A feasibility study on triboelectric nanogenerators for measuring ultrasonic elastic waves

Minah Kim[1], Seung Il Kim[1], Hong Min Seung[1]

[1]Intelligent Wave Engineering Team, Korea Research Institute of Standards and Science, Republic of Korea

A triboelectric nanogenerator (TENG) is a device that converts mechanical energy into electrical energy using a charging phenomenon that occurs during the contact-separation process of two objects. TENG is an eco-friendly and simple structure that can be developed in various forms easily. Especially, due to its high energy conversion efficiency, many researches have been performed in the fields of energy harvesting. In this research, hence, we tried to use TENG as a device for measuring ultrasonic elastic waves, which is widely used for nondestructive tests (NDTs) in solids. First, we designed a TENG by applying a specific distance between an aluminum foil and a PFA film with a plastic spacing plate. To check the performance of the fabricated TENG, we measured peaky voltage outputs by tapping the TENG surfaces. After that, the TENG was attached onto the surfaces of metal specimens by adhesive layers to measure ultrasonic elastic waves generated by ultrasonic actuating transducers. In this experiment, it was seen that the measured ultrasonic elastic waves are obviously recorded and the time-of-flight was confirmed by the theoretical elastic wave speeds. We further carried out a series of experiments with various types of TENGs having different sizes and material properties for wave measurement. By doing so, the effectiveness of TENG is confirmed as an ultrasonic elastic wave sensor for NDT methods such as ultrasonic thickness measurement of solids. With additional researches for optimizing and characterizing the TENG, we will try to use it as ultrasonic monitoring methods for plates and pipes in the future.