FEM MODELLING OF INTERDIGITATED STRUCTURES WITH RESPECT TO POLING PROCESS

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FEM (Finite Element Method) modelling software such as COMSOL Multiphysics can be a powerful tool for modelling of the behaviour and response of piezoelectric materials and devices. Devices based on piezoelectric crystals are particularly well suited, because the polarization magnitude in crystals is predetermined defined by cut direction. In the case of polycrystalline piezoelectric ceramic materials, the overall polarization vector in the material is not oriented in one single direction nor is constant all over the material. Therefore, a poling process, where a strong electrical field is applied across the material to align the dipole domains in one particular direction on a macroscopic level, should be performed. In this paper poling process and performances of SAW (surface acoustic wave) devices with interdigitated electrodes have been investigated through FEM simulations. SAW devices have found a number of applications in physical and chemical sensing. Two poling configurations of SAW piezoelectric ceramic devices have been compared: a standard one having a polarization perpendicular to the substrate and a second one with a more complex polarization but easier for manufacture. The latter one can be achieved by applying a high electric potential to one of the interdigital electrodes while grounding the other one. The standard SAW device and the interdigital poled SAW device have been modelled using the Piezoelectric Devices Module in COMSOL. In order to correctly model the interdigital poled SAW device the poling process has also been modelled by simulating the resulting electric field from the applied voltage on the electrodes. The electric field magnitude was mapped to the polarization magnitude according to the virgin hysteresis curve of the piezoelectric ceramic, while the orientation of the polarization has been aligned in the direction of the simulated electric field. The module of the transfer function between the transmitting IDT (interdigital transducer) and the receiving IDT provides the proper sensitivity comparison of the two SAW devices. It has been shown that COMSOL Multiphysics can used to model not only piezoelectric devices but also the poling process in the case of piezoelectric ceramic materials, which is of utmost interest for users and designers of piezoceramics. In this paper, the focus has been mainly on SAW devices, but it can be applied to any piezoelectric ceramic based devices with non-trivial polarization pattern.