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

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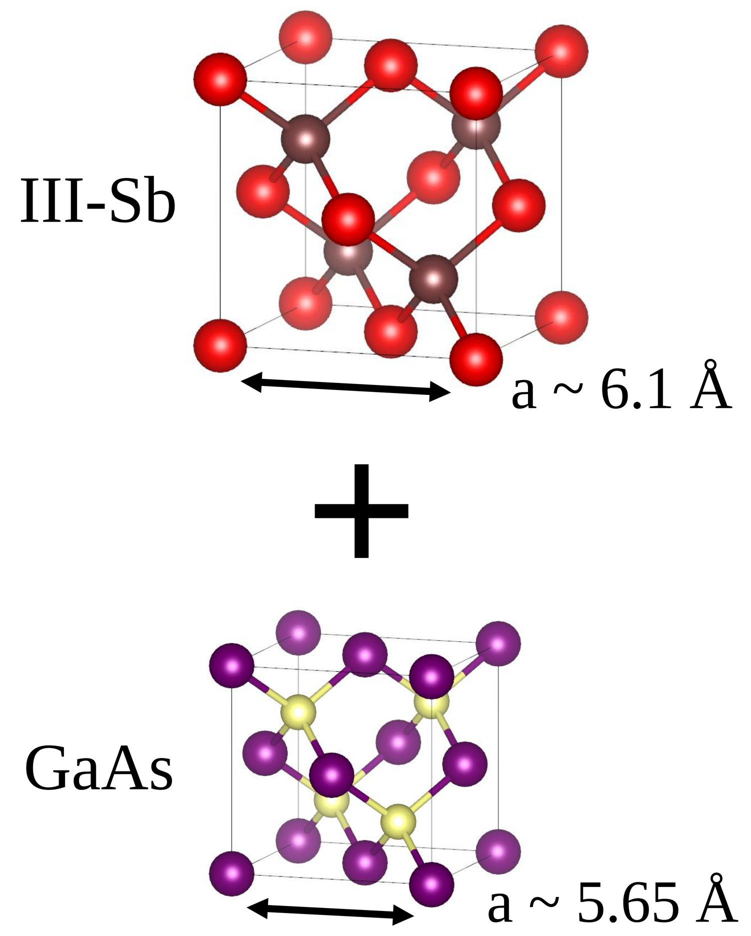
Introduction:

The production of **MIR gas sensors** on PICs requires **Sb-based light sources**. The growth on inexpensive and large-sized **mismatched substrates** (~ 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).



