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Research article

The effect of geometric parameters on the propagation of SH waves in a piezoelectric/piezomagnetic plate

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The propagation features of horizontally polarized shear waves in a magnetoelectroelastic composite plate in contact with vacuum are investigated within the quasi-static approximation. The plate consists of rigidly coupled piezoelectric and piezomagnetic layers. It is assumed that there are no mechanical stresses on the outer surfaces, and the magnetic potential is zero. Depending on the nature of the specified electrical conditions, problems with electrically open and electrically closed external surfaces are considered. The wave process is initiated by the action of a remote source of harmonic oscillations and is assumed to be steady. The solution of the problems is constructed in Fourier images as an expansion into a set of exponentials. Dispersion equations of the problems, which are presented in a matrix form convenient for numerical implementation, were obtained. Using the example of the PZT-5H/$CoFe_2O_4$ plate, the effect of the thickness of each of its layers on the transformation features of phase and group velocities of surface acoustic waves with horizontal polarization (SH-SAW) is established. When changing the geometric parameters, either the plate thickness or the thickness of one of its layers was fixed. Within the framework of the problem with electrically closed external surfaces, significant differences in the behavior of velocities were established depending on the thickness of the piezoelectric and piezomagnetic layers. The conditions for the maximum and minimum effect of the thickness of each layer on the behavior of the 2nd and subsequent SH-SAW modes were determined. It is shown that in the presence of a very thin piezomagnetic layer in the plate, the behavior of the 2nd SAW mode changes significantly: both the mode output frequency and the asymptotic value of the velocity increase. The regularities of the effect of changing the thickness of the piezoelectric and piezomagnetic layers of the plate on the transformation of the electromagnetic-mechanical coupling coefficient in a wide frequency range were revealed. The obtained results are given in dimensionless parameters and can be of interest in the development of new functionally oriented materials, the assessment of their performance characteristics, as well as in the creation of highly efficient devices operating on surface acoustic waves.

Keywords: piezoelectric material, piezomagnetic material, magnetoelectroelastic material, shear horizontally polarized surface acoustic waves, electromagnetomechanical coupling coefficient

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