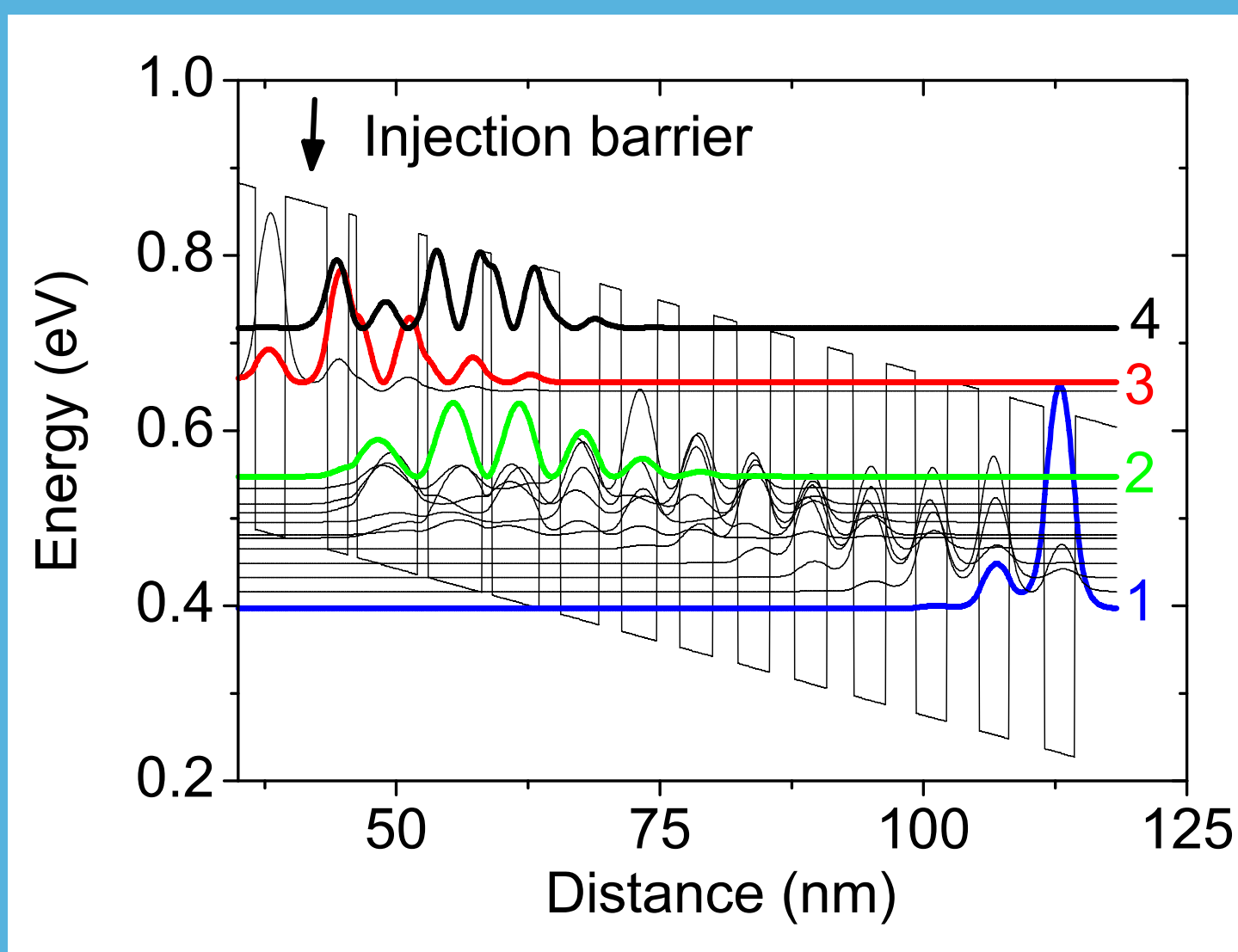


GaAs/Al_xGa_{1-x}As quantum cascade lasers with different aluminium content and heterogeneous cascades