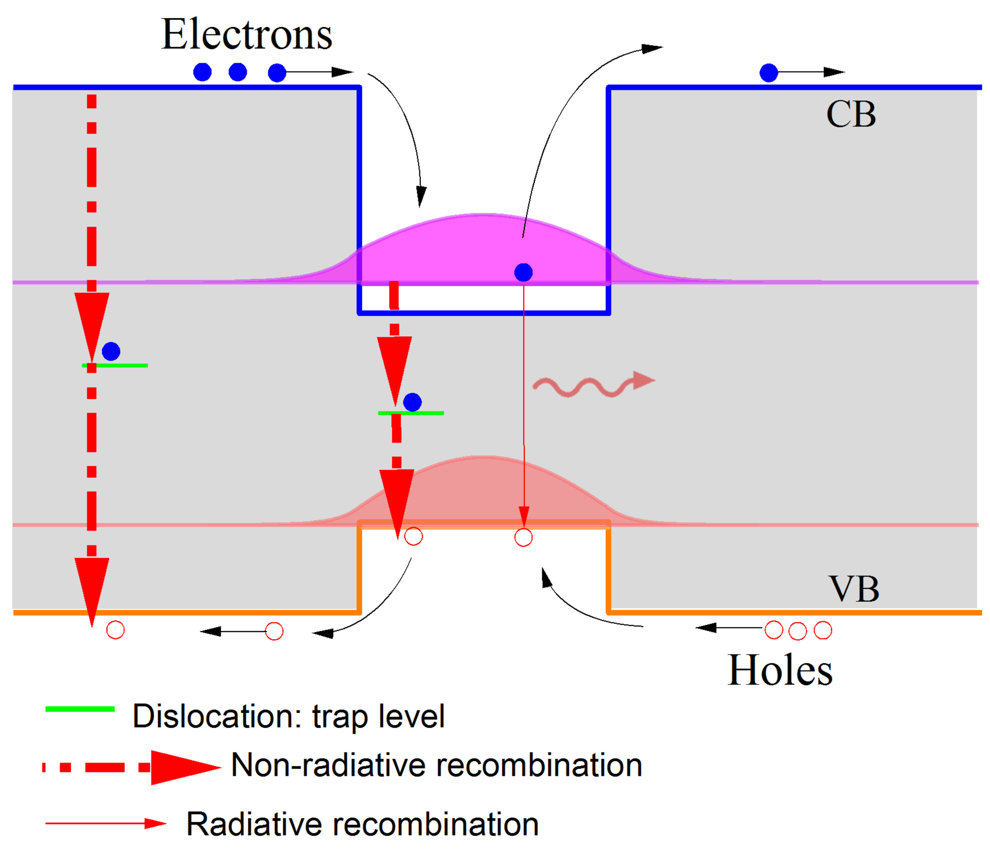


Fig. 1. Impact of dislocations in a type-I QW [1]

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

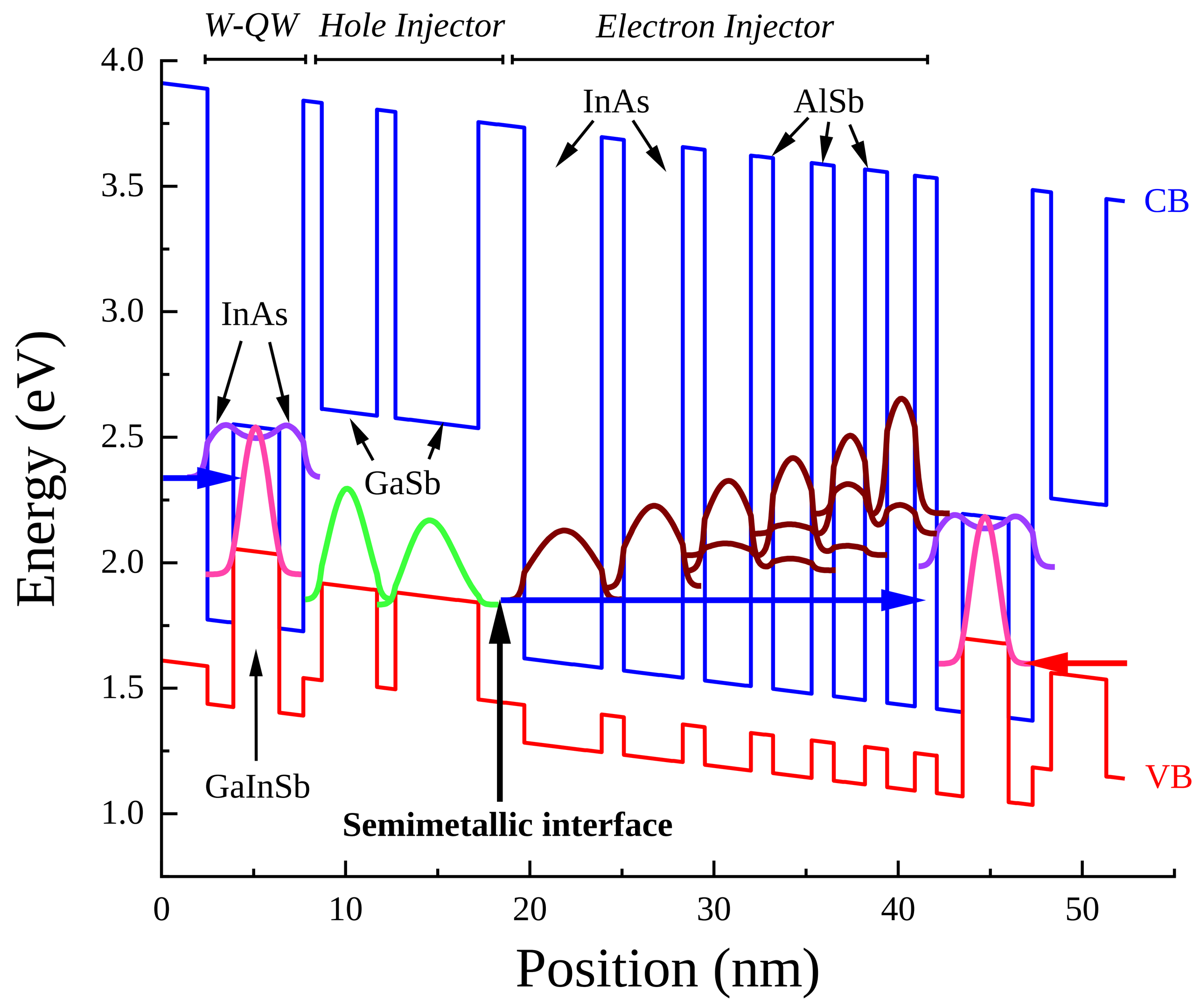


Fig. 2. Band structure of 1 stage of the ICL active zone

Surface and structural characterisations:

