Buried Waveguides using a Quasi-Planar Process

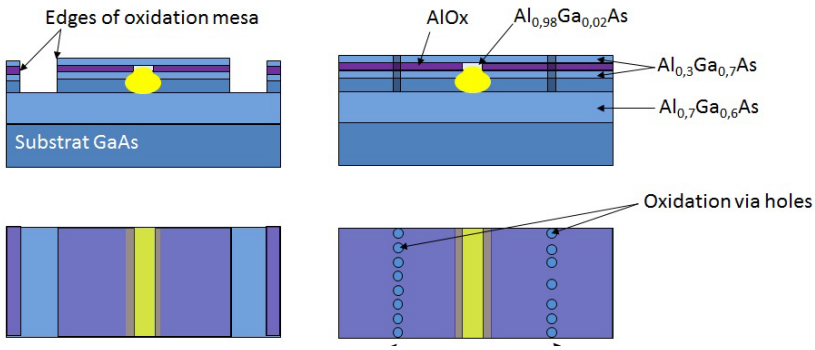
Stéphane CALVEZ[1], Alexandre ARNOULT[1], Pierre-François CALMON[1], Aurélie LECESTRE[1], Chantal FONTAINE[1], Antoine MONMAYRANT[1], Olivier GAUTHIER-LAFAYE[1], Guilhem ALMUNEAU[1]

[1] Laboratoire d'Analyse et d'Architecture des Systèmes, Université de Toulouse, CNRS, UPS, 7 avenue du colonel Roche, F-31400 Toulouse, France

* scalvez@laas.fr

The oxidation of Al-containing III-V semiconductors is an established technology to selectively transform a high-index (2.9) semiconductor layer into an insulating low-index (n~1.6) aluminium oxide (AlOx) and which, thereby, allows the fabrication of buried oxide apertures in either vertical-cavity surface-emitting lasers or waveguide-based devices [1-4]. Because of the chemical selectivity of the process, the oxidation is conventionally carried out as a lateral oxidation from the sides of etched mesas (see Fig. 1 left), resulting in a loss of wafer planarity which, in turns, renders the subsequent fabrication stages of waveguide devices more complex.

In this paper, we report the first demonstration of an alternative technique to make buried optical waveguides where the oxidation is carried out through via-holes (see Fig. 1 right) leading to a quasi-planar approach.



(a) Conventional approach **(b) Quasi-planar approach**

Fig. 1. The two approaches to make AlOx-based buried waveguide.

The oxide-confined waveguides consists of a 1.6µm-thick $Al_{0.7}Ga_{0.3}As$ bottom cladding layer, a 480-nm GaAs core, a 150-nm-thick $Al_{0.3}Ga_{0.7}As$ cladding, a 68 nm-thick $Al_{0.98}Ga_{0.02}As$ layer, a 330-nm-thick $Al_{0.3}Ga_{0.7}As$ layer, a second 68 nm-thick $Al_{0.98}Ga_{0.02}As$ layer and a final 50nm-thick $Al_{0.3}Ga_{0.7}As$ layer. Both $Al_{0.98}Ga_{0.02}As$ layers were oxidized simultaneously to form, under in-situ monitoring [5], ~4µm apertures 16µm away from the via-holes/mesa. The structure was post-processed in a single run to create oxide-confined waveguides using the conventional and the quasi-planar oxidation techniques. In the latter case the holes were 2µm in diameter and their separation was varied between 2.5 to 4.5 µm.

The transmission characteristics of ~2-mm-long cleaved-facet waveguides were measured using a tunable laser at wavelengths around 1.6 µm. Fig. 2 shows the recorded Fabry-Perot transmission curves for a set of hole-to-hole spacing. The waveguide losses were estimated to be ~1cm^{-1} and further shown to be independent of the hole-to-hole spacing and even of the fabrication method (conventional or quasi-planar).

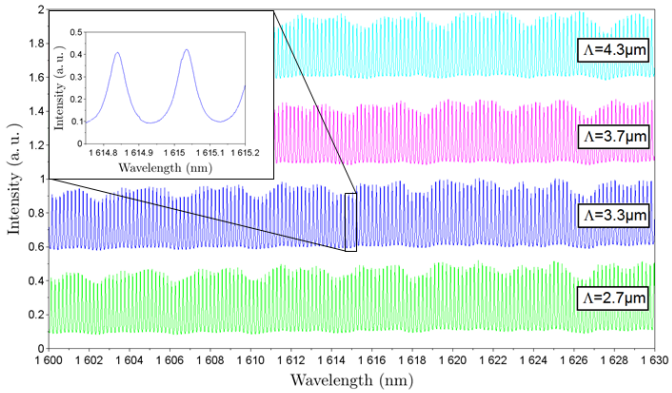


Fig. 2. Transmission characteristics of the waveguide made using the quasi planar process

In conclusion, we have introduced and demonstrated a quasi-planar approach to make buried AlOx/AlGaAs waveguides whose performance are equivalent to the one obtained using the conventional approach but which facilitates the further processing steps required in the fabrication of more complex photonic integrated circuits.

References

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