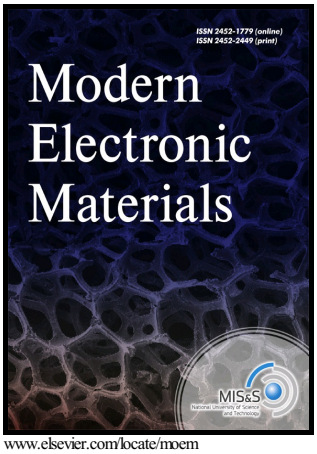

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Non-local dispersion and ultrasonic tunneling in concentrationally graded solids

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Abstract. The non-local dispersion of longitudinal ultrasonic waves is shown to appear in the heterogeneous solids due to continuous spatial distributions of their density and/or elasticity (gradient solids). This dispersion gives rise to the diversity of ultrasonic transmittance spectra, including the broadband total reflectance plateau, total transmission and tunneling spectral ranges. The ultrasonic wave fields in gradient solids, formed by interference of forward and backward travelling waves as well as by evanescent and antievanescent modes are examined in the framework of exactly solvable models of media with continuously distributed density and elasticity. Examples of transmittance spectra for both metal and semiconductor gradient structures are presented, and the generality of concept of artificial non-local dispersion for gradient composite materials is considered. It should also be noted that the wave equation for acoustic waves in gradient media with a constant elasticity modulus and a certain predetermined density distribution reduces to an equation describing the electromagnetic wave propagation in transparent dielectric media. This formal similarity shows that the concept of nonlocal dispersion is common for both optical and acoustic phenomena, which opens the way to the direct use of physical concepts and exact mathematical solutions, developed for gradient optics, to solve the corresponding acoustic problems.

Keywords: gradient solids, non-local dispersion, spatial distributions of density and/or elasticity, ultrasound propagation

I. Introduction

The control of ultrasound transmission is required in a number of practical scenarios, from signals processing to materials testing. The important problems for these elaborations are connected with the improvement of spectral sensitivity of ultrasonic devices and search of