Design



$$z_{32}=2.2 \text{ nm}$$

$$\Delta E_{21}=160 \text{ meV}$$

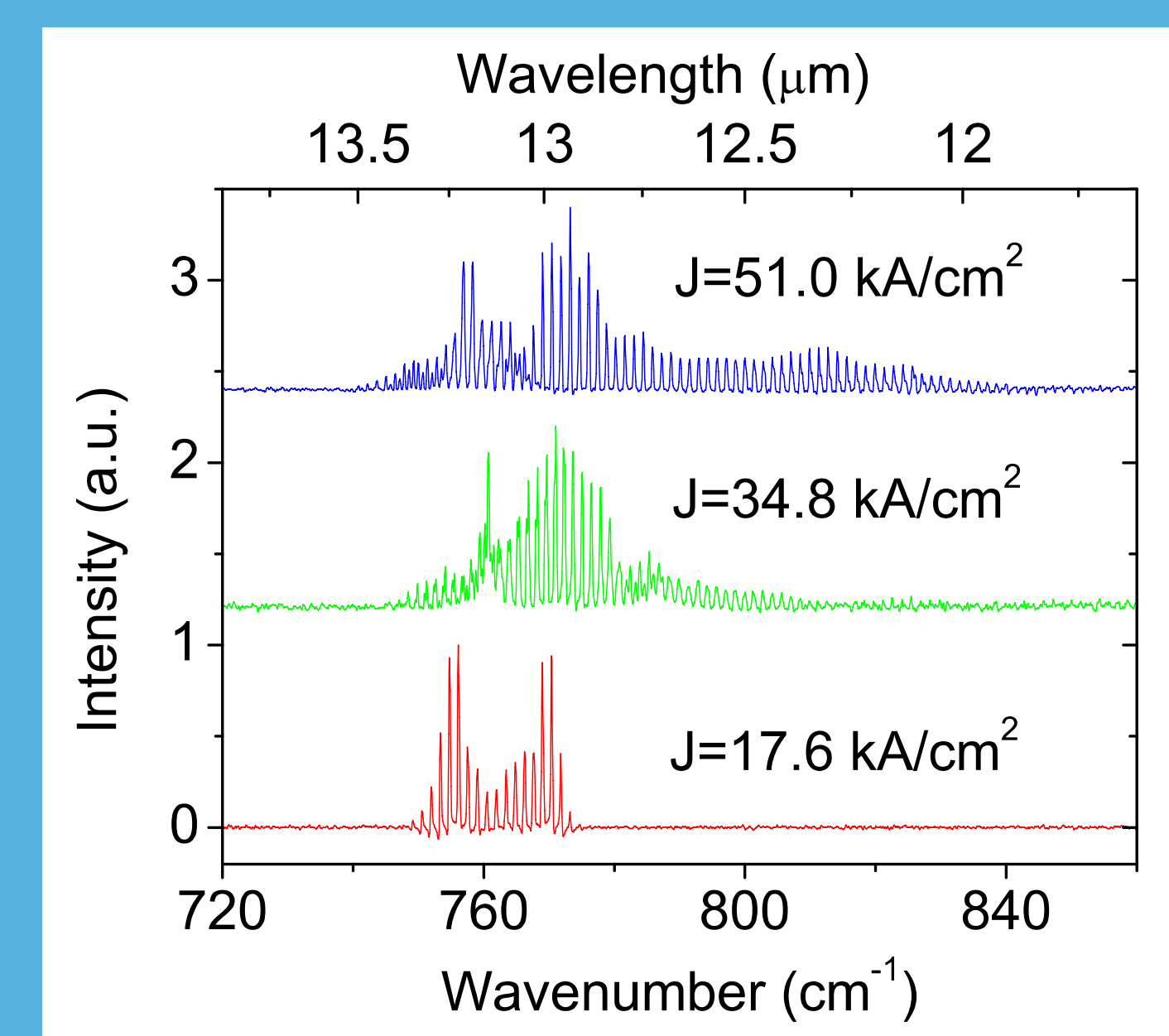
