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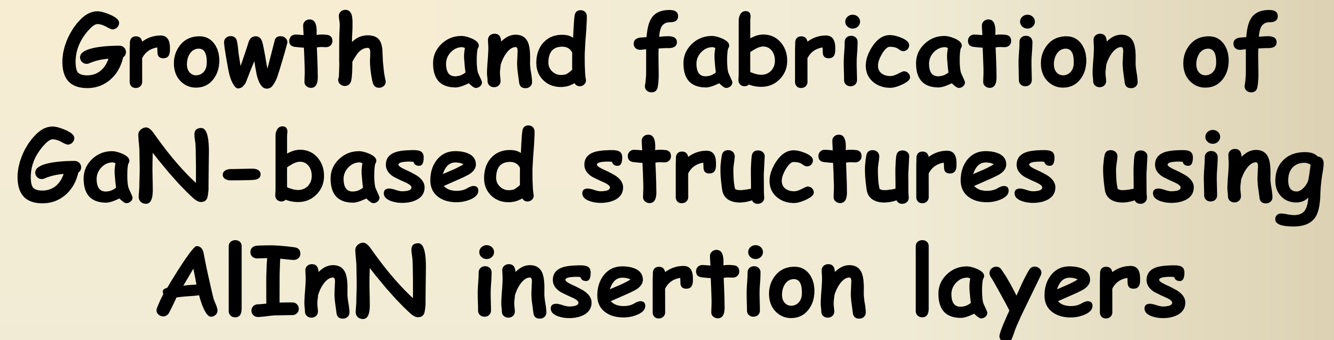

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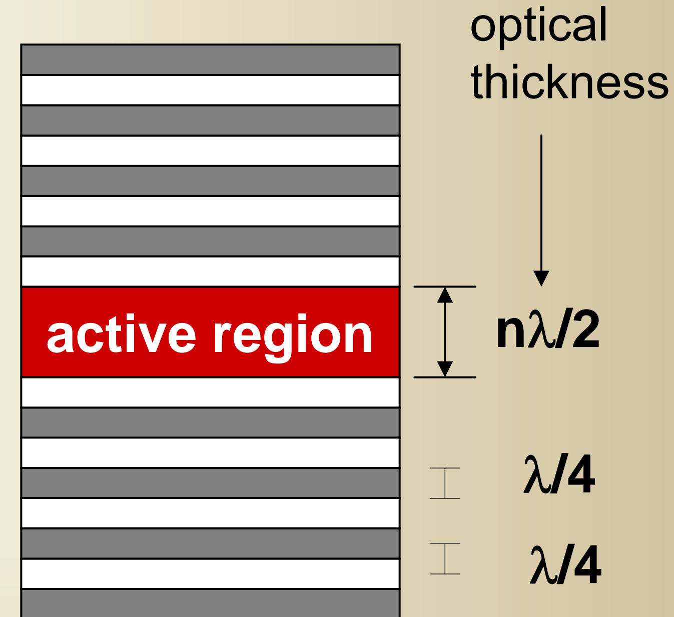
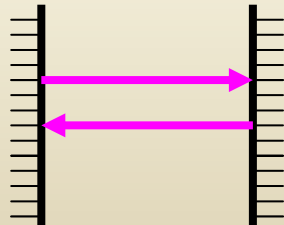
Outline:

- Introduction and motivation
- Design and growth of microcavities
  - Role of AlInN in in-situ monitoring
- Roles of AlInN layer in post-growth processing
  - End point detection in plasma etching
  - Etch selectivity in alkaline solutions
- Summary

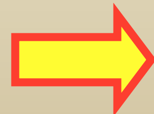
Introduction – What is a MicroCavity?