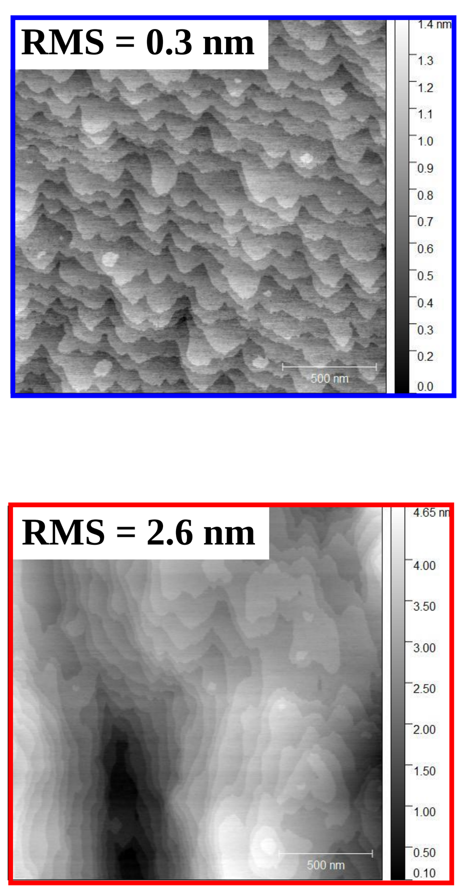


Fig. 3. 2 µm x 2 µm AFM images for ICLs with SLs claddings

Cap - 20 nm InAs

Top cladding – 1.8 µm AlSb /InAs SLs or AlGaAsSb

SCH - 500nm GaSb:Te

Active zone – x7

SCH - 500 nm GaSb:Te

Bottom cladding – 3 µm AlSb /InAs SLs or AlGaAsSb

GaSb or GaAs substrate

Fig. 4. ICL structure

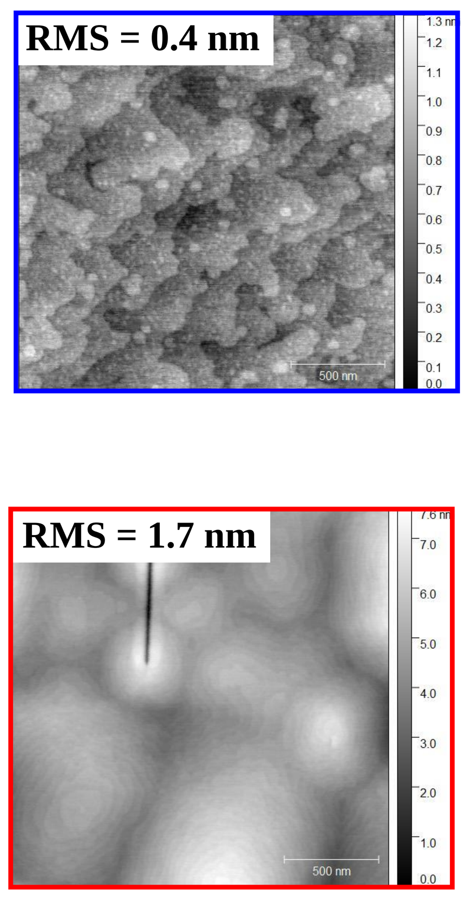


Fig. 5. 2 µm x 2 µm AFM images for ICLs with AlGaAsSb claddings

Higher RMS on GaAs → **Spiral** growth mode (TDD ~ 10^8 cm^{-2})

