Waves in Piezoelectric Solids with Surface Effect

***W.Q. Chen, B. Wu**

Department of Engineering Mechanics, Zhejiang University, Hangzhou 310027, China

*Corresponding author: chenwq@zju.edu.cn

With the miniaturization of functional structures and devices, many phenomena that are not obvious at macroscales become important and play a leading role at nanoscales. Surface effect is such a phenomenon that has been widely studied in nanoscience and nanotechnology. In this study, we report a new method to establish the surface theory for piezoelectric bodies. In contrast to the well-known Gurtin-Murdoch theory, we start directly from the familiar three-dimensional theory for piezoelectric materials. Employing the state-space formalism, and making use of the symbolic method, we are able to derive theories of surface piezoelectricity of an arbitrary order regarding the thickness of the surface, which can be in arbitrary shape, but with required differentiability. It is shown that in some degenerated cases, the derived governing equations match well with those given by the Gurtin-Murdoch theory. Some numerical examples are given for waves in piezoelectric half-space, plates, and cylindrical shells to show the surface effect on the wave propagation behavior.

Keywords: Piezoelectricity, Surface effect, State-space formalism, Wave propagation