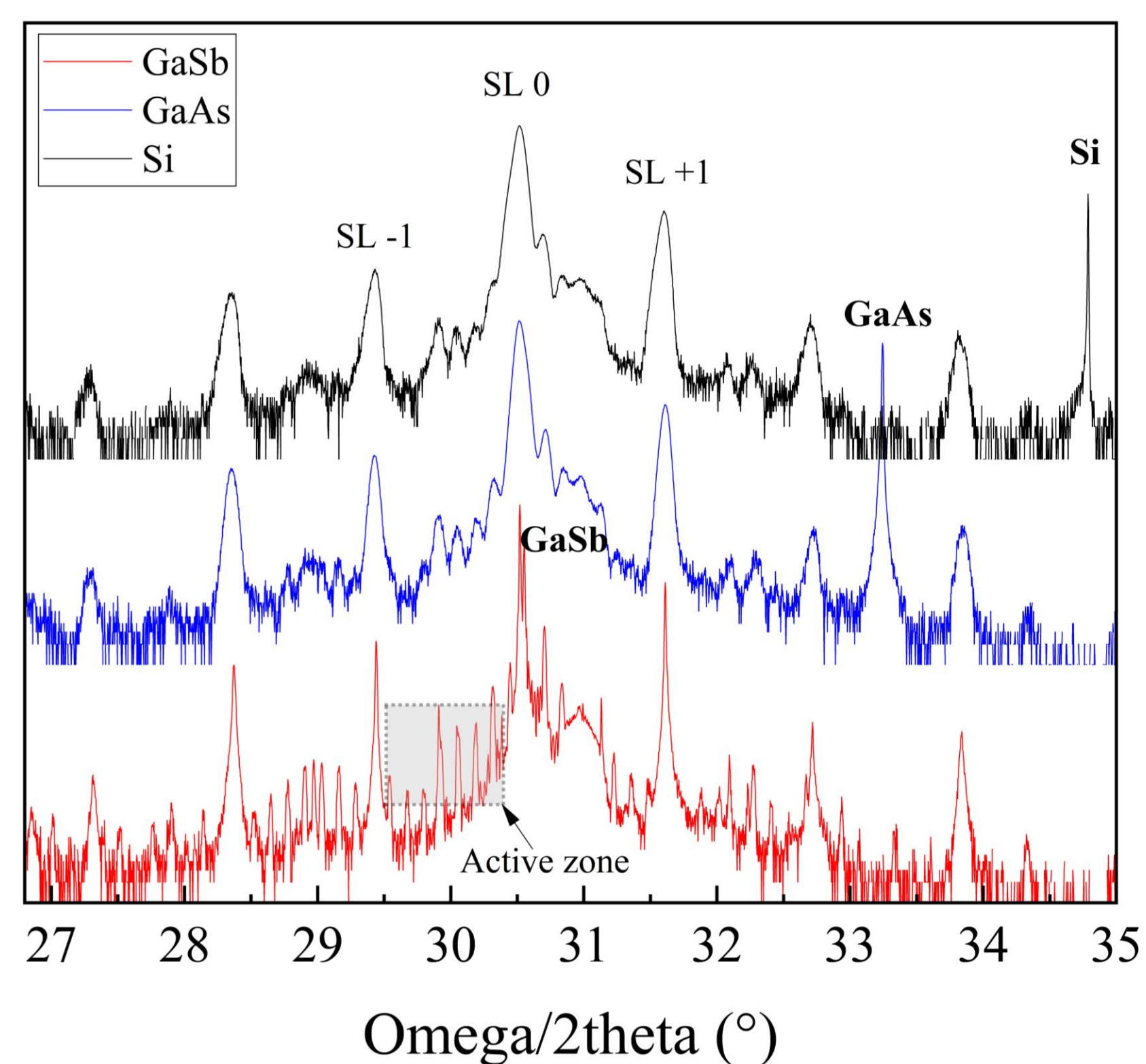
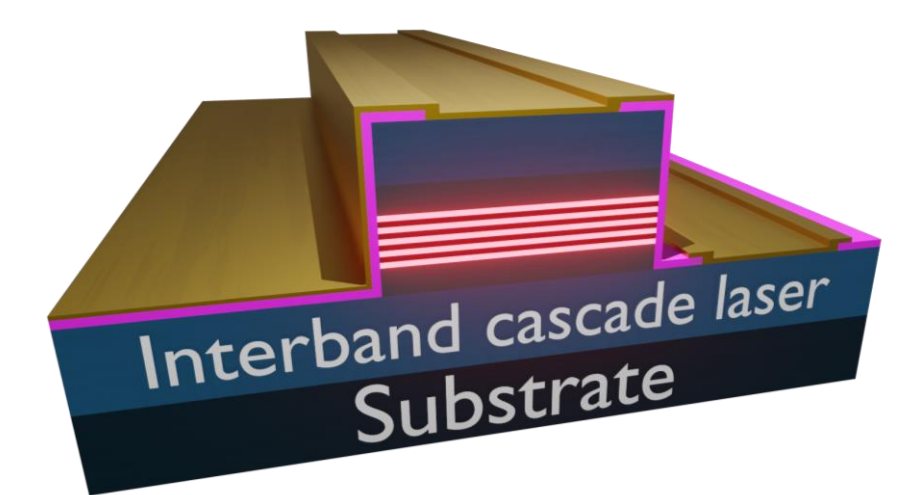


