Invited I-1

Liquid crystals in focus

X.Quintana[1], Morten A.Geday[1], M.Caño-García[2], M.García De Bias[1], J.M.Otón[1]

[1]CEMDATIC, ETSI Telecomunicación, Universidad Politécnica de Madrid, Spain
[2]Department of Nanophotonics, Ultrafast Bio- and Nanophotonics Group, INL-International Iberian Nanotechnology Laboratory, Portugal

1. Introduction

Liquid Crystal (LC) lenses may be used for imaging or projection systems, in portable devices and vision correction in head-mounted devices. There are many types of LC lenses with tunable focal length, but only few have achieved practical importance, due to their small size or due to their limited focusing capability. The three most important classes of LC lenses with variable focus are lenses with curved surfaces, flat gradient index lenses and composite lenses [1]. Fresnel lenses, included in flat gradient lenses, achieve better aperture size (1-2 cm) in thin cells and fast response, but they are on-off lenses or they have a complicated multilevel electrode structures to achieve different focal power.

In this work we present a novel approach to make tunable LC Fresnel lenses, with a very simple electrode structure.

2. Liquid Cristal spiral plates (SPP): liquid crystal vortices with tunable topological charge

An optical vortex is a wavefront in which the phase of the light varies spatially with the angular position in the beam. A special case of the spiral phase plate is the integer spiral phase plate, where the phase retardation variation per revolution about the beam centre is an integer number, l, times 2π. l is the so-called topological charge (Figure 1). Integer spiral phase plates converts planar light waves into continuous helical wavefronts with a singular point in the middle, where no light can exist. The power distribution around the singular point depends on the topological charge.

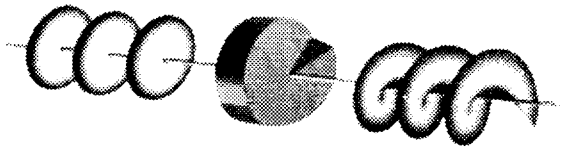

Figure 1: Generation of helical beam shape

One way to generate a LC vortex is alluringly simple. A device with electrodes cut in forms of portions of cheese can be used to generate a tunable topological charge device [2]. The device only has electrical contacts in the periphery.

3. The trick: Combining SPP and Fresnel lens

Adding the phase change introduced by an SPP to the phase change introduced by a Fresnel lens and removing the constant phase change in all the area (phase wrapping) we obtain a spiral fresnel lens with a singularity in the middle. This can be made tunable with LCs, and still the connection diagram is very easy, because all contacts are in the periphery (Figure 2).

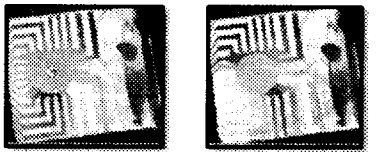

Figure 2: Tunable LC lenses with topologies 1 & 2

4. Conclusions

In this work we present inch-sized tunable LC Fresnel lenses with a simple electrical driving and easy manufacture. Lenses and driving electronics have been fabricated and lenses have been characterized for imaging. Future works will remove the topological charge and polarization dependence.

5. Acknowledgements

Authors are indebted for financial help received from the "Programa RETOS" from the Ministerio de Economía y Competitividad (TEC2016-77242-C3-2-R), the "Programa Regional de I+D SINFOTON 2" from the Comunidad de Madrid and European Structural funds (P2018/NMT-4326 SINFOTON2-CM) (FEDER) and to ATTRACT Program (European Union's Horizon 2020 programme). Manuel Caño García wants to express his gratitude to the Ministerio de Economía y Competitividad for his postdoctoral grant (FPI (POP) research fellowship Ref. BES-2014-070964) & postdoctoral research fellow program NanoTRAINforGrowth II (MSCA-COFUND H2020 framework).

6. References

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