Phase Control for Helical Surface Acoustic Wave Generation on Anisotropic Materials

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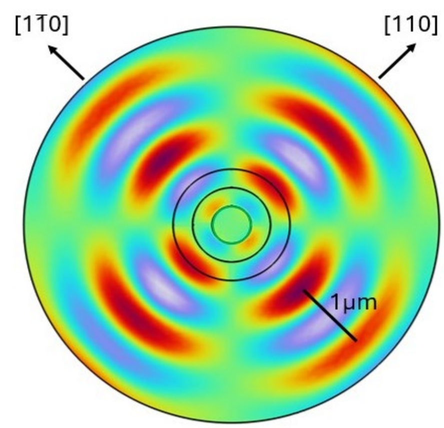
Successful piezoelectric systems for launching helical waves and creating acoustic vortices in liquids have opened new avenues of microfluidic particle manipulation. [1] Helical waves can also be used to manipulate spins in semiconductors. Techniques developed for nearly isotropic spiral interdigital transducers (IDTs) at MHz frequencies [2] may be adaptable to more anisotropic crystalline systems and to the production of GHz chiral phonons that effectively couple to magnetic spin systems or transfer angular momentum to opto-electronic states. This talk will outline the requirements of phase control for helical SAW excitation and the experimental potential of chiral phonons. Finite element models of SAW production on GaAs and by strongly piezoelectric overlayers will be presented. (001) GaAs is a well-studied piezoelectric substrate and rich platform for investigating phonon interactions with low-dimensional charge and spin systems. Strong focusing of acoustic beams along the [110] direction requires close conformation of the launching IDT fingers to the group velocity surface. [3] The simulation in Fig. 1 shows that IDT pairs along the [1-10] direction will generate similar wave surfaces, but with a pi phase shift, due to the rotation symmetry of the 3^{rd} order piezoelectric tensor. To create effective surface acoustic wave vortices within a converging SAW beam, a GaAs based IDT must incorporate this intrinsic phase shift in addition to continuous phase shifts associated with the desired phonon angular momentum.



References

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