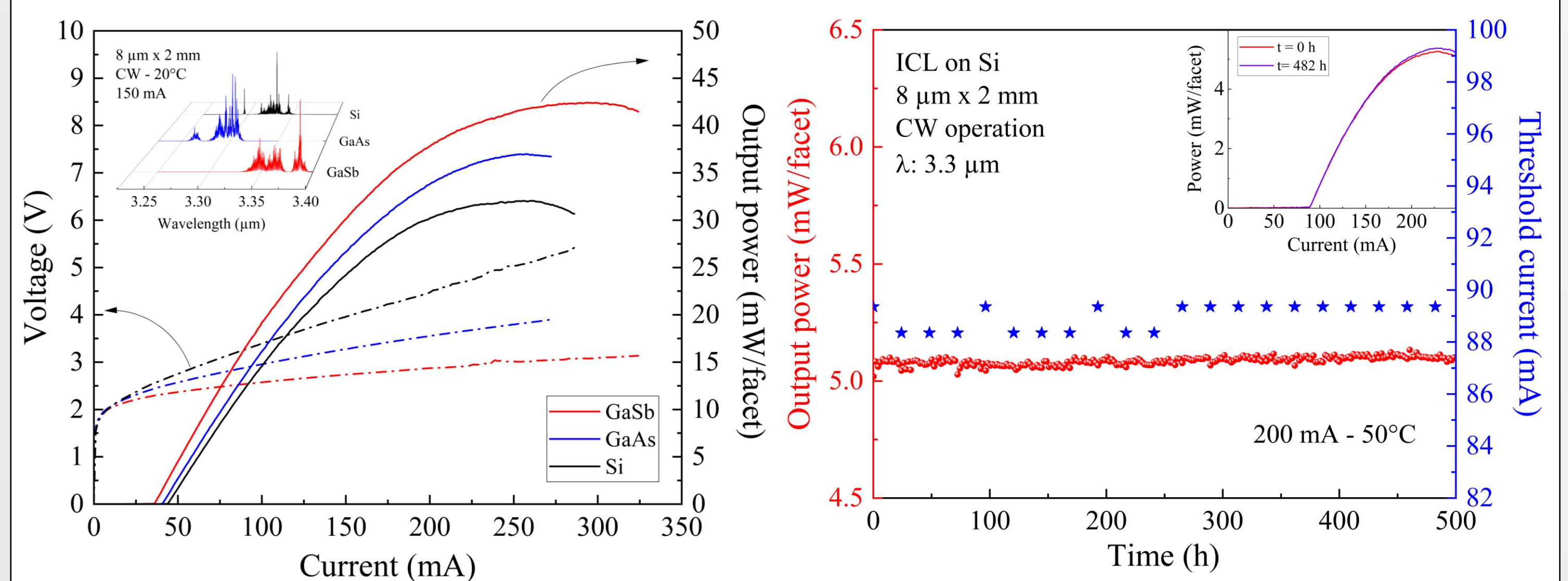
Fig. 6. Comparison of XRD patterns for ICLs grown on different substrates

Results:

ICLs **epi-side-up** with **uncoated facets** and both contacts taken on the epitaxial side

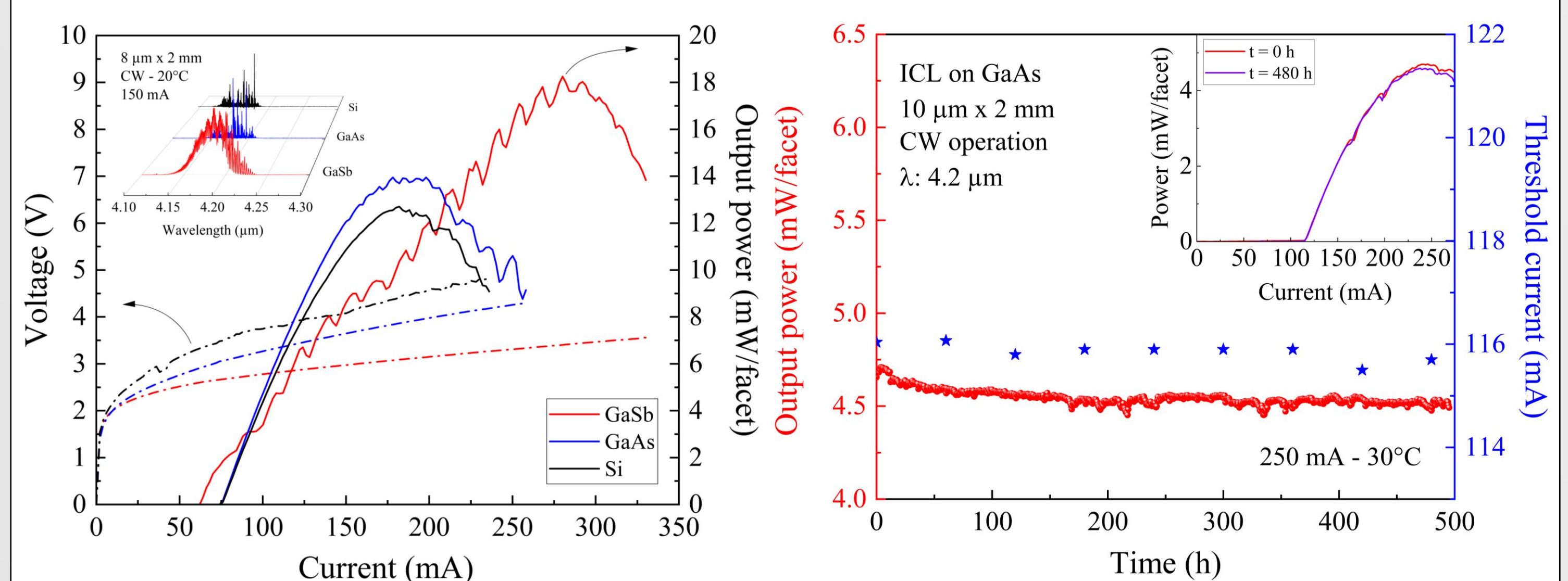


Lasers at 3.3 μm



Similar I_{th} : 40 mA • CW operation up to ~ 65°C • Same T_0 : 39K

Lasers at 4.2 μm



$I_{th}(GaSb) \sim I_{th}(GaAs/Si)$ • CW operation up to 40°C • Same T_0 : 32K

Conclusion:

No degradation during the aging

ICLs tolerant to dislocations between 3.3 and 4.2 μm

Towards integration on PICs

Funding sources:



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