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Anisotropic oxidation of circular mesas for complex confinement in photonic devices: experiments and modelling

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In many different AlGaAs-based photonic and optical devices, the selective oxidation of an Al-rich layer is a very efficient way to create a lateral electrical and optical confinement. The degree of lateral confinement can thus be adjusted with the depth of the oxide within the structure. It is then of primary importance to control the lateral spreading of the oxidation reaction and that in all the crystallographic directions in order to master the waveguide properties in the 3 directions. Thanks to the epitaxial structure the vertical confinement can be designed with the index profile of the epitaxial multilayers, but in the lateral directions (in the plane of the epilayers) only the kinetics of the selective oxidation steers the waveguide dimensions.

The crystallographic anisotropy in the reaction of wet thermal oxidation of Al(Ga)As is well known since the discovery of this process in the early 1990s' [1-3]. As an example, in oxide confined VCSELs, the resulting asymmetric shape of the confinement aperture has a great impact on the properties of the output laser beam, positively as it may be a way to stabilize the polarization, or detrimentally as it modifies the transverse modes compared to a perfectly circular waveguide [4].

In this paper we propose to explore the process parameters that can act on the anisotropic character of the oxidation reaction.

[1] J. M. Dallesasse and N. Holonyak Jr. Appl. Phys. Lett. 58:4, 394-396 (1991)

[2] Floyd et al. Electron. Lett. 32 114 (1996)

[3] K. D. Choquette et al., JSTQE 3, 916-926 (1997)

[4] P Debernardi et al, JQE 38 73 (2002)