Simulation of Spiral Phase Plate VCSELs

P. Debernardi[1], A. Tibaldi[1], P. Gerlach[2], R. Orta[1,3]

1. Consiglio Nazionale delle Ricerche (CNR), Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni (IEIIT) c/o Politecnico di Torino, Corso Montevecchio 71, 10129, Torino (TO), Italy.

2. Research and Development of Philips Photonics, Philips Technologie GmbH U-L-M Photonics, Ulm 89081, Germany.

3. Politecnico di Torino, Dipartimento di Elettronica e Telecomunicazioni (DET), Corso Duca degli Abruzzi 24, Torino (TO), Italy

Several groups belonging to different scientific communities are focusing their efforts on the theoretical and applied research on the orbital angular momentum of light (OAM). Among the most significant examples in the field of ICT, the OAM-division multiplexing recently emerged as a viable approach for increasing the capacity of the next generation optical networks. Optical beams featuring an OAM are usually generated through the conversion of a standard laser mode; such techniques usually rely on bulk optical components such as computer-generated holograms, spatial light modulators or spiral phase plates (SPPs).

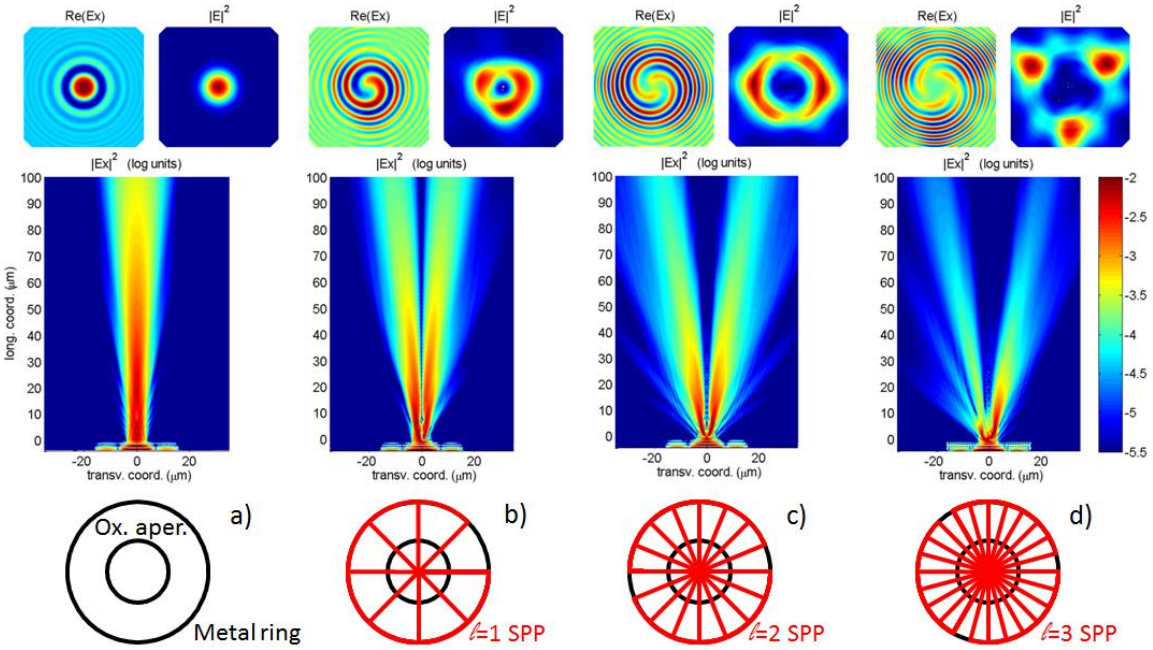

Fig. 1: Modal profiles of 4 devices: *a*, bare device, *b* − *d*, SPP with *l* = 1 to 3. Top maps refer to a 30×30 μm^2 area at 100 μm distance from the outcoupling section. Center, (x,z) cuts of the field intensity. Bottom, top view of the transverse geometries; the SPP is shown in red.

In a recent paper Li *et al.* proposed the possibility to load a commercial GaAs VCSEL with a micro-SPP [1]. The resulting device, which can emit directly OAM modes, is extremely appealing in view of reducing manufacturing costs, even opening up the possibility to introduce it in mass market applications, with an eye to the "green technology" paradigm in which VCSELs perfectly fit, due to their well-known low consumption features. The experimental work described in [1] has been complemented by a theoretical study performed by means of our in-house Vcsel ELectroMagnetic simulator (VELM) [2]. The possibility to estimate the OAM mode efficiency with full-wave simulations allowed to perform a thorough analysis of the sensitivity of the device to the possible manufacturing issues. As an example of the several numerical results that will be presented during the conference, Fig. 1 shows the simulated field profiles for the unprocessed VCSEL and for three micro-SPP geometries producing various OAM orders.

Furthermore, the flexibility of VELM opens up the possibility to explore alternative implementations of SPP-VCSELs. Such solutions, supported by a technological affordability study, may allow to further develop these devices, in view of improving the emitted OAM mode purity while lowering the manufacturing costs.

References

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