- Used for improvement of efficiency of light emission and to obtain a narrower and more directed emission from light emitting devices
- Our MCs will employ two parallel mirrors between which light can be reflected with little loss

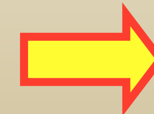




MC confine light



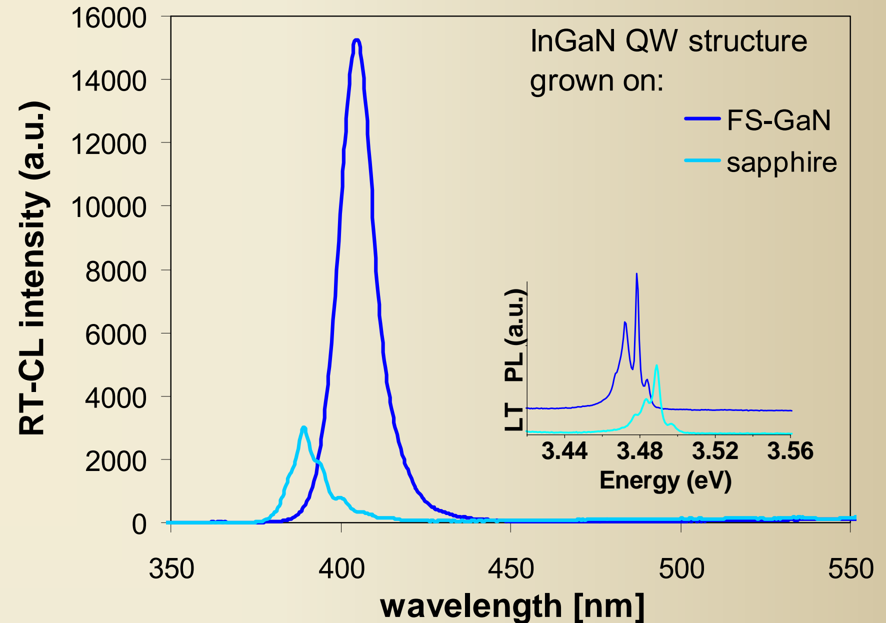
MC store light at certain resonant frequencies



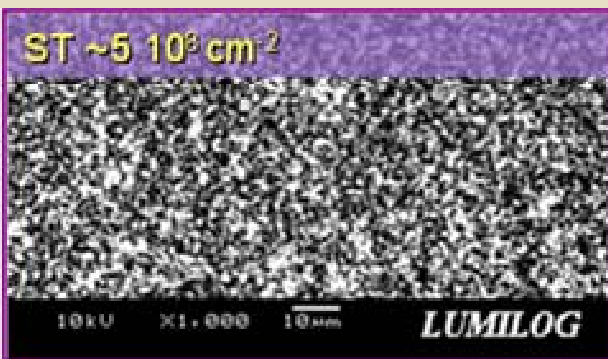
Quality of mirrors very important

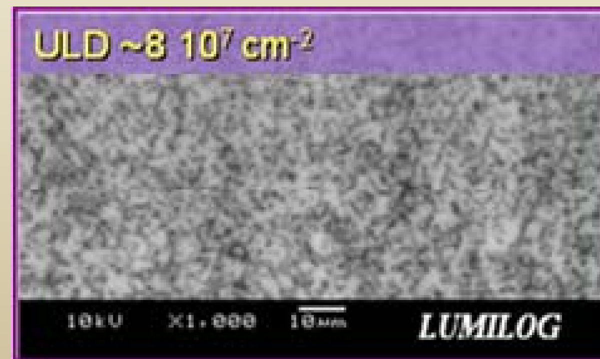
Free Standing-GaN: motivation

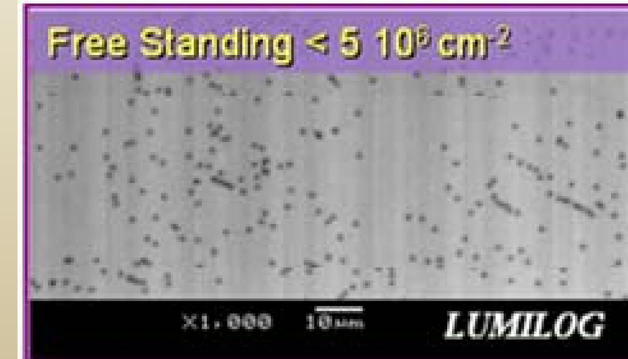
Increasing availability of free-standing GaN (e.g. Lumilog)



