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Professor Se Myung Wang's joint research team has developed a zero refractivity meta-material that transmits sound without reflection

☐ Researchers in Korea have developed a material that allows the penetration of incoming sound without reflecting the sound waves in water. It is expected to be applied as the core technology of underwater stealth because it can produce the same effect as if no object exists.

☐ GIST (President Seung Hyeon Moon) – Professor Se Myung Wang of the School of Mechanical Engineering and KRISS (President Sang-Ryoul Park) jointly developed a meta-material with zero refraction and succeeded in water experiment.

◦ This meta-material is not only permeable to sound waves but also can be controlled in a desired direction, which is applicable to various fields such as military, manufacturing, and medicine.

☐ Interest in metamaterials with characteristics that are not found in the natural world is increasing. Transparent cloak is considered to be the most representative technology utilizing metamaterials. The transparent cloak was originally created because of the extreme

control over light refracted in the positive (+) direction and further down to negative (-) or zero (0) refraction.

□ This not only applies to light but also to sound. If you control the refractive index of the sound to zero just as you control the refraction of light to make the cloak transparent, you can see the same stealth effect in the water with sound waves.

□ However, the zero refraction of underwater sound that enables stealth in water has only been reported as a virtual experiment using a computer. The hypothesis was that the material in the water is able to control the refractive index only when the transmission speed of sound is slower than that of water.

◦ The hypothesis suggest that a substance with a slow sound transmission rate like air should be placed in the water, which is practically impossible.

□ A team of collaborators presented the results that reversed the existing 'slow material hypothesis.' The phononic crystal metamaterial was realized by arranging the copper to have a transmission speed three times faster than that of water.

◦ The researchers also found that the new 'fast material hypothesis' can be linked to the symmetry of the crystal structure, which is not the opposite of the existing hypothesis. The theoretical foundation of the zero refractive index research has been established for the future.

□ When sound waves are fired on a zero refractive metaphase, waves of the same phase are produced just before they pass at the end of the material. This is why it seems to be continuing without any interruptions or distortions in the wave. In addition, sound waves can be collected or spread depending on the type of the metamaterial.

□ Professor Se Myung Wang said, “This research can be applied to the fundamental problem of noise in the mechanical and medical industry

as well as construction sites because the sound can be controlled in a desired direction." KRISS researcher Won Jae Choi said, "If you can design a submarine with metamaterials, then you can build a stealth submarine that is never detected by sonar systems."

□ The results of this research, which was supported by the National Science and Technology Research Institute Creative Fusion Research Project, was published in May 2018 in *Scientific Reports* (IF: 4.259).

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