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## The Characteristics of HTM Free Perovskite Solar Cell with Gas Pressure Assisted Modified Fabrication Process

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2009년도에 Perovskite가 태양전지에 처음 적용된 이후, Perovskite를 기반으로 하는 태양전지는 급속한 발전을 이루고 있으나, 향후 상용화를 위해서는 추가적인 공정개선 및 제조 단가를 낮추는 노력이 필수적이다. 초창기 Perovskite의 증착 공정은 One step deposition 방법이 사용되었으나, Layer의 thickness, uniformity 등을 조절하기 어려워 Sequential deposition 방법으로 개선되었다. 하지만 결과적으로 초기방법 대비 추가공정이 발생함에 따라 시간 및 비용의 증가가 불가피하였다. 제조단가 측면에서는 Perovskite 태양전지를 구성하는 재료 중 HTM(정공수송물질)을 구성하는 Spiro-MeOTAD의 비용이 가장 비싸다. 따라서 저비용 태양전지를 위해서는 HTM이 없는 구조가 필요하다.

이 페이퍼에서는 Perovskite 물질이 고흡광 능력 외에 충분한 전하수송능력을 보유한다는 점에 착안하여, Gas Pressure Assisted Modified One Step Deposition을 이용한 HTM Free Perovskite를 제작하고 기존의 Sequential Deposition Method 통해 만들어진 Perovskite 태양전지와 비교/분석하였다.

**Keywords:** HTM Free Perovskite, Solar cells, One step deposition method, Sequential deposition method

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## Output performance enhanced triboelectric nanogenerator with gear train support

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Triboelectric nanogenerator (TENG) is one of ways to convert mechanical energy sound, waves, wind, vibrations, and human motions to available electrical energy. The principal mechanism to generate electrical energy is based on contact electrification on material surface and electrostatic induction between electrodes. The performance of TENG are dependent on amount of the input mechanical energy and characteristics of triboelectric materials. Furthermore, the whole TENG system including mechanical structure and electrical system can effect on output performance of TENG. In this work, we investigated the effect of gear train on output performance and power conversion efficiency (PCE) of TENG under a given input energy. We applied the gear train on mechanical structure to improve the contact rate. We measured the output energy under a constant input energy by controlling the size of the working gear. We prepared gears with gear ratios (rin/rw) of 1, 1.7, and 5. Under the constant input energy, the voltage and current from our gear-based TENG system were enhanced up to the maximum of 3.6 times and 4.4 times, respectively. Also, the PCE was increased up to 7 times at input frequency of 1.5 Hz. In order to understand the effect of kinematic design on TENG system, we performed a capacitor experiment with rectification circuit that provide DC voltage and current. Under the input frequency of 4.5 Hz, we obtained a 3 times enhanced rectifying voltage at a gear ratio of 5. The measured capacitor voltage was enhanced up to about 8 fold in using our TENG system. It is attributed that our gear-based TENG system could improve simultaneously the magnitude as well as the generation time of output power, finally enhancing output energy. Therefore, our gear-based TENG system provided an effective way to enhance the PCE of TENGs operating at a given input energy.

**Keywords:** Triboelectric nanogenerator, Working frequency, Performance, Gear train