Improvement in emission properties with comparison to sapphire

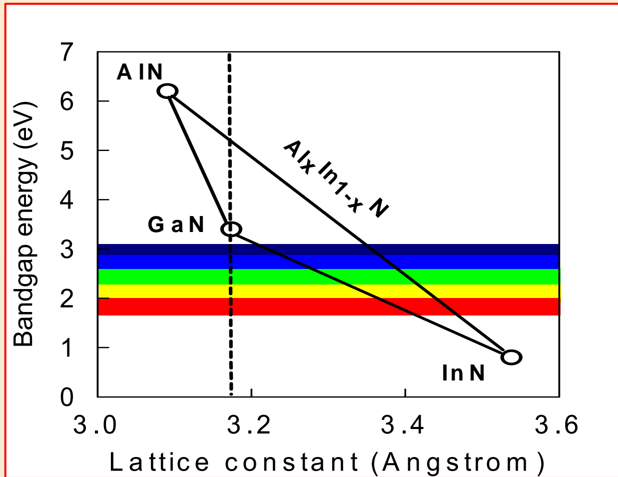




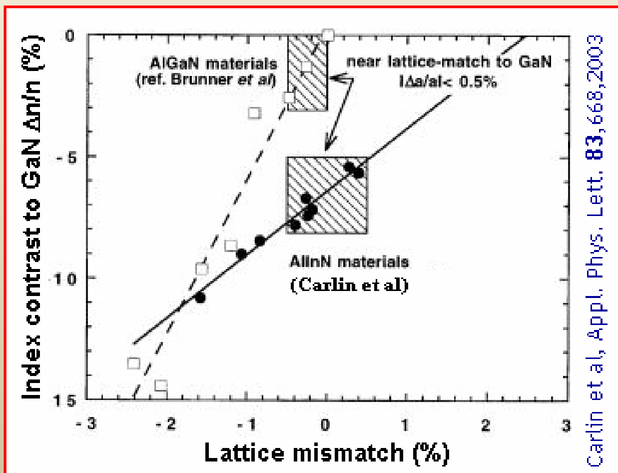