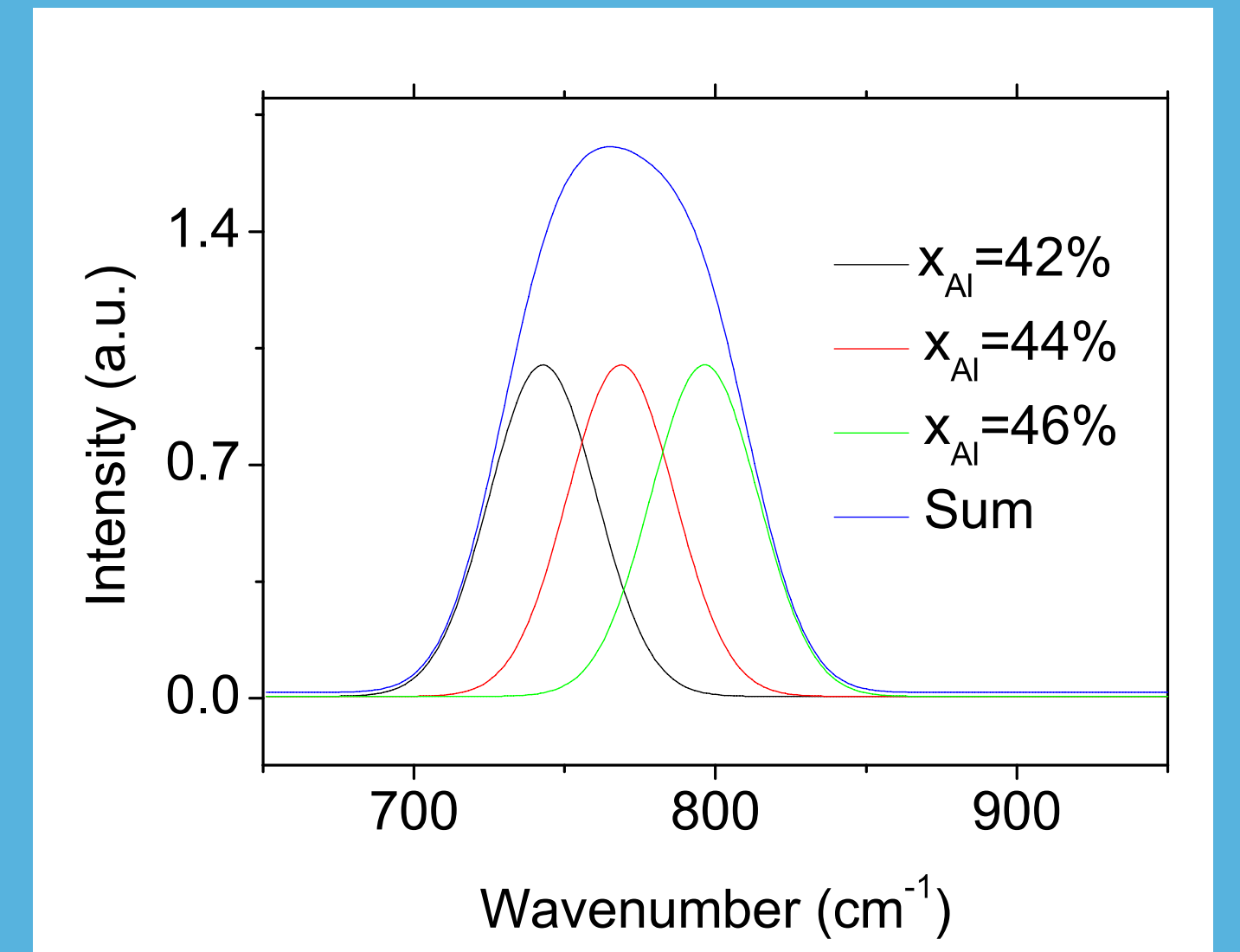
- strong suppression of thermal backfilling
- good temperature stability

