Dry Etching of High [Al] AlGaAsSb Compounds Using Cl₂ / N₂ / Ar ICP RIE

Brice Adelin, Quentin Gaimard, Alexandre Larrue, Aurélie Lecestre, Pascal Dubreuil, Yves Rouillard, Guilhem Boissier, Aurore Vicet, Antoine Monmayrant, Olivier Gauthier-Lafaye

To cite this version:

Brice Adelin, Quentin Gaimard, Alexandre Larrue, Aurélie Lecestre, Pascal Dubreuil, et al.. Dry Etching of High [Al] AlGaAsSb Compounds Using Cl₂ / N₂ / Ar ICP RIE. International Conference on Micro and Nano Engineering (MNE) 2014, Sep 2014, Lausanne, Switzerland. hal-01102417

HAL Id: hal-01102417
https://hal.science/hal-01102417
Submitted on 12 Jan 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
GaSb based compound semiconductors emit in the mid-infrared range and present extremely good opto-electronic properties, with demonstrated bipolar laser diodes emitting from 2 to 3.5 µm with good performances. One key challenge remaining is the realization of high performance single mode emitters to enable the realization of efficient trace gas detection systems. Such diodes are often made with a core waveguide embedded in claddings made of AlGaAsSb with high Al content. Deep etching of high Al content claddings is known to be a particular challenge for deep etching with high aspect ratio, and restricts the designs achievable for laser diodes fabrication. We present our work on deep etching of sub-micron 1D and 2D periodic structures designed to achieve DFB effect in edge emitting mid infrared lasers. DFB cavities can be realized using several geometries. We investigated two thoroughly opposite ones. The first studied geometry relies on periodic modulation of a waveguide width, and requires smooth etching of narrow 1D trenches with a mostly open etch mask. The other investigated geometry relies on 2D photonic crystal cavities, and requires deep etching of sub-micron diameter holes with high aspect ratios, in a mostly closed mask.

**Context**

**Issue**

Towards the realization of laser diodes all PhC electrically pumped in GaSb system

- Heterostructure AlGaAsSb / InGaAsSb for an emission around 2.3µm
- Etching of submicron patterns with high aspect ratio in the heterostructure:
  - Characteristic dimensions: Ø ~ 375 nm, H ~ 3.5 µm
  - Aspect ratio: 1:9

Towards the realization of side wall corrugated index coupled distributed feedback GaSb based laser diode

- Heterostructure AlGaAsSb / InGaAsSb for an emission around 2.3µm
- 2nd order DFB laser
- Feedback from corrugated waveguide
- Shallower etching
- Smooth sidewalls
- Smooth etched bottom

**Previous work**

Realization of laser diodes all PhC electrically pumped in GaSb system

- Masking strategy adopted
- Development of a multi-step etching process combining Cl2/N2, O2, and N2 ICP plasma etching

Realization of side wall corrugated index coupled distributed feedback GaSb based laser diode

- Realization of the grating by holographic lithography in resist
- Transfer of the grating by CHF3/O2 ICP-RIE through a 150 µm SiO2 mask
- Definition of the mesa by optical lithography
- Dry etched with C2/N2/Ar ICP-RIE of the pattern through the top cladding. The etching is stopped on the top of the waveguide

**Optimization of the process of chlorinated ICP-RIE etching III-V materials**

**Conclusion**

- Establishment of a high aspect ratio deep etching process of PhC in GaInAsSb/AlGaAsSb system
- Successful insertion of this technological step in a complete process

Acknowledgments: This work was supported by the French National Research Agency (ANR) under Grant ANR-2011-NANO-028 01 (ANR MIDAS)