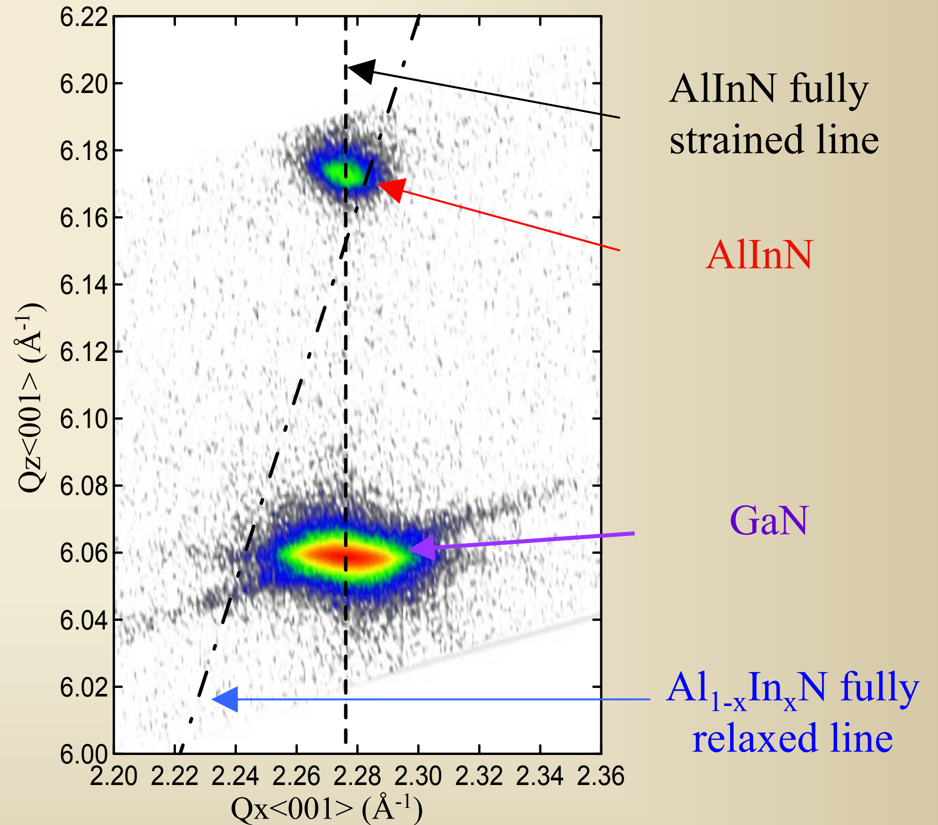
AlInN layers

- AlInN: lattice matched to GaN



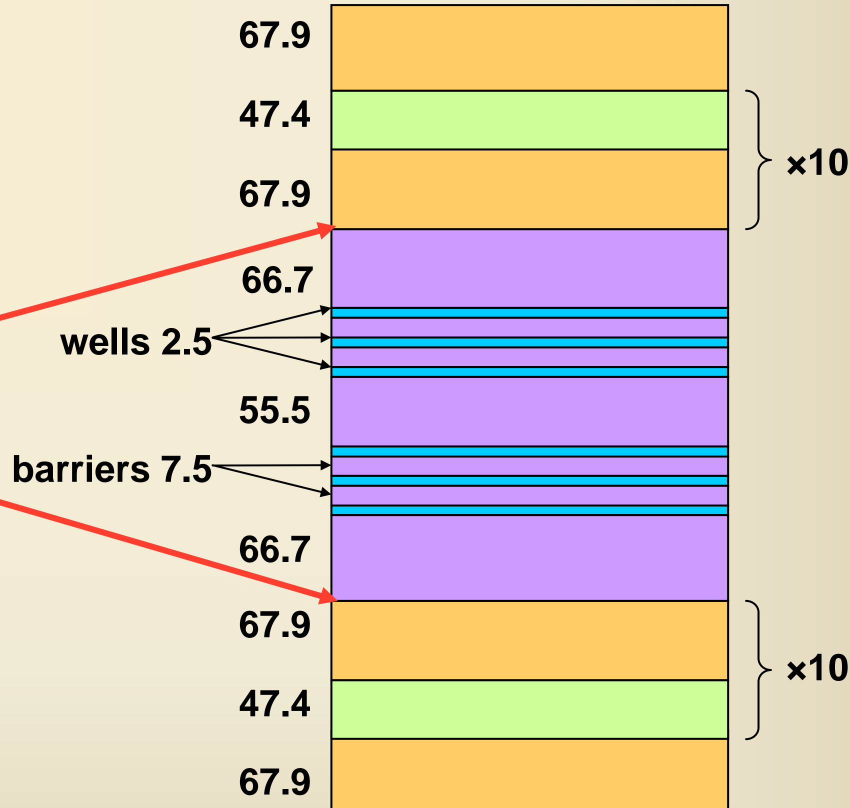
- AlInN/GaN: high refractive index contrast

