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Tuning of nanophotonic and nanoplasmonic components with liquid crystals

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1. Introduction

Due to the strong electro-optic effect of liquid crystals, their refractive index can be modified by using relatively small voltage signals. This effect has been exploited in many configurations to tune the properties of optical components. In the past few years this tuning effect has been demonstrated with optical components with nanometer-scale size. The optical tuning is not only interesting to modulate the propagation of light, but also to tune the emission of light.

2. Tuning light propagation

The silicon nanophotonic platform is interesting because optical waveguides and components can be fabricated using the same equipment for CMOS fabrication. Due to the high index contrast the waveguides are small and sharp bends can be made. By combining such waveguides with liquid crystals it has been demonstrated that the effective index of the modes can be tuned. The advantage of slot waveguides is that the interaction of light with liquid crystal is very strong and large tuning of the phase of the light is possible [1]. By using shallow etched waveguides we have demonstrated that also loss tuning is possible [2].

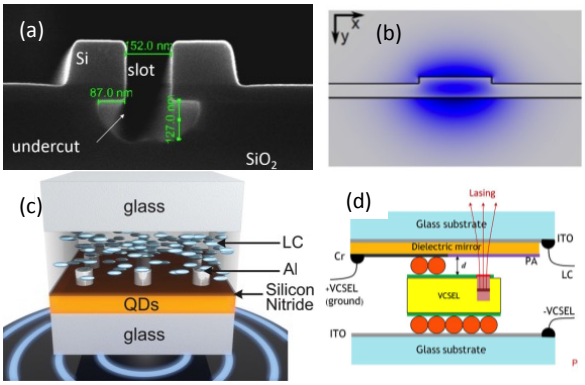

Figure: slot waveguide (a), TM mode of a shallow etched waveguide (b), liquid crystals in combination with a layer of quantum dots and a plasmonic array of Al nanoparticles (c), liquid crystals on top of a vertical-cavity surface-emitting laser (d)

3. Tuning light emission

The emission of light by quantum dots, organic dyes or other emitters is strongly dependent on the optical properties of the environment. By changing the optical properties of the surrounding medium the light emission can be modified. By using either plasmonic effects [3] or interference effects in a laser cavity [4], small variations of the refractive index can lead to abrupt changes in the emission properties. The polarization, wavelength or emission direction of the light can be controlled in this way.

References

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