Controlling TENGs via Mechanical Energy Conversion Systems

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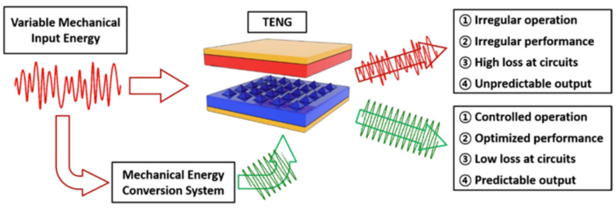
1. Introduction

In this study, I focus on mechanical energy conversion systems (MECS) for the regular or controlled operation of TENGs; to do this, we employ kinematic designs [1-4]. Once we control the mechanical operation of TENGs, we can predict the power production from these devices. Furthermore, mechanical frequency matching can greatly reduce power loss from electrical circuits. Motion control from, rotational to linear movement, can effectively provide high-frequency operation of contact-separation mode TENGs, enabling us to obtain sustainable and high-performance TENGs.

2. Results and Discussion

Fig. 1 illustrates that by employing MECS, we can produce regular, predictable, and controlled output power from TENGs. By making the power output predictable, despite the irregular mechanical inputs, we can reliably design circuit systems which is essential for practical applications of TENGs.



2.1. Gear train-integrated TENG systems

The gear mechanism can modify the angular velocity, rotation direction, and motion. In particular, the angular velocity can be enhanced by changing the gear ratio of the gear train. In this work, three different gear trains were utilized to compare the effect of angular velocity on TENG performance. As mentioned above, a large spur gear was connected to the input energy source and a small spur gear was connected to the crank. Therefore, the TENG mechanism is a vertical contact-separation mode. The peak power density dramatically enhanced the gear ratio, by more than a factor of six [1].

2.2. TENGs based on the cam-follower mechanism

The cam-follower mechanism can be utilized to make a TENG based on the vertical contact-separation mode with rotational energy. This basic system is composed of a cam and TENG device attached to a follower. A bumper spring is required to ensure clear contact and separation of the TENG device. Without the bumper spring, the TENG device can become stuck during contact. The cam system could apply to environments that have high-speed rotational motion. To increase the electricity generation, the number of noses and devices can be controlled. With multiple noses and followers, the generation cycle is stable and reliable. The cam system acts as a mechanical motion converter and improves the lifetime of the TENG device by taking advantage of the vertical contact-separation mode [2,3].

2.3. Spiral spring-based TENG system

The key elements of a spiral spring-based TENG system, which is called a mechanical frequency regulator TENG (MFR-TENG), are a pawl ratchet, mainspring (i.e., spiral spring), stopper, gear train, and flywheel. Input mechanical energy turns the handle and winds up the mainspring. When input mechanical energy is irregularly induced or disappears, the mainspring can release the stored mechanical energy. The stored mechanical energy rotates the gear train, cam, and flywheel attached to the shaft. The controllable frequency range is especially wide, going from 10 Hz to over 50 Hz. Frequency matching is important when a user wants to utilize a commercialized electric component, such as industrial transformers [4].

3. Conclusions

This study systematically explored kinematic energy conversion systems for TENGs from their fundamental theory to their different use cases. In the case of kinematic energy conversion systems, the mechanical components could be categorized as (i) gear-train integrated TENGs, (ii) cam-follower integrated TENGs, and (iii) spiral spring based TENG systems. We believe that our MECSs can make great effects for commercializing TENGs in near future.

References
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