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An elastic electrode model for wave propagation analysis in piezoelectric layered structures of film bulk acoustic resonators

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Abstract-- Wave propagation in a piezoelectric layered structure of a film bulk acoustic resonator (FBAR) is studied. The accurate results of dispersion relation are calculated using the proposed elastic electrode model for both electroded and unelectroded layered plates. The differences of calculated cut-off frequencies between the current elastic electrode model and the simplified inertial electrode model (often used in the quartz resonator analysis) are illustrated in detail, which shows that an elastic electrode model is indeed needed for the accurate analysis of FBAR. These results can be used as an accurate criterion to calibrate the 2-D theoretical model for a real finite-size structure of FBAR.

Keywords: FBARs; Elastic electrode; Waves propagation; Dispersion curves

1. INTRODUCTION

The thin film bulk acoustic resonator (FBAR) consists of a thin film of AlN or ZnO with a proper electrode layout on a silicon substrate and has the working frequency ranging from one to dozens of GHz [1-2]. Compared with the dielectric or surface acoustic wave (SAW) resonators, FBARs present much more advantages in size, working frequency, Q-factor and fabrication, and thus have broad applications and great potentials in telecommunication, signal processing, control, guidance, and sensing [3]. Typical FBARs operate in thickness-extensional modes of thin films, giving rise to three different types of structures for FBARs, i.e. the back etching type, air gap type and solidly mounted type.

For the sake of analysis and design of FBARs, accurate predictions of their vibration frequencies and mode shapes are not only useful and necessary but also increasingly demanded [4], which have drawn much attention from researchers to theoretical and

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