Tunable Deeply Etched V-notch Reflectors

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Monolithically integrated and tunable semiconductor lasers are of great interest for dense wavelength division multiplexing (DWDM) and conventional (WDM) networks. Distributed Bragg reflector and Distributed feedback lasers have demonstrated excellent performance in terms of supplying a single mode output with high stability. However, Bragg based lasers require high resolution lithography and multiple epitaxial growth steps, which adds to the fabrication complexity, time and cost.

Regrowth free, monolithically integrated single mode lasers that use standard UV lithography with relatively simple fabrication processes have drawn a lot of interest. One such laser is the slotted Fabry Perot (SFP) [1], which exploits mini inter-cavity reflections by using index perturbation along the ridge in a form of slots. Also, slots can be used as mirrors to create a monolithically integrated facet-less or single-facet lasers [2,3]. A single slot etched just above the active region provide a maximum of around 2-3% reflection. Therefore, to create sufficient reflection to replace a cleaved facet, 9 slots are often used to build an effective mirror [2]. For example, to achieve a facet-less SFP laser with a 400 GHz discrete tuning step requires 2 mirrors each, with a length of approximately 900 μm.

A limitation of the slot is that its reflection is highly sensitive to the etch depth [4], and this reflection strength governs both the laser performance and the consistency across the wafer. Therefore, a wet etch is often used in conjunction with a dry etch to reach the intended depth. The effect of crystal orientation on the wet chemical etching [5] limits the cavity design flexibility across the chip.

In this paper, we demonstrate a novel V-notch reflector that uses lithography to control reflectance instead of depth. Moreover, by lithographically manipulating the V-notch dimensions, flexible control over the reflected power and loss is possible. The deeply etched V-notch reflector overcome the depth sensitivity of the slot, allowing various reflection options without the need of additional fabrication steps, accurate depth control or a wet etch. Fig.1 show an illustration and a SEM image of the V-notch

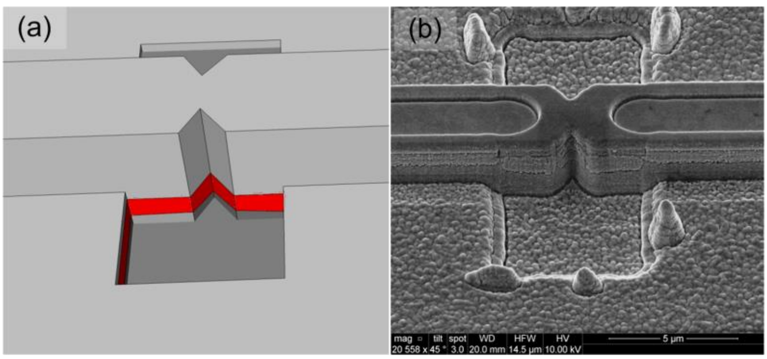
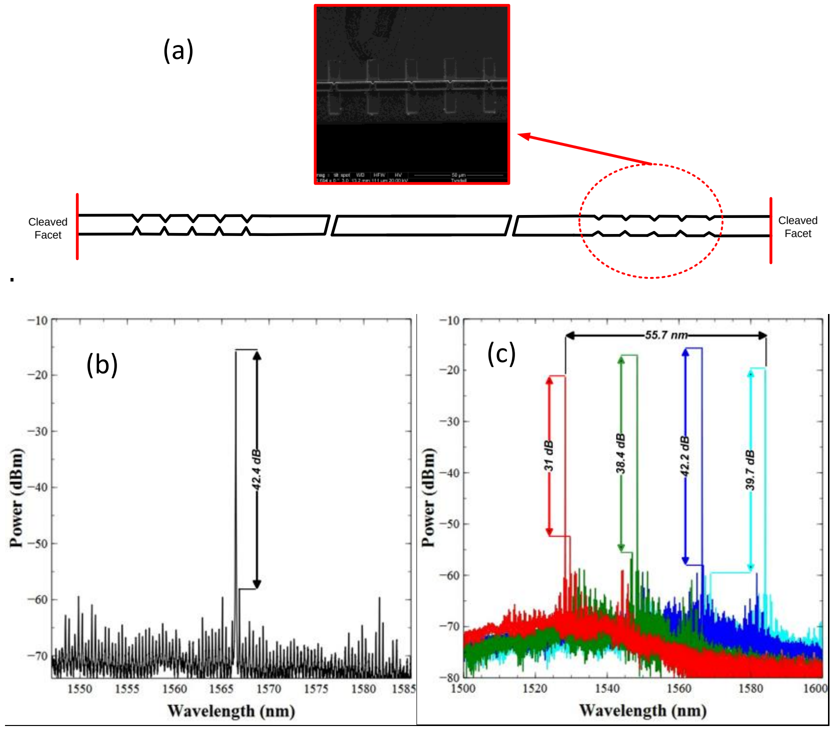


Fig.1 (a)V-notch illustration showing the active region in red(b) V-notch SEM

These lithographically controlled V-notches can be valuable in generic fabrication foundries where the depth options are limited or only deep etch ridges are used. Some of the V-notch structures have higher reflectivities than the slots, which reduces the mirror size compared to the slotted mirrors used in conventional SFP. By measuring the modulation depth and L-I curves of various V notch structures it was possible to estimate their reflection and loss. Simulation results using commercial Eigen mode expansion (EEM) software ModePROP from RSOFT agrees well with the experimental data. Finally, a V-notch laser cavity that exhibits an SMSR up to 42 dB and tuning range across 55 nm using V-notch with various dimensions will be presented (Fig.2)



Fig,2 (a)cavity Design (b) single mode with a SMSR of 42.4 dB (c) Tuning across 55.7 nm with SMSR>31 dB

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