- GaAs/Al_xGa_{1-x}As bound-to-continuum design
- Wavelength between 12 μm and 13.5 μm accessible by variation of barrier aluminium content

Broad-band QCL

Combination of periods with barrier aluminium content of 42%, 44% and 46%

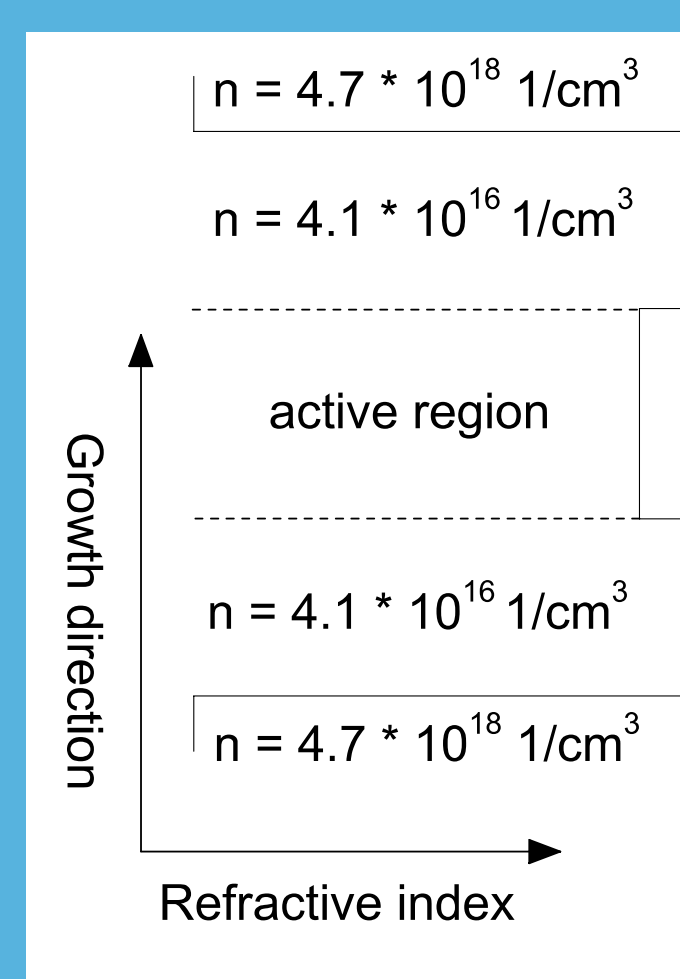
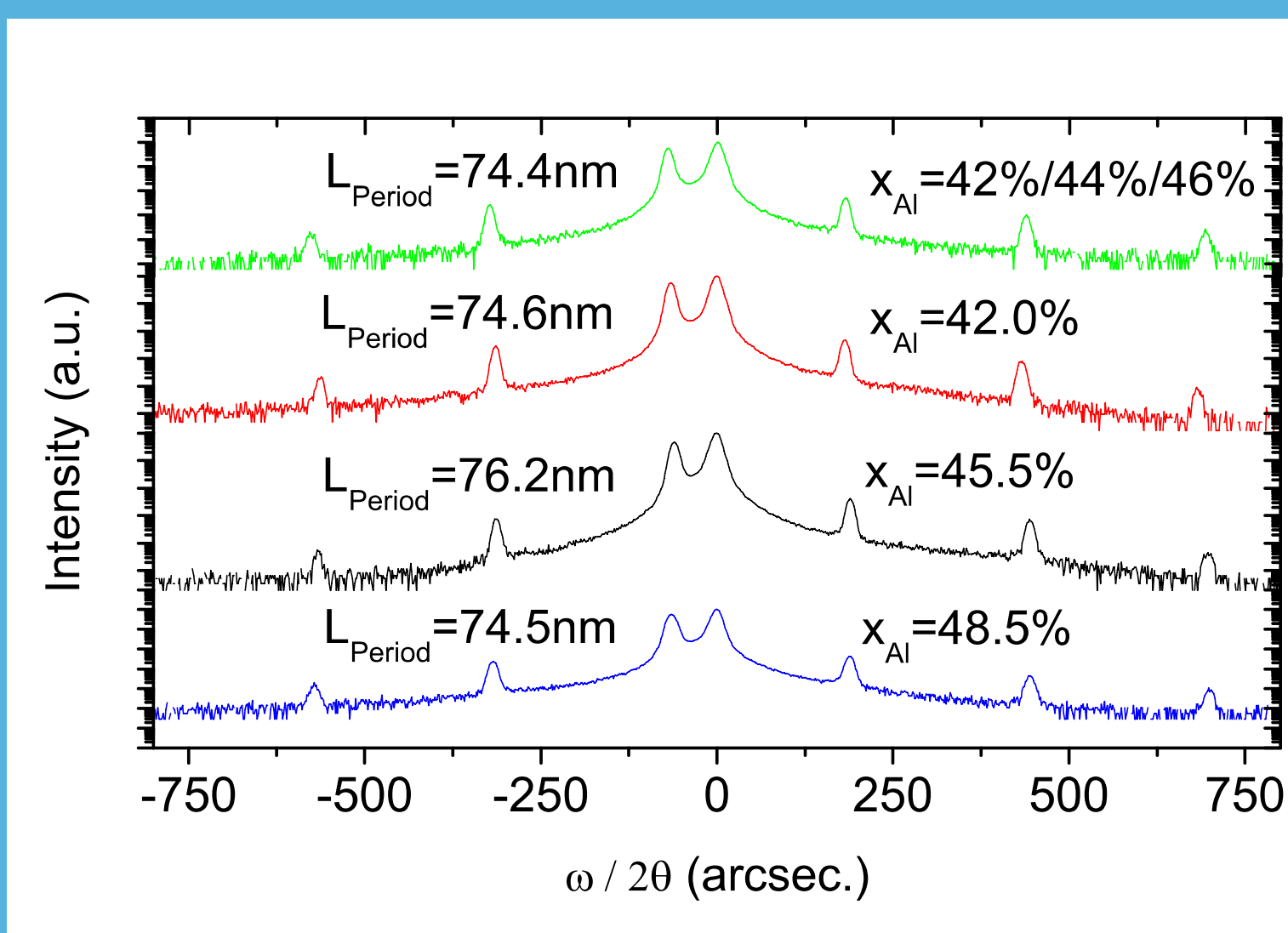
- Broad gain function



