1 Introduction

The shaping of light fields, a topic of interest to the optics community for some time, has taken many forms, e.g., from coherent field mapping to diffusing elements for incoherent light shaping.[1–5] Since the advent of the laser, structuring laser light in amplitude and phase has been achieved outside the laser cavity (with refractive, adaptive, and diffractive elements) and inside the laser cavity (through a variety of amplitude or phase objects that force the laser internally to oscillate on particular transverse modes). We will not discuss in detail the contribution of these tools for controlling light, but the reader is referred to the references provided for further details. Instead, we will consider a modern derivative of the above, namely shaping light with computer-generated holograms (digital holograms) using spatial light modulators (SLMs).[6] Digital holography for structured light has enabled many new advances, ranging from classical to quantum physics, including communication, microscopy, imaging, metrology, and education.[6–12] The advent of liquid crystal on silicon (LCoS) SLMs has made the aforementioned techniques accessible to the inexperienced researcher. LCoS devices, colloquially referred to as SLMs, have allowed researchers to display computer-generated holograms as images; thus, controlling light digitally can be realized with just a little know-how.[13–15] Here, we will show how to "get started" with SLMs for the creation and detection of structured light fields.

This guide focuses on the shaping of coherent light with these tools. We outline the means by which one can get started with digital holography as well as introduce phase-only, amplitude-only, and complex amplitude modulation as tools to create structured light fields in the laboratory.

2 Spatial Light Modulators

2.1 Brief introduction to liquid crystals

The different states, or phases, in which matter can be found are related to the mobility of individual atoms or molecules. The most evident are the solid, liquid, and gaseous states. For solids, molecules are kept close together at a fixed position and orientation, with a well-defined shape, due to intermolecular forces. Even though the molecules are packed together in liquids, they have more mobility and will not form a rigid body but rather take the form of the container holding it. In the gaseous state, the molecules have even more freedom to move around and will always expand to fill the container holding it. As a result, their intermolecular spaces will be larger. Even though these three categories seem obvious, the boundaries between the different phases are not well defined and there exist a large number of other intermediate phases. This is the case for liquid crystals (LCs), which are described by a state of matter at the interface between the liquid- and the solid-state phases. LCs are composed of elongated, rod-like, organic molecules that exhibit unique properties from both liquids and solids.