

Project **ANR-08-NANO-053** (avril 2009 – mars 2012)

- **Institut d'Electronique du Sud (IES)**, UMR CNRS 5214, Université Montpellier 2. Contact : eric.tournie@um2.fr
- **Alcatel-Thales III-V Lab**, Palaiseau. Contact : michel.garcia@3-5lab.com
- **Paul-Drude-Institut**, Berlin (Germany). Contact : trampert@pdi-berlin.de

## Objective :

### New GaSb-based nanostructure lasers (NSLs) for the mid-IR

Active zones : short period superlattices, quantum dots, digital alloys  
Materials : transmission electron microscopy (TEM), X-Ray, photoluminescence  
Technology : DFB technology based on a new approach

### Active zones: First results: Tensile strained $Ga_{1-x}In_xAs$ in GaSb

- Compressively strained layers  $\Rightarrow$  self-organized quantum dots (QDs). Case study:  $Ga_{1-x}In_xAs$  on GaAs.
- Tensile strained layers : much less clear....

### The $Ga_{1-x}In_xAs$ / GaSb system

- The tensile strain can be varied from -7.9% ( $x=0$ , GaAs on GaSb) to -0.7 % ( $x=1$ , InAs on GaSb)
- Type-II band alignment at the interface
- Strong reduction of the bandgap due to tensile strain: mid-IR sources ?

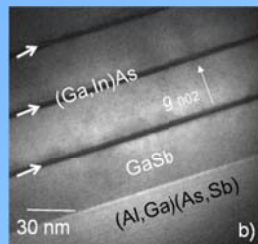
### Possible mid-IR active zones : $Ga_{0.5}In_{0.5}As$ in GaSb

MBE growth



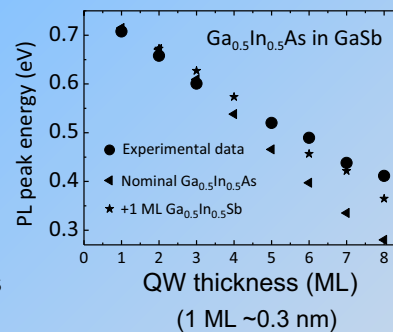
RHEED suggests the formation of QDs.

TEM

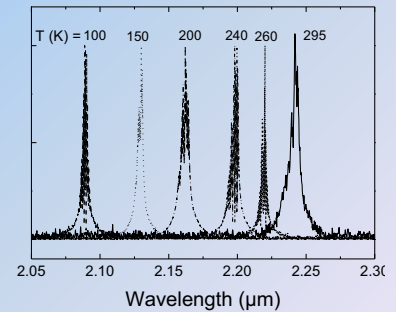


No QDs... but QWs

Room temperature PL



Laser diode with 5 MLs active zone

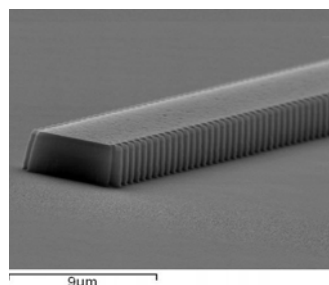


- The tensile strained  $Ga_{1-x}In_xAs$  / GaSb system exhibits a very particular growth behaviour : the initial QDs are smoothed out during overgrowth which results in perfect 2D QWs with the formation of 1 ML GaInSb at the upper interface.
- Mid-IR emission is readily achieved at room temperature. Lasing is demonstrated near 2.3  $\mu$ m.
- Still, the type-II band alignment precludes entering deeply into the 3 – 4  $\mu$ m wavelength range.

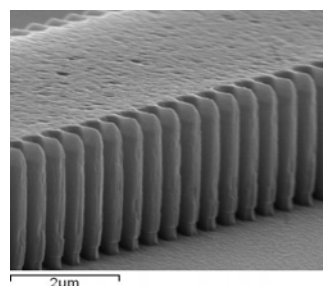
### Other nanostructures are under study

### Technology: 1<sup>st</sup> order Lateral Coupled DFB (LC-DFB)

- E-beam definition of the cavity laser and LC-grating



- Pattern transfer on thick  $SiO_2$  mask



- ICP dry etching using  $SiCl_4$  plasma

← 1<sup>st</sup> test on GaSb substrate



Transfer on real samples