Elastic metasurface for wave focusing in wide angle of incident

Geon Lee[1], **Jehyeon Song**[1], Dongsu Lee[2], Wonjae Choi[2,3] and Junsuk Rho[1,4,5,6,*]
[1]*Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Republic of Korea*
[2]*Intelligent Wave Engineering Team, Korea Research Institute of Standards and Science (KRISS), Daejeon 34113, South Korea*
[3]*Department of Precision Measurement, University of Science and Technology (UST), Daejeon 34113, South Korea*
[4]*Department of Chemical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Republic of Korea*
[5]*Department of Electrical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Republic of Korea*
[6]*POSCO-POSTECH-RIST Convergence Research Center for Flat Optics and Metaphotonics, Pohang 37673, Republic of Korea*
**E-mail:jsrho@postech.ac.kr*

Recently, the metasurface has attracted attention as an innovative artificial structure that can efficiently control various types of waves, including elastic waves.
However, most of the existing elastic metasurface studies are designed to control only vertically incident plane waves, and in particular, they have limitations in controlling waves only under limited conditions using hyperbolic phase profiles. These constraints are a major cause that makes it difficult to control elastic waves with various angles of incidence that commonly occur in real industrial and engineering environments. As a result, it has brought great restrictions on its application in various practical applications.
In order to overcome the limitations of previous studies, this study proposed a new elastic meta-lens that can effectively control elastic waves with a wide range of incident angles using a quadratic phase profile. The meta-lens proposed in this study have the ability to effectively focus and control elastic waves reaching a wide angle (up to 180 degrees) regardless of the incident angle, and through this, it is expected to provide more effective and practical performance in real-world application environments.
In this study, the performance of the proposed elastic meta lens was verified through numerical simulation. According to the simulation results, the proposed meta lens showed excellent elastic wave focusing performance even in a very wide angle of incidence, and it was confirmed that the wave energy was effectively concentrated at the focusing point. In addition, the structural simplicity and ease of manufacture of meta lenses also emerged as important advantages.
The results of this study are expected to provide important guidelines for effectively controlling and designing elastic waves and other wave elements incident at a wide angle in various practical applications. In addition, this study is expected to promote innovative applications in various fields in the future as it has the potential for technological development that can be widely used not only in the field of elastic waves but also in various wave-related fields such as optics and acoustics.

References

1. Pu, M., Li, X., Guo, Y., Ma, X., & Luo, X. (2017). Nanoapertures with ordered rotations: symmetry transformation and wide-angle flat lensing.Optics Express,25(25), 31471-31477.