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# An MMI-based Tunable Laser for Integrated Photonic Circuits

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**Abstract:** A single mode, tunable semiconductor laser is presented for the L band. This facetless, regrowth-free laser shows a tuning range extending from 1564nm to 1611nm, with side-mode suppression ratio values over 30dB.

## 1. Situation overview

With the growing demand for optical bandwidth, there is a need for the development of cost-effective solutions for optical communications. One of the options that can be considered to reduce fabrication costs and time is the integration of photonic components on a single chip, forming photonic integrated circuits (PICs). A building block of photonic circuits is the laser, which needs to be single-mode and tunable to achieve satisfactory performance in communication systems.

These two aspects are commonly achieved using grating-based designs, such as distributed Bragg reflector (DBR) lasers [1] or distributed feedback (DFB) lasers [2]. However, such designs often require multiple epitaxial growth steps and the use of high-resolution lithography techniques that increase the production cost and time. Regrowth-free solutions using standard lithography exist with slotted Fabry-Perot lasers [3] but are sensitive to slot depth, requiring careful control and presenting a risk of reducing the fabrication yield [4].

Such designs also often rely on the use of cleaved facets to achieve optical feedback, causing a constraint in the design of photonic integrated circuits by forcing the laser to be positioned next to a facet.

## 2. Proposed solution

A design for a laser is presented here, based on gold-coated on-chip etched facets and multimode interference (MMI) couplers [5]. The laser (shown in Fig.1) was fabricated from commercially obtained 1550nm laser material and using exclusively standard UV lithography and without regrowth steps. The fabrication process is a two etch-depth process compatible with most standardized shared foundry processes [6].

Single-mode is achieved using an MMI coupler to couple multiple cavities of different lengths. The use of etched facets coated in gold (metal on etched facets, MEF) to terminate waveguides, rather than cleaved facets, makes the design integration-friendly by removing the constraint on the position of the laser, facilitating the design of monolithic PICs.

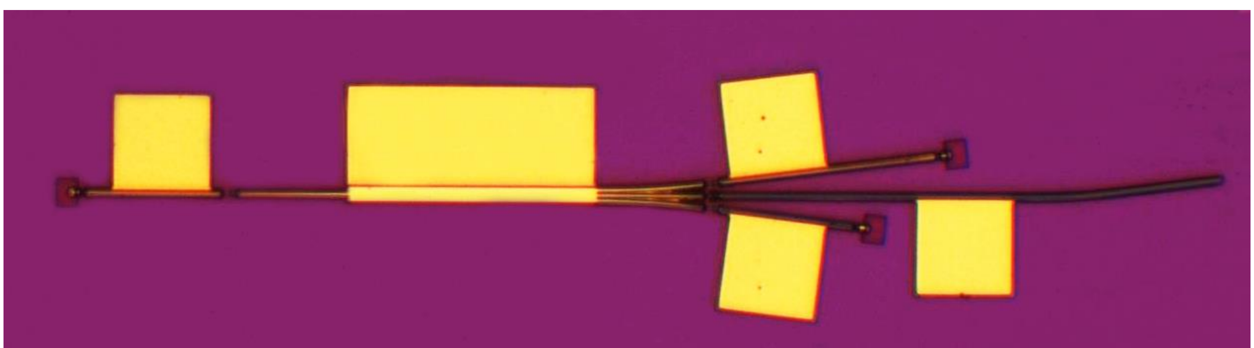

Figure 1: Microscope image of the fabricated laser

## 3. Characterization results

Discrete tuning was achieved over a range of 47nm in the L band, from 1564nm to 1611nm while keeping the side-mode suppression ratio (SMSR) above 30dB, by adjusting the current provided in the different sections of the laser. Superimposed emission spectra for various bias configurations are shown in Fig.2. The laser linewidth was measured to be 800kHz by the means of a self-heterodyne technique [7].

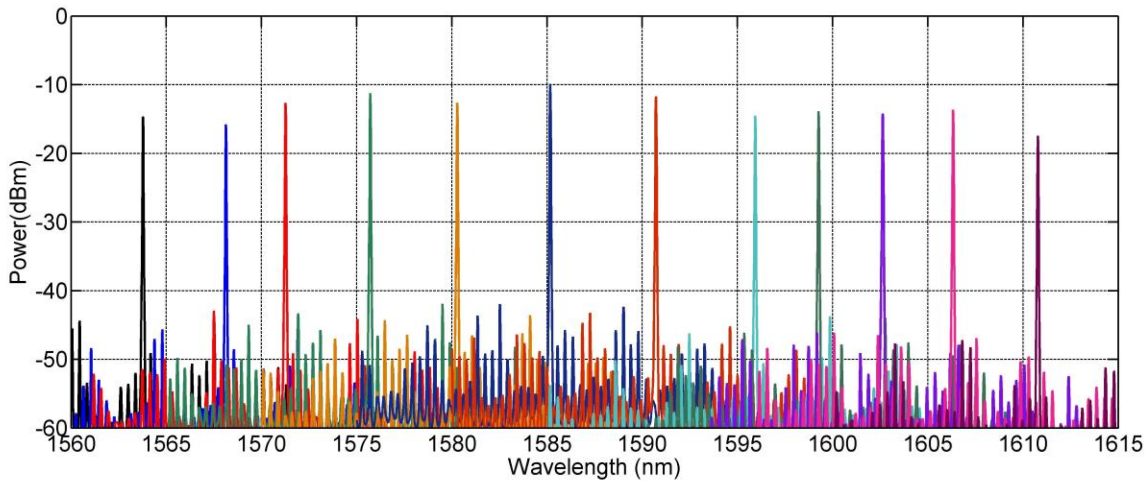


Figure 2: Superimposed laser emission spectra

## 4. Conclusions

An MMI-based laser design is proposed and demonstrated. It was fabricated from commercially obtained 1550nm regrowth-free material, using contact UV lithography. The fabrication simplicity and the facetless design make it a suitable candidate for large-scale production and monolithic integration into PICs. Tuning was achieved over a range of 47nm in the L band, with a linewidth of 800kHz.


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