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Fabrication and characterization of VCSELs with liquid crystal overlay

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We have designed and fabricated a novel liquid crystal (LC) cell developed for optoelectronic devices. A VCSEL laser of 250 μm by 250 μm is placed inside a liquid crystal cell with a gap between the emitting area and the upper glass plate of about 30 μm. This allows to cover the VCSEL with a thin layer of liquid crystal after filling the cell through capillary forces. In this work we present the optimization of the technological processes to fabricate such a device. After mastering the technological aspects, the device can be used to modify the properties of the laser light in terms of polarization, beam shape, wavelength, etc. which may open the way to a wide range of applications.
In order to prove that the device works, the properties of the laser beam are investigated, including the optical power, divergence and polarization, all in function of the applied current to the VCSEL and the voltage applied across the liquid crystal layer. The dependence of optical power on the current at different polarization directions is measured in order to obtain the polarization properties of the laser beam (in terms of the Stokes parameters). Before the LC is filled into the cell, I-P curves were acquired. The measurements are then repeated after the LC (E7, Merck) was filled in. It is observed that the dominant polarization direction of the laser beam could be changed by applying different voltages over the LC layer. Stokes parameters were calculated to describe the polarization state in more detail. Our results show that the polarization state is linear polarization when there is no LC in the cell and it changes to elliptical polarization if LC was filled into the cell. This technology opens an effective way to fabricate integrated VCSEL chips in optoelectronic devices and different experiments are planned in the future with the fabricated devices.

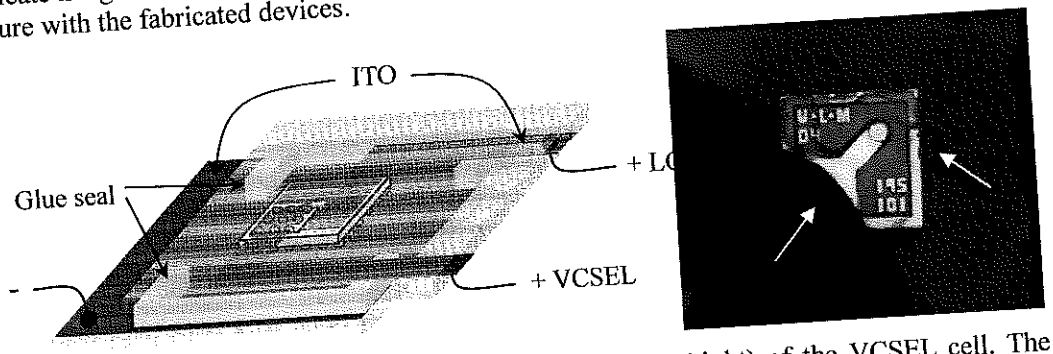

Fig. 1. Schematic structure (left) and microscopic picture (right) of the VCSEL cell. The bottom (cathode) and the top (anode) pad of the VCSEL are conductively connected to the bottom and top ITO electrodes, respectively, through micro-sized gold balls embedded in cured optical glue (white arrows).

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