Supporting information for:

Vanadium-doped ZnO Nanosheets-Polymer Composite for Flexible Piezoelectric Nanogenerators

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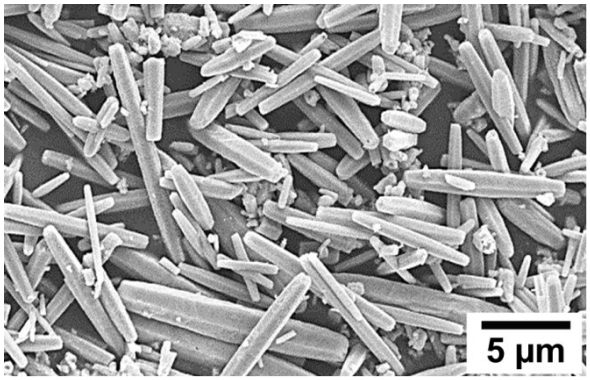


Fig. S1 SEM of the synthesized ZnO NWs grown without V_2O_5 doping agent. It clearly shows the one-dimensional nanowire shape.

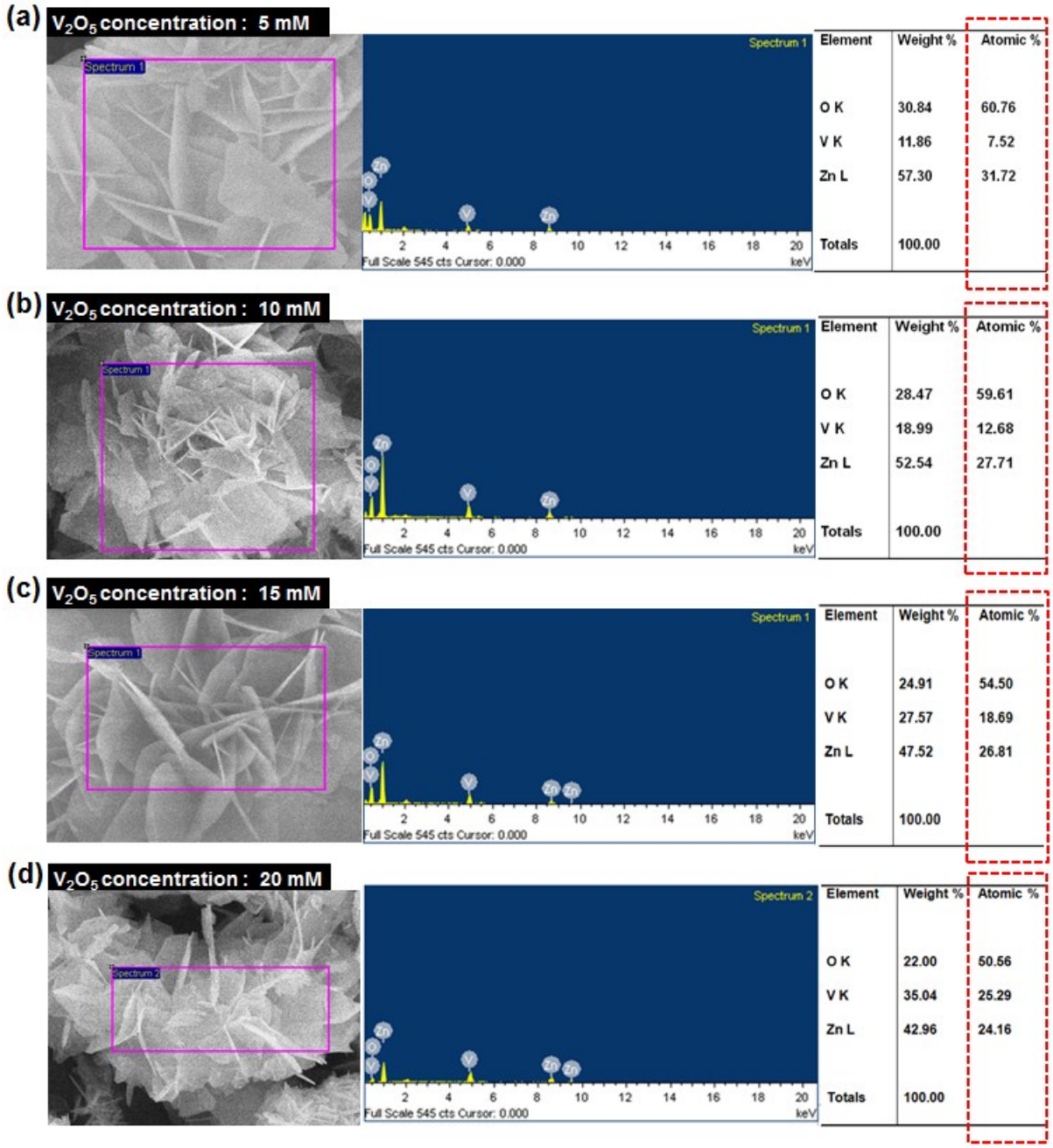


Fig. S2 EDS analysis of the ZnO NSs synthesized in the solution containing different V_2O_5 concentrations. The atomic percentage (at. %) increases from 7.52 at. % to 25.29 at. % as the doping concentration increases. The highest output performance was obtained from the PENG fabricated using the NSs synthesized in the solution containing 10 mM of V_2O_5 (~12.68 at. % of V element in the V-doped ZnO NSs)

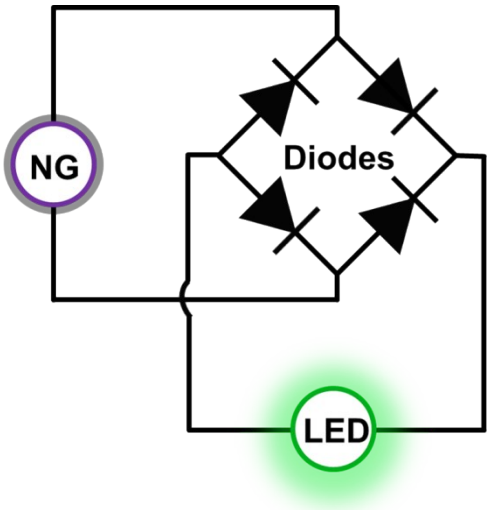


Fig. S3 Schematic representation of the full-wave rectified diodes bridge directly connected to the NG, lighting up the green LEDs.

