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Integrated study of triboelectric nanogenerators for ocean wave energy harvesting: Assessing their behavior in model buoys and real sea conditions

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Ocean related activities are often supported by offshore equipment with particular power demands. These are usually deployed at remote locations and have limited space, thus small energy harvesting technologies, such as photovoltaic panels or wind turbines, are used to power their instruments. However, the inherent energy sources are intermittent and have lower density and predictability than an alternative source: wave energy [1]. The triboelectric nanogenerator (TENG) is a promising and efficient energy harvesting technology capable of addressing these problems as it can efficiently convert regular/irregular external mechanical energy into electrical power based on the triboelectrification and electrostatic induction effects [2-4]. In this work, three TENGs based on rolling-spheres were developed and their performance compared in both a "dry"bench testing system under rotating motions, and in a large-scale wave basin under realistic sea-states installed within a scaled navigation buoy. The experiments showed that the electrical outputs of these TENGs tend to rise with increasing pitch amplitudes and decreasing period due to the increase of the spheres'velocity. The capability of these TENGs to harvest energy from ocean waves when incorporated into a navigational buoy was demonstrated under realistic sea states. The voltage generated by the TENGs achieves maximum values for periods close to the natural period of the scaled buoy (˜ 0.92 s). The wave basin tests clearly demonstrated a significant dependency of the electrical outputs on the pitch degree of freedom and the need to consider the full dynamics of the buoy, and not only that of TENGs, when subjected to the excitations of waves.

References
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