At ILCC 2012 we reported that an imposed macroscopic torsion strain on a configurationally achiral nematic phenyl benzoate liquid crystal results in an electroclinic effect, a signature of chirality [1]. We suggested that the energy cost of the imposed director twist could be reduced by a partial conformational deracemization of molecules, which would be strongest very close to the two bounding surfaces owing to the near-discontinuous azimuthal orientations of the easy axis and the director adjacent to the alignment layer. But there exist possibilities other than conformational deracemization: (i) an orientational deracemization of the right- and left-handed conformers, in which the numbers of left- and right-handed conformers remain the same in the presence of the imposed twist, but conformers of opposite handedness adopt different orientational distributions in the helical environment, and (ii) a reduction from $D_2$ to $C_2$ point symmetry on application of an electric field to a twisted director arrangement, even if the molecules are achiral. We examined experimentally these two scenarios by (i) using a racemic mixture of a configurationally achiral mesogen having essentially frozen-in right and left-handed conformers, and (ii) using a configurationally achiral mesogen with a rigid and conformationally achiral core. We found that neither species exhibits a measurable electroclinic signature. Taken as a whole, the results strongly suggest that the macroscopic torsional strain results primarily in a partial conformational deracemization of the phenyl benzoate cores [2].

Addressing the question of where in the cell this deracemization occurs, we filled a twist cell having a thickness gradient with a mixture containing a configurationally achiral nematic phenyl benzoate liquid crystal and chiral dopant. We observed that the magnitude of the electroclinic effect varies monotonically with the cell thickness $d$, changing sign at $d = d_0$, where the twisting power of the chiral dopant exactly compensates the imposed twist. The results indicate that a significant chiral electrooptic effect always exists at the alignment layer of a twist cell containing molecules that can be conformationally deracemized [3]. Additionally, this approach can be used to measure the helical twisting power (HTP) of a chiral dopant in a liquid crystal.

References: