A PUSH-PULL TRANSDUCER FOR OCEAN WAVE ENERGY HARVESTING

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Ocean wave energy is one of the primary energy sources, which is available during day and night, in various weather conditions. It was previously proven that energy harvesting from ocean waves could be used to generate electric power to supply sensors or small electronic devices located in buoys. Using a combination of various energy harvesters would enable more remote and unmanned future offshore sensor applications that can facilitate more effective monitoring and control. In this study, we successfully demonstrated a simple, low-cost and environmentally friendly energy harvester which can be optimally used as an Ocean Wave Energy Harvester (OWEH).

The primary purpose of this study is to design, built, and characterize a push-pull electret-based electrostatic energy harvester device (see Figure 1) for low-frequency applications. Experimental data was obtained and analyzed to determine the factors, such as vibration frequency, acceleration, and surface charge, which influence the performance of such a system. Also, a custom vibration shaker that is capable of testing such a system at low-frequencies is developed and utilized as a mechanical excitation source. Teflon FEP film was chosen as the electret material and being charged using corona triode method. Different surface potentials on electret films (300-1800 V), vibration frequencies (1-45 Hz), and accelerations (0.1-1.0 g) were analyzed to evaluate their effect on voltage, energy, and power outputs of the energy harvester (see Figure 2). Peak-peak voltage outputs of 300 V were observed. Besides, an output power of ~15 μW and energy of ~1 mJ were obtained over less than a minute harvesting at 18 Hz. These quantities can be easily enhanced through design optimization. It was successfully proven that our electrostatic energy harvester could be used to power small electronics by harvesting energy from low-frequency mechanical vibrations. Besides, our EH device can be easily mounted to a structure such as a floating buoy and replaceable if any problem occurs during the long term of use. Considering the irregular vibrations, environmental- friendliness, and harsh environmental conditions of oceans and offshore, our EH device could be one of the most appropriate solutions for small-scale ocean wave energy harvesting applications.

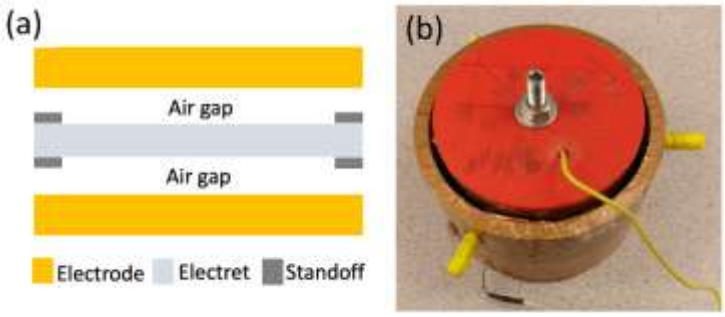

Figure 1 – Prototype device (a) illustration and (b) assembly

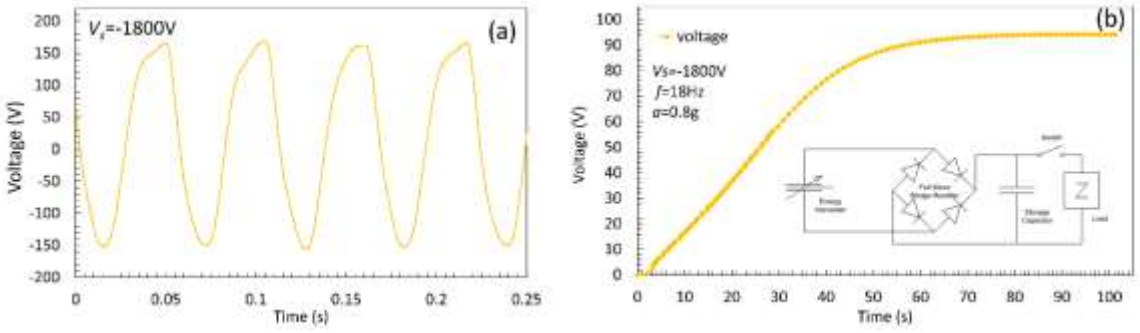

Figure 2 – Voltage measurements of our EH device (a) open-circuit and (b) charging a capacitor