Modelling bistable liquid crystal devices using conformal mappings

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Abstract

Modelling methods for liquid crystals have become more advanced over the last decade, producing results faster and more accurate than ever before with the assistance of advances in computer processing power. These models are useful for emerging display technologies as predictions can be made for optimising the device without the expense of trial and error in manufacturing. One issue that many of these methods have is that they can still take a lot of computational time to reach a solution and in devices where there are several possible stable states it is often difficult to obtain different intial conditions in complicated geometries.

We present a simple conformal mapping method that can quickly calculate the liquid crystal director profile in confined and semi-confined geometries. These resulting profiles can be used as initial conditions in more complex models, such as the Q-tensor method, vastly reducing the time required to run these simulations.

In particular we look at geometries which support more than one stable state, including those which are currently in use as bistable displays. Using the conformal mapping method we can investigate the existence of potential stable states and how energetically stable they are. A basic transmission calculation can be used to examine the optical properties of each given state and from this information we can alter the geometry to find the optimal optical stable states.

The conformal mapping technique can also be used to quickly simulate the director profile of a device as it is switched between stable states but to more accurately model the switching dynamics we use the conformal mapping solution as an initial condition for a Q-tensor model.

We compare our model solution to experimental results and show that there is a good correlation between them. This allows us to deduce how the director behaves as the cell switches between stable states and to better understand the mechanics behind the switch.