Journal of Acoustical Engineering Society of Iran, Vol. 10, No. 1, 2022

(Research Article)
Thermal tuning of focal point in fluid-fluid gradient index phononic crystal lenses

F. Ahmadzadeh, A. Bahrami*

Optoelectronic and Nanophotonic Research Laboratory (ONRL), Faculty of Electrical Engineering, Sahand University of Technology

Received: 2021/12/18, Accepted: 2022/09/20
DOR 20.1001.1.23455748.1401.10.1.11.0

Abstract

Acoustic waves, like electromagnetic waves, can be converged at a focal point, which can be achieved with the help of negative refraction of waves and structures with gradient refractive indices. In this study, with the help of a fluid-fluid phononic crystal of methyl nonafluorobutyl ether (MNE) scatterers in an ethanol matrix, a gradient index structure at its homogenization frequency (i.e. $\lambda \geq 4a$) designed and simulated. Gradual changes in structure with gradual changes in the radius of cylinders (or changes in filling factor), a hyperbolic secant profile for the refractive index is obtained to force the waves to follow curved paths in the structure. In most phononic crystal lenses, the focal point is fixed after it is made. Due to the temperature sensitivity of ethanol and methyl nonafluorobutyl ether, in this paper, an attempt is made to shift the focal point with the help of temperature effect, and two temperatures of 10 °C and 40 °C were investigated. The focal point from 199 mm at a temperature of 25 °C reaches 184 mm at a temperature of 40 °C, while at a temperature of 10 °C the focal point is almost unchanged. The finite element method has been used to calculate the band structure of the unit cell and also to investigate the wave propagation inside the two-dimensional gradient refractive index structure.

Keywords: Phononic crystal lens, Hyperbolic secant refractive index profile, Thermal effects, Thermal tuning, Focal point shift.

pp. 105-111 (In Persian)

* Corresponding author E-mail: bahrami@sut.ac.ir

[DOR: 20.1001.1.23455748.1401.10.1.11.0]