BROADBAND CLOAK FOR UNDERWATER ACOUSTICS

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ABSTRACT

Pentamode (PM) materials are degenerated elastic solids which support only one stress state not necessarily hydrostatic. Water is a natural isotropic PM material, however a general PM material is able to support off-axis shear. These materials can be made approximately from conventional solids with careful microstructure design. The peculiar property of PM materials is recalling promising applications in underwater acoustic wave control. Here, we report the design and experimental validation of an underwater solid cloak with broadband property utilizing pentamode material machined from aluminum. The designed cloak is made of a graded subwavelength scale microstructure to meet the required effective property by design. Transient wave experiments conducted in a water waveguide demonstrate its good performance, i.e. the underwater acoustic wave is indeed guided around the cloaked object with substantial reduction of both scattering and shadow over a broad frequency range. The finding paves the way for controlling underwater acoustics using broadband solid metamaterials, and may stimulate development of new technologies, such as directed communications or cloaking devices against underwater acoustics.

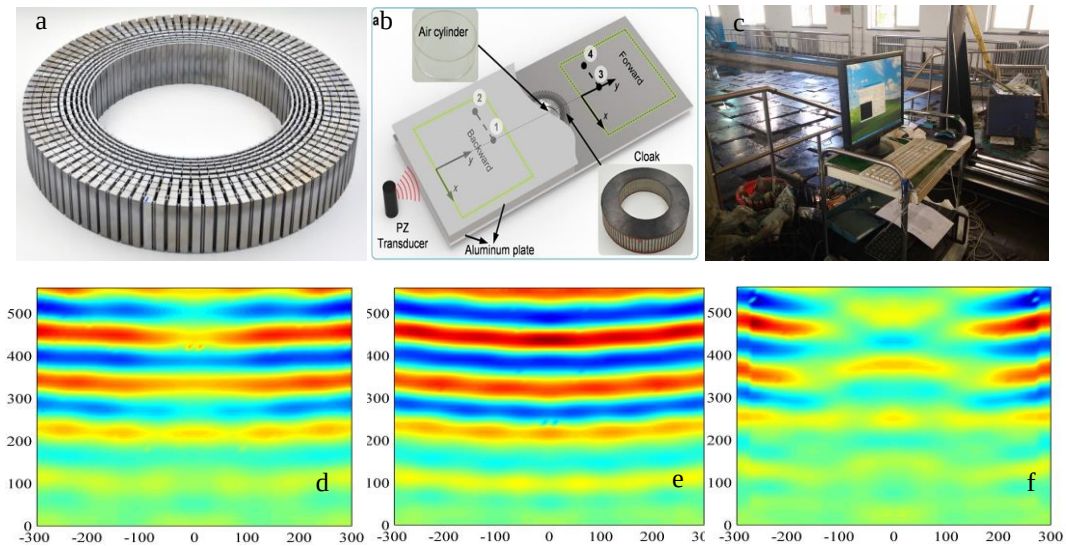

Figure 1: Broadband underwater cloak: a) sample, b) designed water waveguide, c) experiment setup; Pressure distribution of cloaking case d), of reference case e) and of uncloaking case f)

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