Lasing and tunable optical amplification in non-chiralnematic liquid crystals

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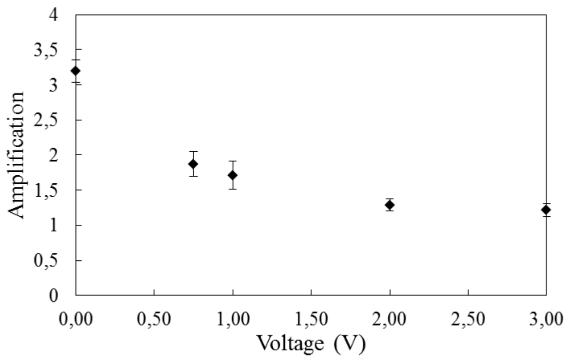
In the last decade, chiral liquid crystals have been studied extensively for the generation of laser light [1]. When the reflection band of the chiral liquid crystal is matched with the gain spectrum of the laser dye, efficient lasing can be obtained. The laser signal has a wavelength which is either equal to the short edge wavelength of the reflection band or the long edge wavelength. Our accurate simulation tools are able to simulate the lasing threshold which results in a good match with experimental results [2].

Also in non-chiral nematic liquid crystals, lasing can be obtained. Then an optical cavity must be formed outside of the liquid crystal region. In this work, we demonstrate lasing from non-chiral nematic liquid crystals in standard nematic liquid crystal cells. The optical cavity originates from very small reflections at the liquid crystal – glass boundary, or from reflections originating from metallic or dielectric layers on the glass substrates. We investigate the influence of different parameters (cell thickness, dye concentration, reflection of substrates, etc.) on the lasing characteristics. Additionally it is shown that voltage tuning of both the lasing wavelength and optical output power is possible.

Next to lasing, we also demonstrate that an optical beam can be amplified by a nematic liquid crystal cell with laser dye inside. For this application all reflections should be minimized as much as possible. Because of the dichroic emission of the laser dye, the amplification can be tuned by applying a voltage over the cell. Interestingly, the dichroicity of the emission not onlyaffects the spontaneous emission, but also the stimulated emission which is responsible for the amplification. For a director orientation parallel to the polarization of the signal beam (no voltage) the amplification is maximal, while for perpendicular orientation (high voltage) the amplification is almost zero. Experimentally we obtain a change in optical amplification from a factor 4 to a factor close to 1 as shown in the figure below. Such tunable amplification is interesting for applications ranging from optical communication systems to projection systems.



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References

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