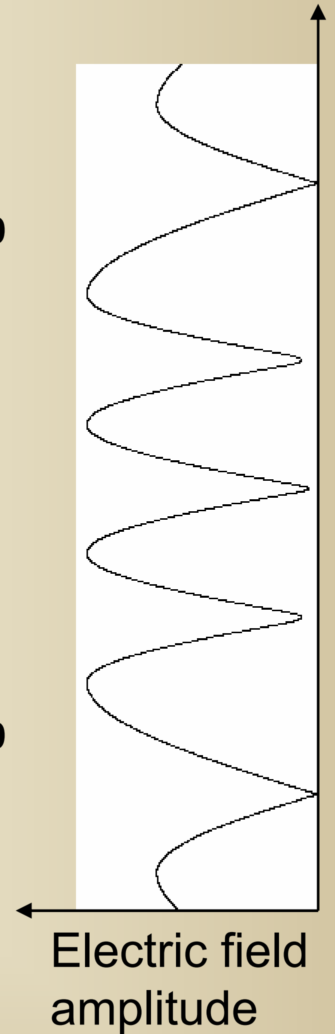


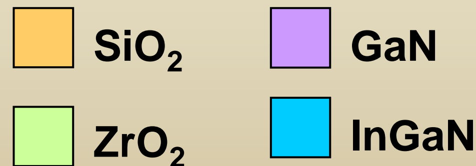


X-ray reciprocal space mapping performed by N. Franco at ITN, Sacavém, Portugal using Cu $K_\alpha 1$ X-rays

MC structure







All dimensions in nm

In-situ growth monitoring

Temp (°C)

1200
1000
800

Reflectance at 625 nm (a.u.)

0.2
0.15
0.1
0.05
0

GaN growth

λ/4 AlInN layer growth

GaN growth

λ/4 AlInN layer growth

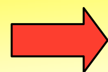
InGaN/GaN MQW growth (3 periods)

1st set 2nd set

0 2000 4000 6000 8000 10000 12000 14000

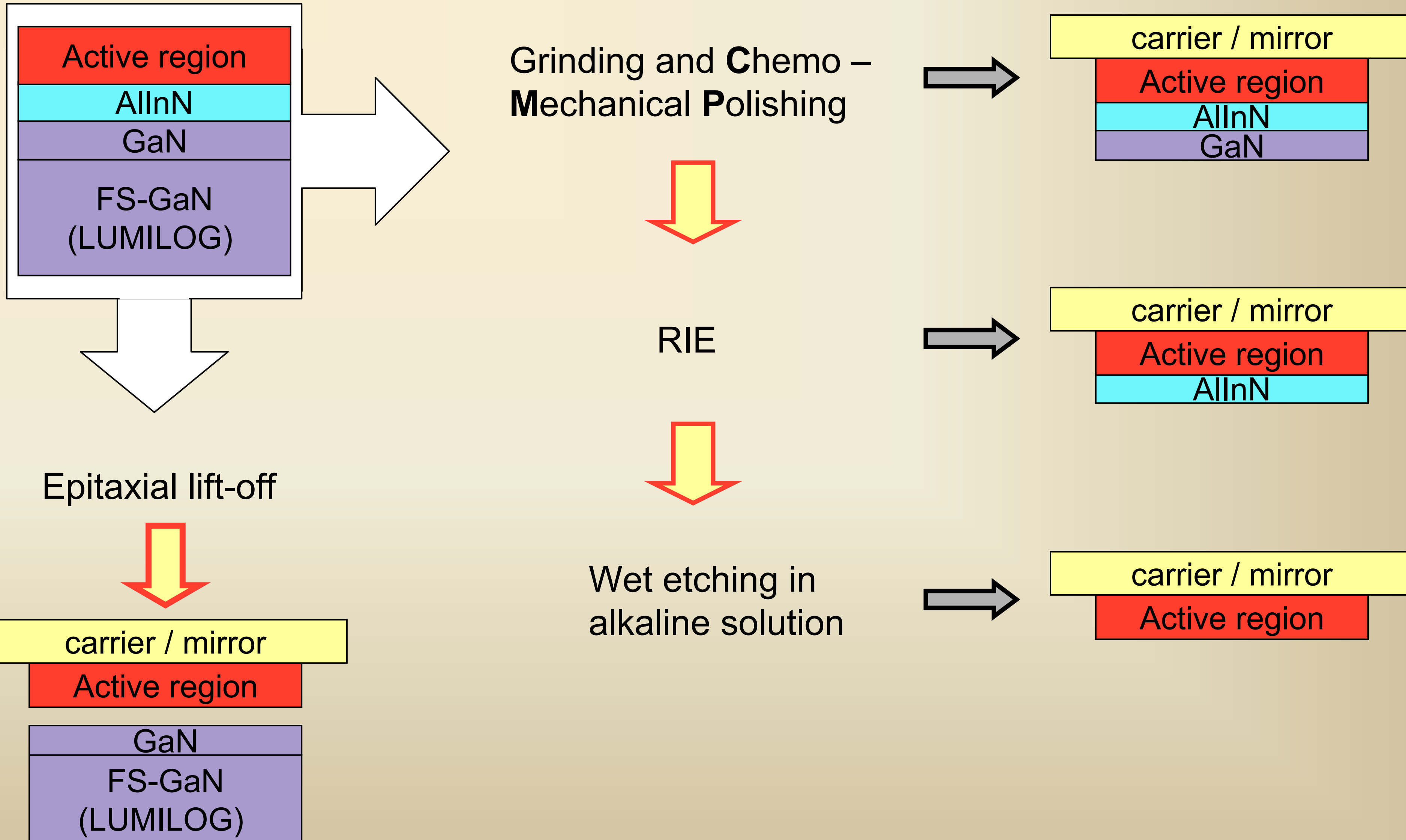
Time (seconds)

