Localization of light on defects in microcavities with built-in uniform lying helix

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Uniform lying helix (ULH) is a type of cholesteric liquid crystal arrangement, where the helix axis is oriented parallel to the substrate surface. The rotation of liquid crystal molecules results in the appearance of a periodic structure of refractive indices in the form of sripes (see Fig. 1). Molecules in each stripe are aligned parallel to each other, In our study, we placed such a structure inside a 3 micron optical microcavity made of two distributed Bragg reflectors (DBR), fabricated by the method of vapor deposition out of six-pairs of SiO_2 and TiO_2 grown on transparent Indium tin oxide electrodes. The center of the stop band of the DBRs was 530 nm.

The periodic modulation of refractive index of the ULH is responsible for the formation of photonic bands, similar to bands formed in a 1D photonic crystal. The introduced bandgaps are of around *40* meV, depending on period of the stripes, which slightly varied across the sample.

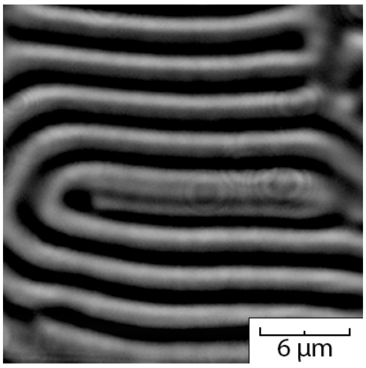

Figure 1. A defected state of ULH. The pitch of the stripe in the middle of the spiral is smaller than the pitch of the surrounding ULH.

In the study we focused mainly on on certain imperfections in the ULH periodicity, where the helix wound up on itself (see Fig. 1.) forming an elongated spiral. The optical defect state inside of this spiral was found to have a different energy compared to the regular ULH around it. We performed statistical analysis to determine a correlation between the energy of the optical defect state and its size. It was found that if the pitch of the defect was smaller than the pitch of the regular ULH, the energy of the defect state lay inside the energy bandgap generated by the regular ULH. If the helix pitch inside the spiral was bigger, the defect's energy lied beneath the minimum energy of ULH state.

By applying the electric field to electrodes built-inside the cavity we found that the pitches, as well as energy states of the optical defect and the regular ULH structure were tunable up to 3V of external voltage, above that level, the structure deteriorated into a nematic and periodic structure disappeared. The presented work introduces a new, interesting system, where the 1D photonic crystal can be controlled and tuned by external electric field.