論文の要旨

題　目 Characteristics of the mechanical motions and electric performance on the Triboelectric generator and Piezoelectric generator - Preliminary stage for ocean energy harvester

(摩擦及び圧電効果による発電体の機械的運動特性と起電力特性

～ 海洋エネルギーハーベスターに関わる基礎的検討 ～)

氏 名 EDE MEHTA WARDHANA

Abstract

High innovation in the field of the internet of things (IoT) and Microelectromechanical systems (MEMS) have led to the dire need for a new sustainable power source. The current power source for the IoT and MEMS mainly depends on the batteries, supercapacitors, and micro-fuel oil cells have the main disadvantages since it only has a finite amount of energy. There is a need for developing generator that can scavenge energy for longer, especially if the device's main location is in a difficult and hazardous place (such as the ocean). In order to solve those problems, This study proposed, developed, and improved energy harvester devices based on the triboelectric generator (TEG) and piezoelectric generator (PEG). This study served as the first stage for developing the actual ocean energy harvester, focusing on the fundamental characteristics of the mechanical motions and the device's electric performance. Four main phases were studied and elucidated in separate chapters. The investigation is started by measuring the output voltage of the single TEG periodically under its output voltage time histories with strong responses found without electrical noise. The output voltage has good results, and the characteristics of the working mechanism of the TEG were clarified in the separation, contact, and compression modes. In the next phase, we developed the theoretical model of the vertical contact-separation modes with a dielectric elastomer. Using the theoretical model, the resulting average, maximum, and minimum output agreed well with the experimental data. This similarity means that the model could be used as a basic design tool for predicting the FC-TEG before practical usage. To improve the TEG's electrical output, we expanded and created a multi-layer TEG setup for the vertical vibration tests. Characteristics of the multi-TEGs under the contact and compression modes were clarified. In addition, the relationship between key

parameters such as vibration frequency, vibration amplitude, initial distance, and compression force was investigated. We found that the vibration frequency and amplitude have a direct correlation and positive relationship to multi-TEG outputs. However, the initial distance and compression force only have a small role in increasing the voltage results. This means that the separation velocity plays a major role compared with separation distance Since natural energy fields (such as ocean waves or wind) have several spectrums for energy harvesting, a study on hybrid energy harvesters has been conducted using the combination of multi-TEG with PEG devices for scavenging more energies. We found that all key parameters are similar to previous studies. Furthermore, we also found that each PEG and TEG could compensate for the deficiencies of each device under different distance spectra.