Refractive index contrast between AlInN and GaN!

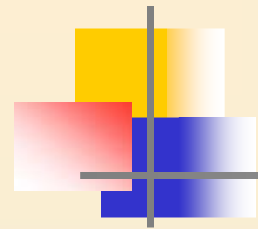


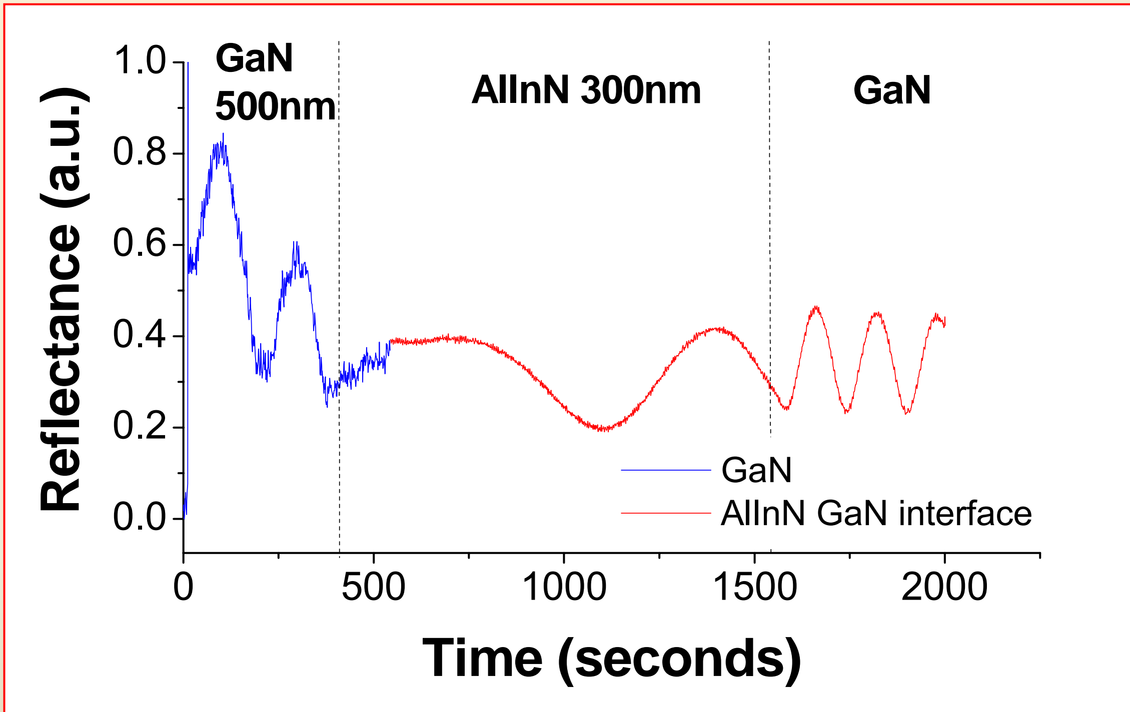
Measurement of growth rate (in real time) allows to optimize thickness of MC active region