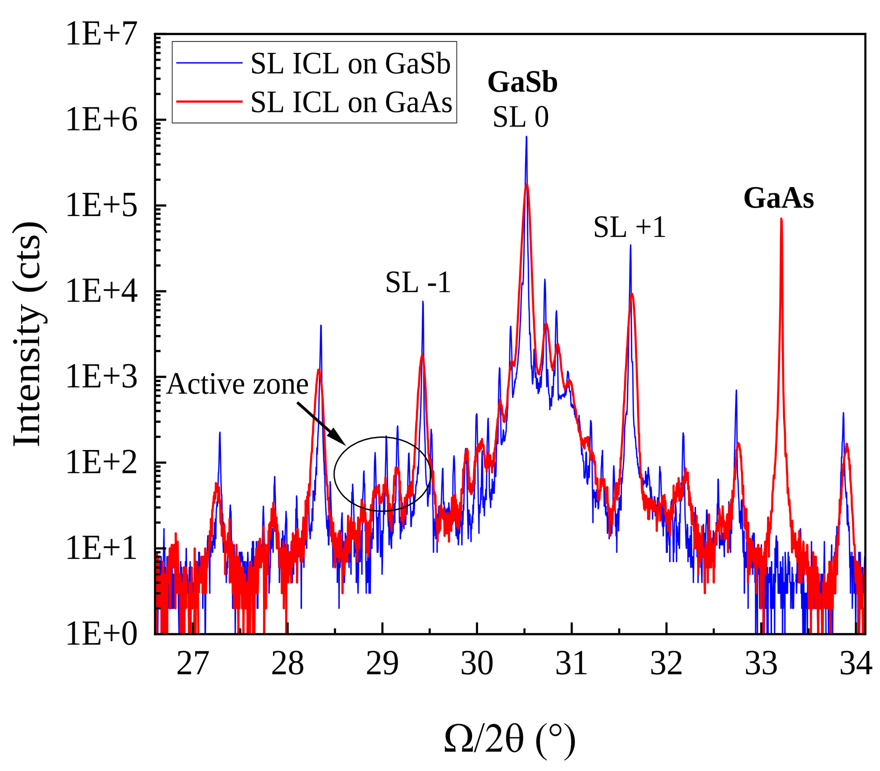


*Fig. 6. XRD pattern for ICLs with **SLs** claddings*

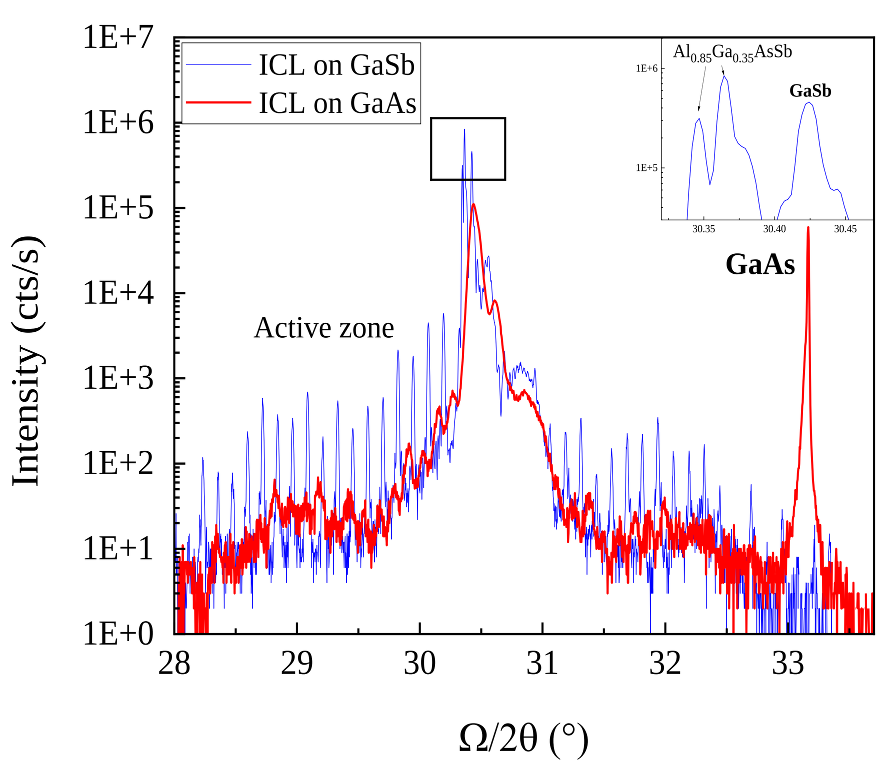


*Fig. 7. XRD pattern for ICLs with **AlGaAsSb** claddings*

Broad the satellites peaks on GaAs → dislocations

Results:

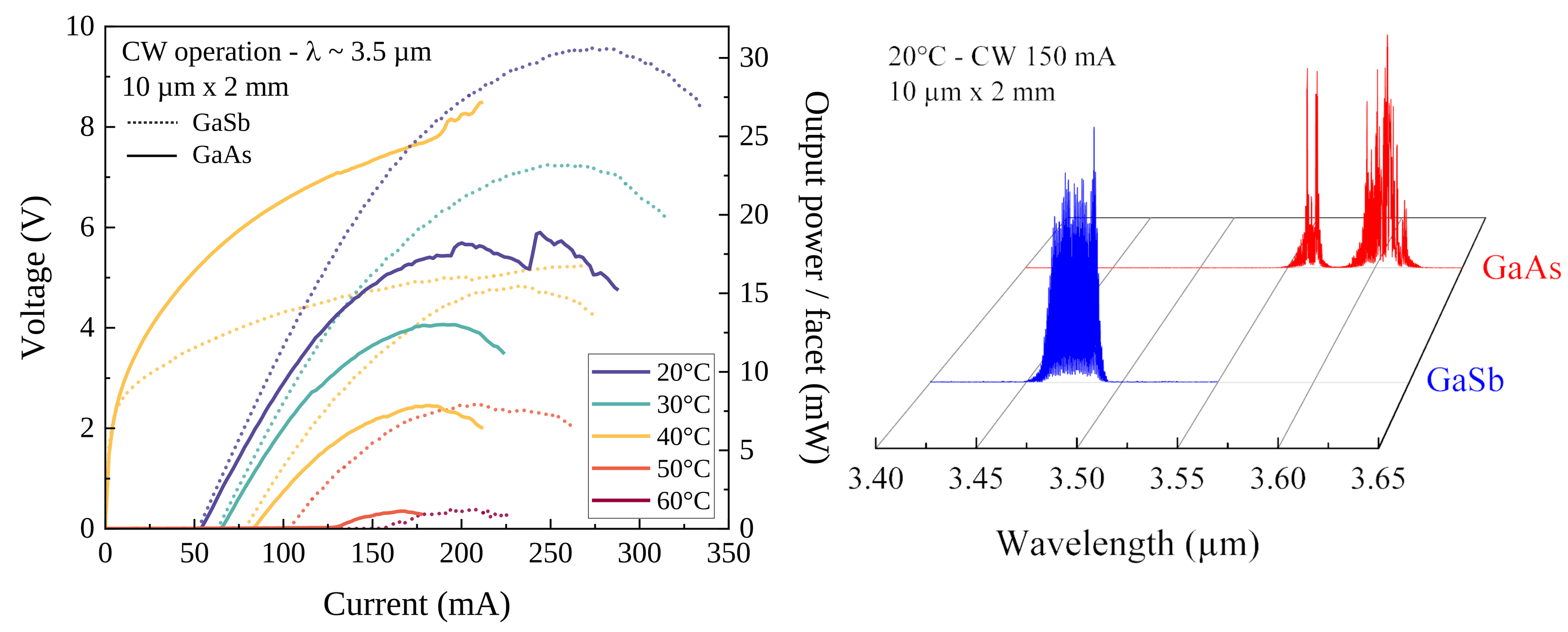


*Fig. 8. (a) LIV curves of a 10 µm x 2 mm **AlGaAsSb ICL** on GaSb and GaAs (b) Spectra*

