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Multiple Electrodes-based Bubble Motion Active Transducer for Effective Electrical Energy Harvesting

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Extended Abstract

Solid- Liquid contact electrification has become a promising method to convert water-solid interfacial energy to electrical energy. Raindrops, ocean waves, and rising air bubbles can be used to convert interfacial energy to electrical energy [1-2]. However, the energy harvesting efficiency of water-solid contact electrification is weaker than solid-solid contact electrification. To address this low efficiency, researchers have developed interdigitated multiple electrodes-based devices, in which multiple electrical signals can be generated utilizing a single water droplet [3]. However, we found that the energy is dramatically decreased with the number of interdigitated electrodes in the system for air bubble-based electrical energy harvesting devices. To overcome this limitation, we experimentally demonstrated individually rectified multiple electrodes device to improve the efficiency of air bubble-based electrical energy harvesting.

Energy harvesting from the usual interdigitated electrode-based device was demonstrated using air bubbles, in which the number of the current signals increases with the number of interdigitated electrodes in the device. However, the magnitude of the current signals decreases with the number of electrodes in the system. The only effect that could affect decreasing the current signal is the water- electrode contact area. The water- electrode contact area increases with the number of electrodes in interdigitated electrode devices. To demonstrate the effect of the water-electrode area, a specially shaped two-electrode was designed in which the water- electrode contact area can be changed while keeping the contact area of the bubble- electrode along the bubble path unchanged. Interestingly, the current was decreased with increasing the area of the electrodes. This reveals that the interdigitated electrode device cannot be used to enhance the electrical energy of air bubble energy harvesting.

Therefore, to overcome this issue, a multiple electrodes-based device was designed with each adjacent electrode connected with a bridge rectifier. Each adjacent electrode pair acts as an individual energy harvester and does not influence each other increasing water- electrode contact area. The number of the current pulses and the magnitude of the pulses increases with the number of electrodes in the newly designed device. The high efficiency of the newly designed device is further confirmed by charging a capacitor.

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