Multi-Level Lossless Phase Modulation in Liquid Crystals for High-Speed Spatial Light Modulators

David Engström

Photonics Lab., Chalmers Univ. of Techn., Göteborg, Sweden

The spatial light modulator (SLM) is a compact device that enables highly precise control of light propagation with low drive voltages and no moving parts. By imposing a certain phase modulation onto the incident lightwave, functions such as multi-beam steering, beam shaping, and air turbulence corrections can be achieved in real time. Thanks to the rapid development of liquid crystal (LC) displays, the LC-based SLM is the primary technology for phase modulating SLMs. Future important SLM applications may include novel beam steerers, optical correlators, and adaptive optics, but these require faster SLMs than are presently available, preferably with analog phase modulation. Today, commercial SLMs have response times of ~20 ms or more for analog phase modulation and ~1 ms for binary modulation.

In this seminar, our efforts to achieve multi-level, or even analog, phase modulation without loss, using LC cells that already had proven to allow fast amplitude modulation will be described. It turned out that anti-ferroelectric LC (AFLC) cells can be used to obtain three almost equidistant phase levels, ideally without any induced loss. Further, fast with a response time of ~1 ms) four-level phase modulation has been realized by combining two binary ferroelectric LC (FLC) SLMs. Also, the analog mode of FLCs, referred to as V-shaped switching (V-FLC), has been utilized to obtain analog phase modulation up to π rad and 2π rad, for a simulated transmissive and reflective device, respectively; these values being 0.8π rad and 1.6π rad for slightly non-ideal fabricated cells.