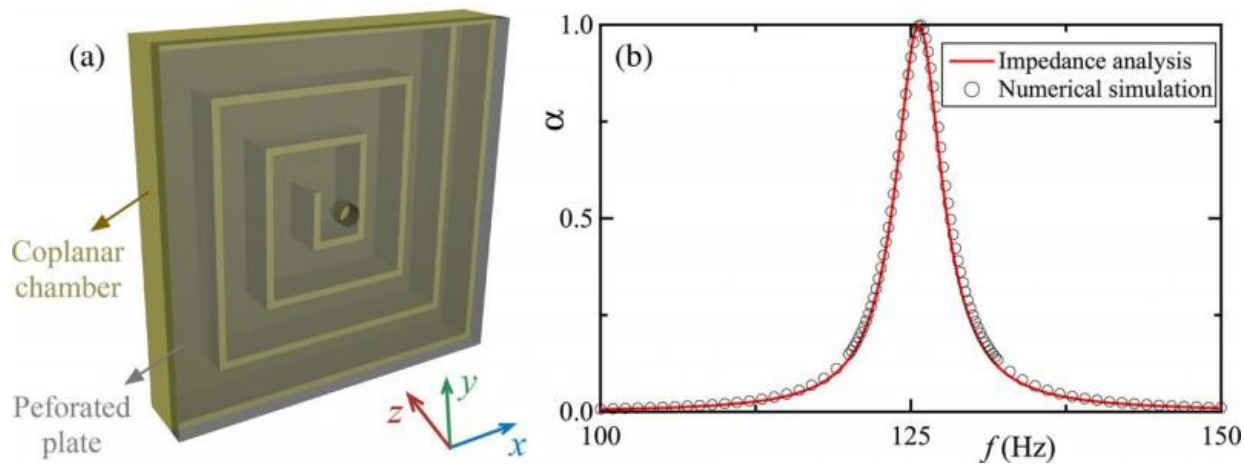
Absorbing acoustics with soundless spirals

February 9 2016



(Left) The metasurface composed of a perforated plate (transparent gray region) with a hole and a coiled coplanar air chamber (yellow region). (right) The absorption coefficient, α, of the presented metasurface with a total absorption at 125.8 Hz. Results from the impedance analysis and numerical simulations show excellent agreement.

Researchers at the French National Centre for Scientific Research, CNRS, and the University of Lorraine have recently developed a design for a coiled-up acoustic metasurface which can achieve total acoustic absorption in very low-frequency ranges.

"The main advantage is the deep-subwavelength thickness of our absorber, which means that we can deal with very low-frequencies - meaning very large wavelengths - with extremely reduced size structure,"

said Badreddine Assouar, a principal research scientist at CNRS in Nancy, France.

Assouar and Li, a post-doc in his group at the Institut Jean Lamour, affiliated with the CNRS and the University of Lorraine, describe their work this week in *Applied Physics Letters*.

Acoustic absorption systems work by absorbing sound energy at a resonant frequency and dissipating it into heat. Traditional acoustic absorbers consist of specially perforated plates placed in front of hard objects to form air cavities; however, in order to operate at low frequencies, these systems must also be relatively thick in length, which makes them physically impractical for most applications.

To remedy this, Assouar's group, whose previous work consisted of developing coiled channel systems, designed an acoustic absorber in which sound waves enter an internal coiled air channel through a perforated center hole. This forces the acoustic waves to travel through the channel, effectively increasing the total propagation length of the waves and leading to an effective low sound velocity and high acoustic refractive index. This allows them to make the absorber itself relatively thin, while still maintaining the absorptive properties of a much thicker chamber.

This is made possible because the coiled chamber's acoustic reactance - a property analogous to electrical reactance, a circuit's opposition to a change in voltage or current - compensates for the reactance of the perforated hole and allows for impedance matching to be achieved. This causes all of the acoustic energy to be transferred to the chamber, rather than reflected, and to be ultimately absorbed within the perforated hole.

Further applications of such metasurface may deal with the realization of tunable amplitude and phase profile for acoustic engineering, which

would allow for the manipulation of an acoustic wave's propagation trajectory for special applications, such as manipulating particles with a vortex wavefront. Future work for Assouar and his group will include developing the sample fabrication process with 3D printing and subsequent performance analyses.

More information: Acoustic metasurface-based perfect absorber with deep subwavelength thickness, dx.doi.org/10.1063/1.4941338 , scitation.aip.org/content/aip/ … /6/10.1063/1.4941338

Provided by American Institute of Physics