Broad-band emission between 11.9 μm and 13.5 μm (80K)

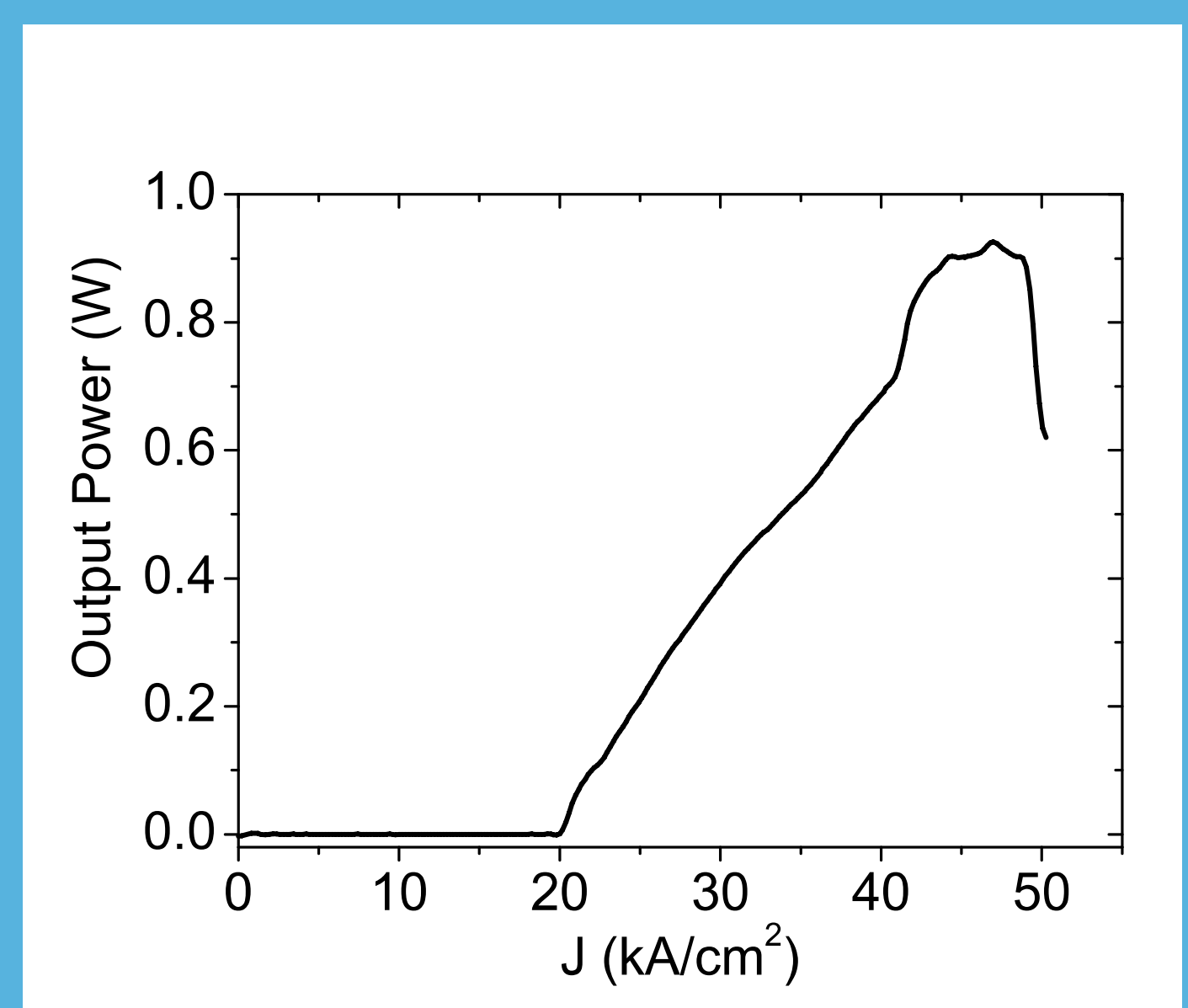
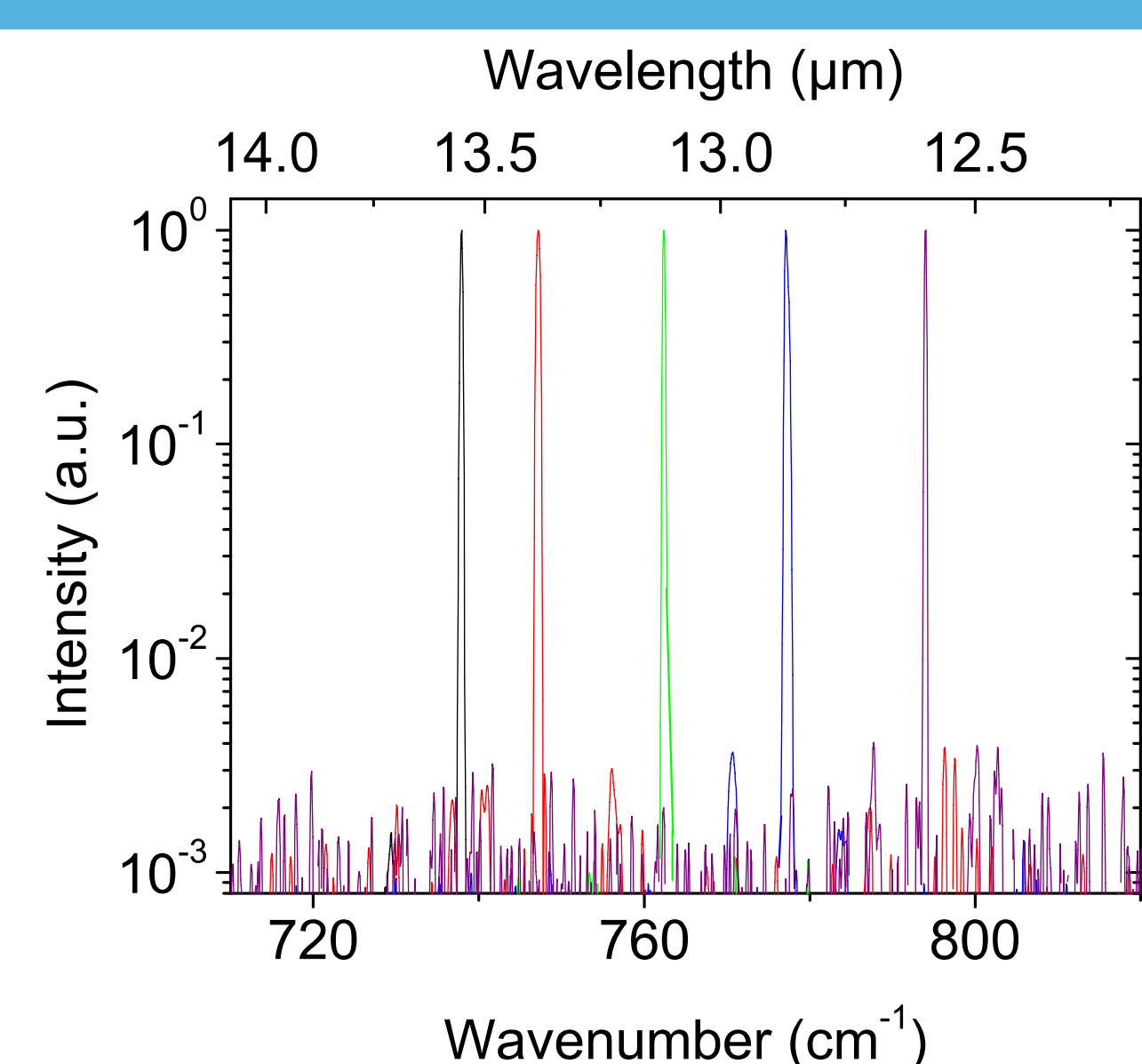
MBE Growth

- Solid-Source Molecular Beam Epitaxy on (100) GaAs
- Plasmon-enhanced waveguide
- Variation of barrier aluminium content