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

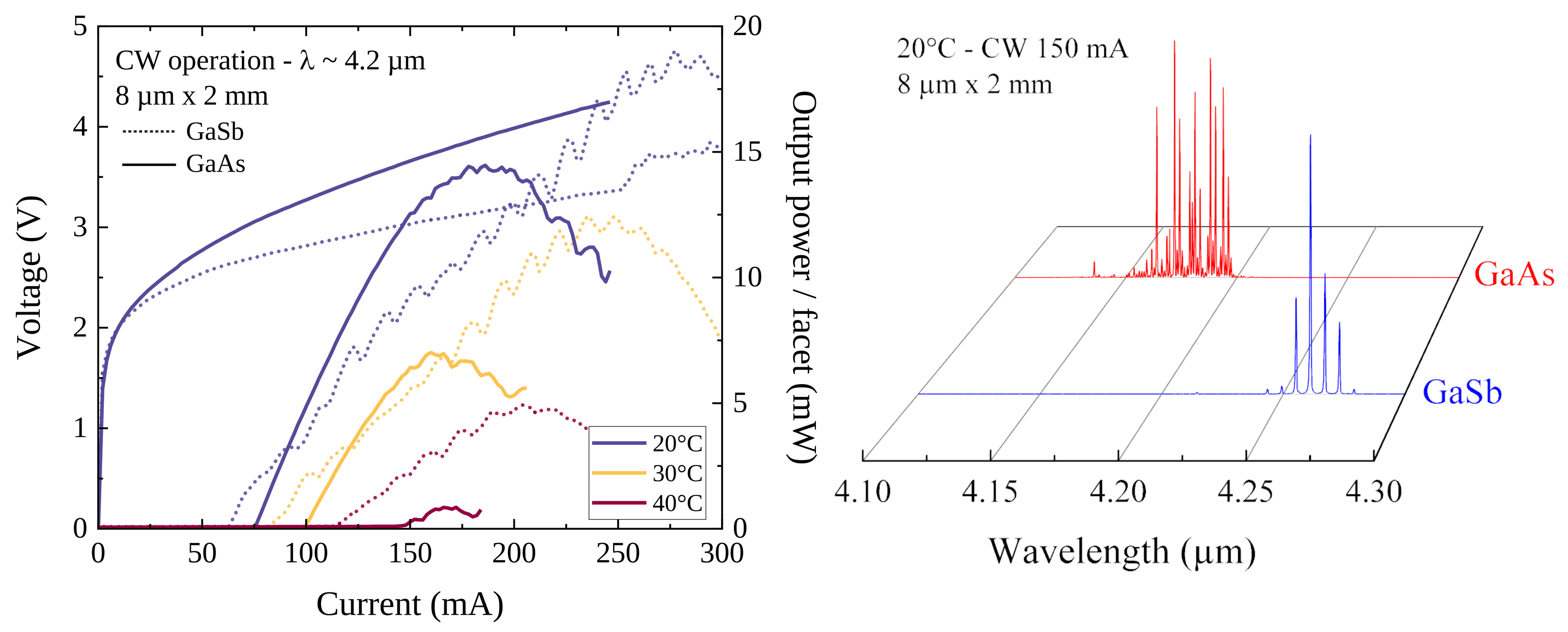


*Fig. 9. (a) LIV curves of a 8 µm x 2 mm **SLs ICL** on GaSb and GaAs (b) Spectra*

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

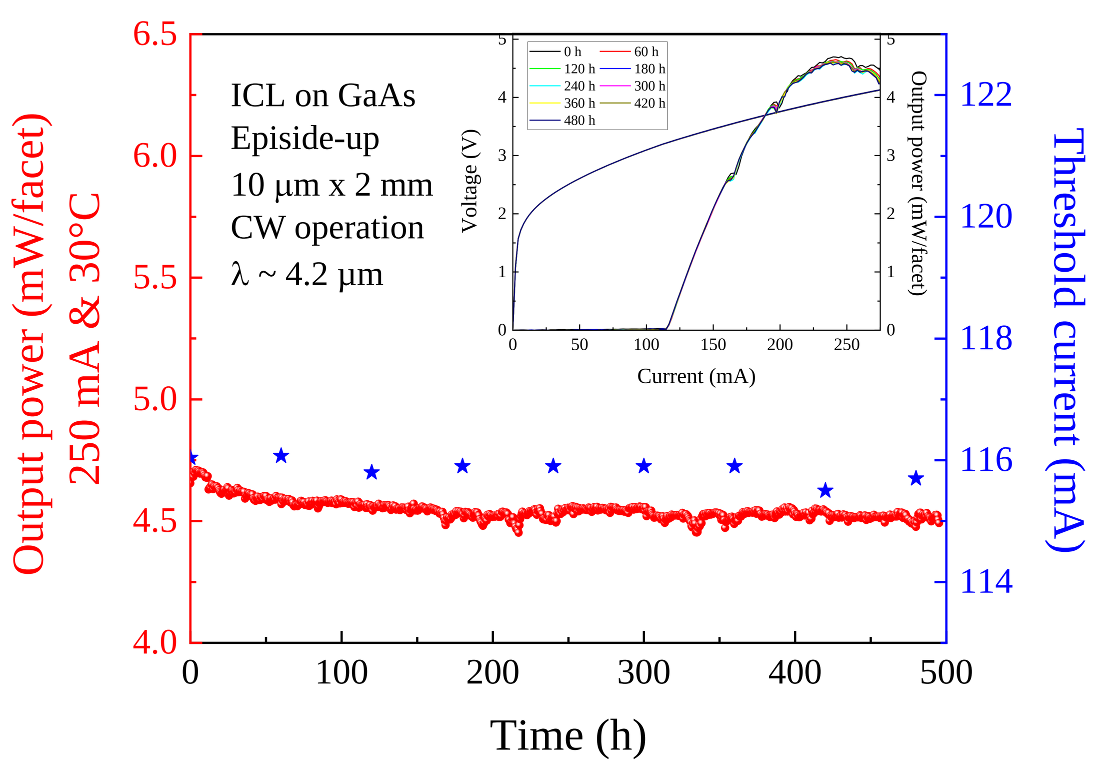


Fig. 10. Ageing of an ICL on GaAs

No degradation during ageing

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TOLERANCE to dislocations

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Towards integration on Si

Funding sources:

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