From grown structure to microcavity



Reactive Ion Etching – in-situ monitoring





Cl_2+CH_4+Ar:

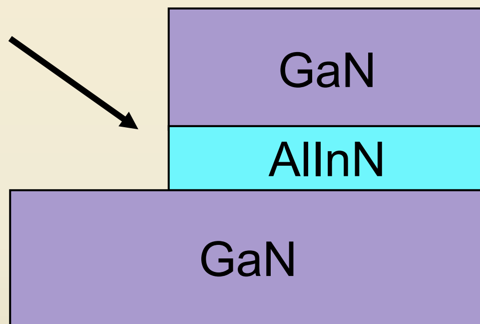
Etch rate:

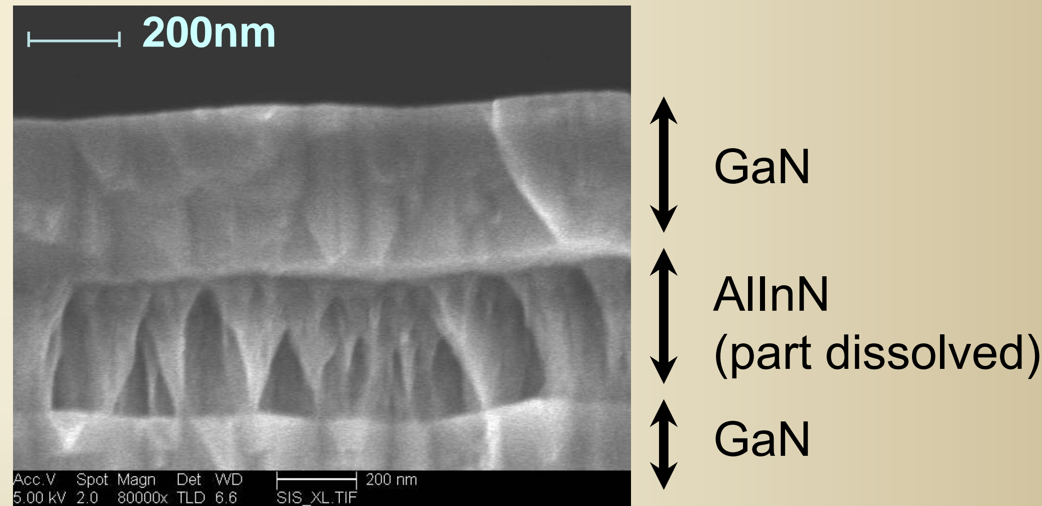
GaN/AlInN ~ 5/1

layer	on	Etch rate [Å/min]
GaN	AlInN	463
AlInN	GaN	105
GaN	Al_2O_3	550

Etching in alkaline solution

Secondary electron image of the edge of a mesa produced by initial plasma etching of a GaN/AlInN/GaN trilayer after etching in 1,2-diaminoethane.





The 300nm AlInN layer has been undercut and etched into conical forms

this demonstrates selectivity which can be exploited in lift-off processing

- Insertion of $\lambda/4$ AlInN layers allows measurement of growth rates by a standard method which allows accurate control of layer thicknesses
- Selectivity demonstrated between AlInN and GaN layers in RIE
- Etching in alkaline solutions also shows strong selectivity