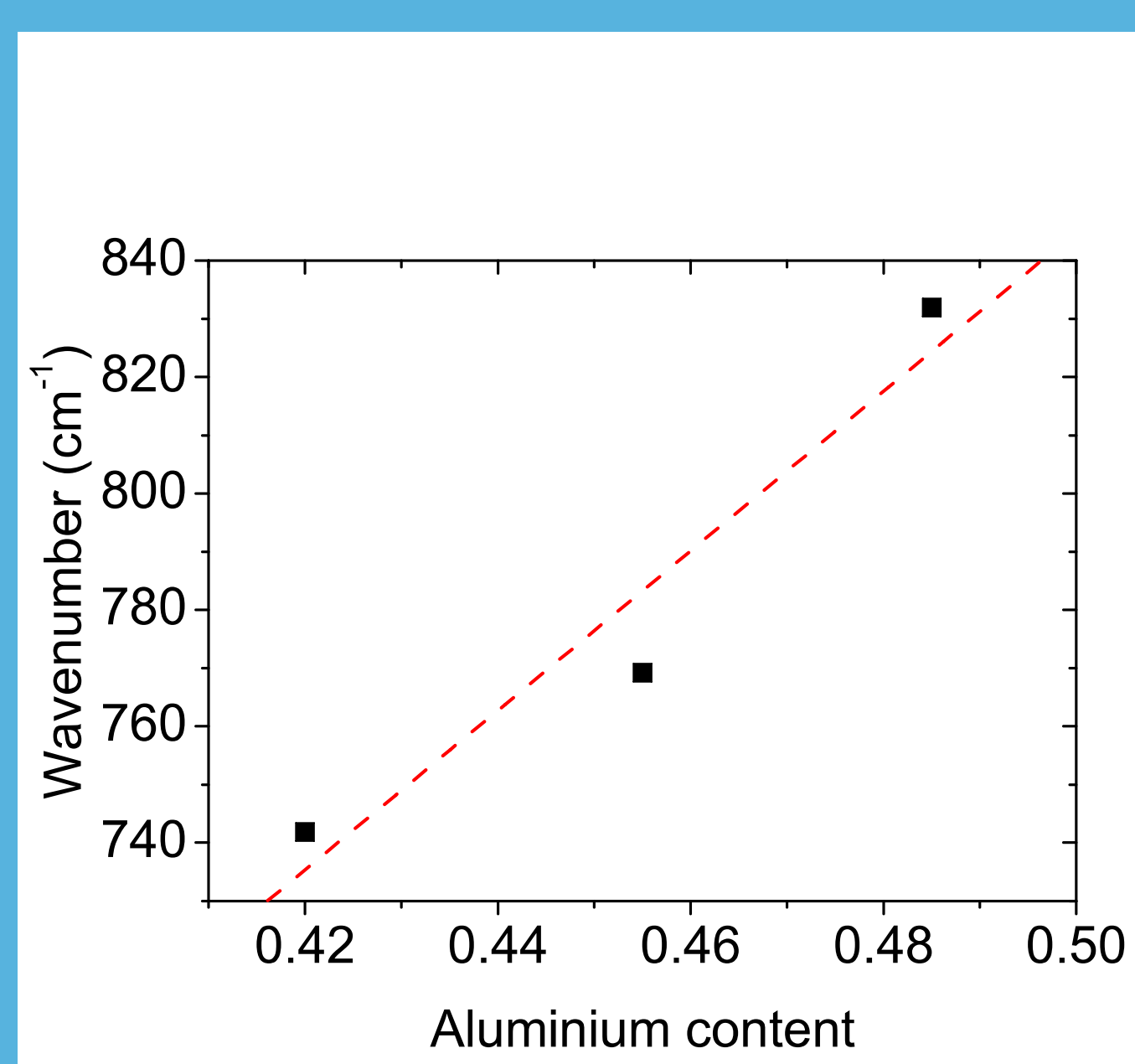
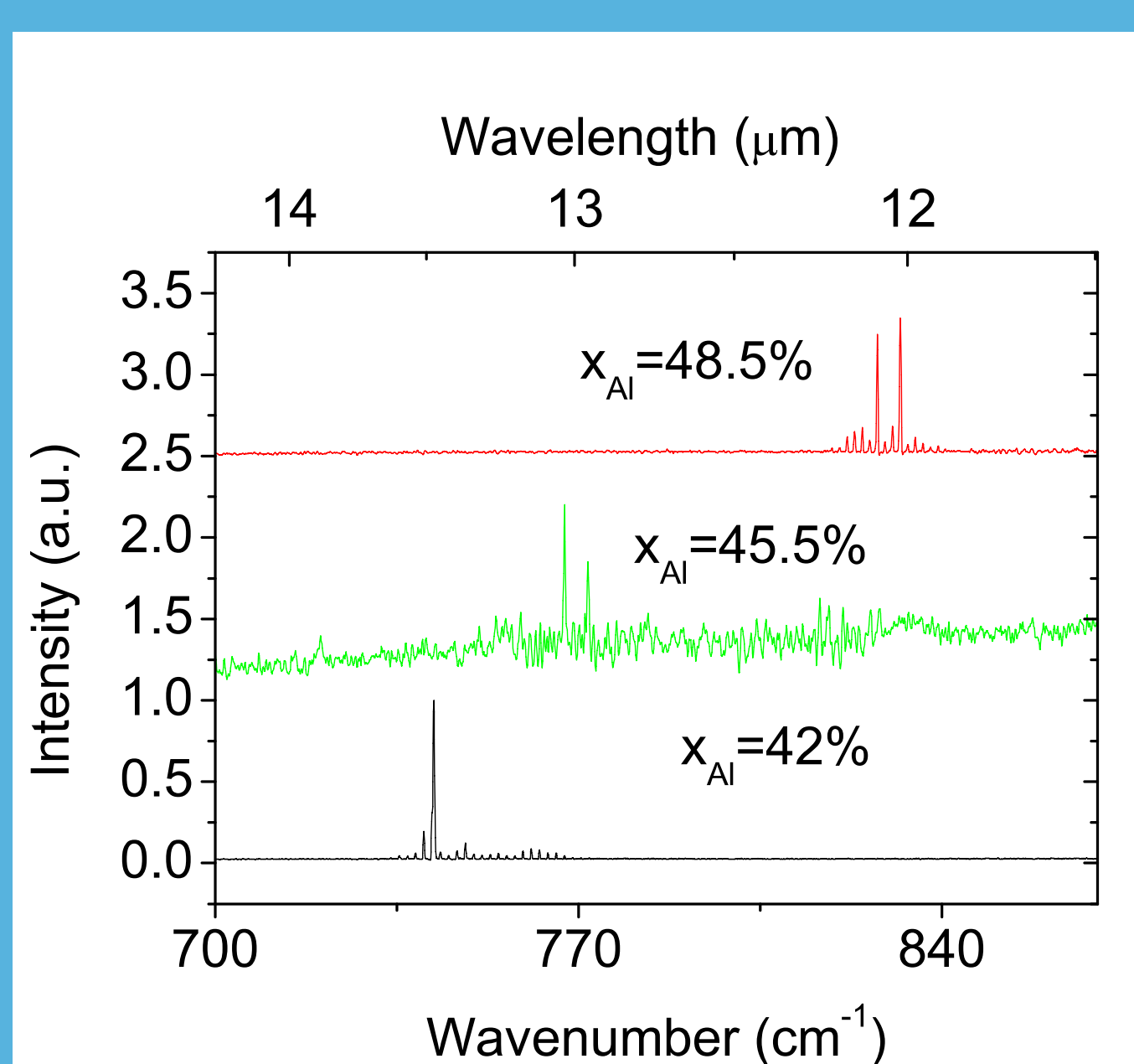
- Good reproducibility of period length
- Period length in good agreement with design value of 74.8 nm

DFB Lasers



- First-order DFB gratings with broad variation of grating periods ($n_{\text{eff}} \sim 3.1$)
- > 20 dB side-mode suppression between 12.6 μm and 13.6 μm (80K)
- Output powers exceeding 200 mW (single-mode) and 900 mW (multi-mode)
- $dn_{\text{eff}}/d\lambda = 3.5 \cdot 10^{-2} \text{ 1/}\mu\text{m}$

Spectral Characteristics



- Barrier aluminium content influences emission wavelength
- Comparable threshold current densities at 80K ($J_{\text{th}} \sim 17 \text{ kA/cm}^2$)
- Room temperature operation

Conclusion

- Change of emission wavelength from 13.5 μm to 12.0 μm by changing barrier aluminium content from 42% to 48.5%
- First demonstration of room-temperature operation beyond 13 μm for a GaAs-based QCL
- Broad-band QCL covering emission wavelengths from 11.9 μm to 13.5 μm
- >20 dB side-mode suppression between 12.6 μm and 13.6 μm with DFB gratings

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