

SHOWPAM: System of High-efficiency Ocean Wave Power with Acoustic Metamaterial

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Ocean wave is both powerful and steady energy source. However, commercialization of ocean wave power (OWP) is limited because very few coastlines can offer a viable amount of wave energy. The conventional approaches to overcome this hurdle were to improve the wave-to-electricity conversion mechanisms so that a sufficient portion of energy can be extracted even from the harsh conditions. However, major mechanisms seem to be a variation of decades-old methods, proving the lack of space for innovation. In this project, we directly amplify the ocean wave by proposing SHOWPAM — System of High-efficiency Ocean Wave Power with Acoustic Metamaterial. SHOWPAM adopted the coiling up space acoustic metamaterial, a spatial structure widely used for modulation and amplification of an acoustic wave (AW). We anticipated the metamaterial is also applicable for amplifying a water surface wave (WSW), based on our proof of the mathematical analogy between AW and WSW. Using COMSOL Multiphysics simulation, six geometric parameters of the metamaterial are optimized to maximize the amplification of WSW. Then, we crafted SHOWPAM, consisting of a central cavity with a wave energy converting device and the optimized metamaterial attached on both sides of the cavity. A control model was built by removing the metamaterial part from SHOWPAM. By placing the models inside the self-constructed wave generating pool, performances of the models are tested by measuring generated electric voltage and power. SHOWPAM produced 13.6Wh electrical energy with 175% peak voltage and 225% average electric power compared to the control model. The result insists that with SHOWPAM, coastline candidate for viable wave energy production will increase to 203% in length, dramatically improving the accessibility to OWP.

Awards Won:

Intel ISEF Best of Category Award of \$5,000

First Award of \$3,000

Acoustical Society of America: Second Award of \$1000, plus students School will be awarded \$100 and Mentor awarded \$250.