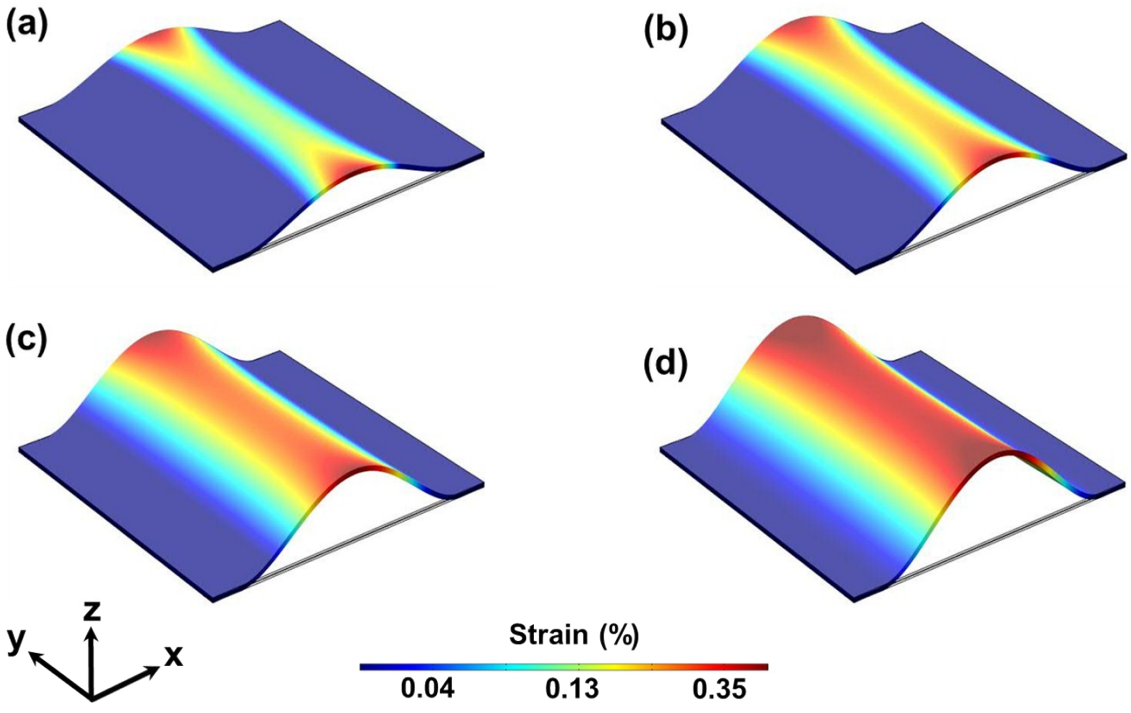


Fig. S4 Calculated strains by varying actual displacement, corresponding the horizontal travel

range using COMSOL simulation software. (a) 0.15 % of strain under bending state at the displacement (x) of 1.25 mm, (b) 0.21 % at 2.5 mm, (c) 0.27 % at 3.75 mm, and (d) 0.32 % at 5.0 mm.

To calculate the strains (%) for bending states in Fig. 4a, we used COMSOL simulation software. We modeled the device structure based on the actual size of device. In the modeling, the width (x cm) × depth (y cm) of the device are 2.5 cm × 2.5 cm. The composite layer (60 μm) is sandwiched between two PET (170 μm) substrates as top and bottom. We note that the composite layer was approximated as PDMS layer due to low NSs % in the composite layer. Both ends (0.25 cm) of the NG were fixed. Young's modulus of PDMS and PET in the model was 650 kPa and 2 GPa, respectively. The strain was calculated by varying the displacement toward x direction, which is horizontal travel range in this paper. Here, the each displacements (x) of the actual device was measured at the each bending states and applied in the simulation.

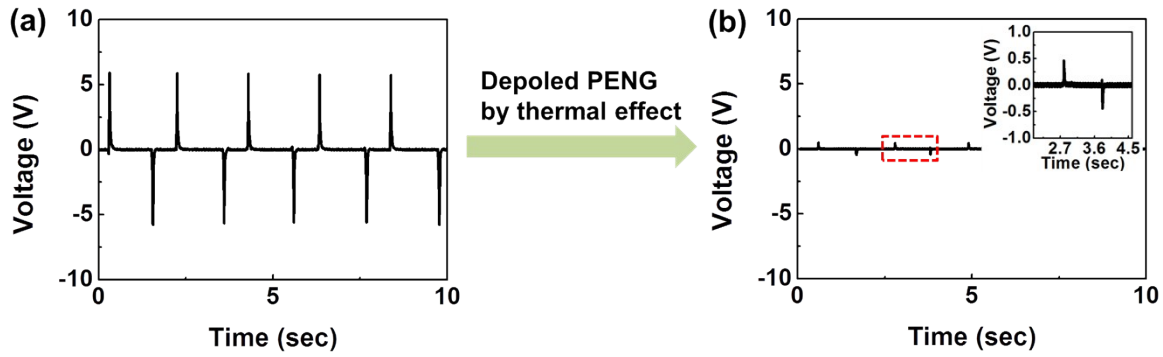
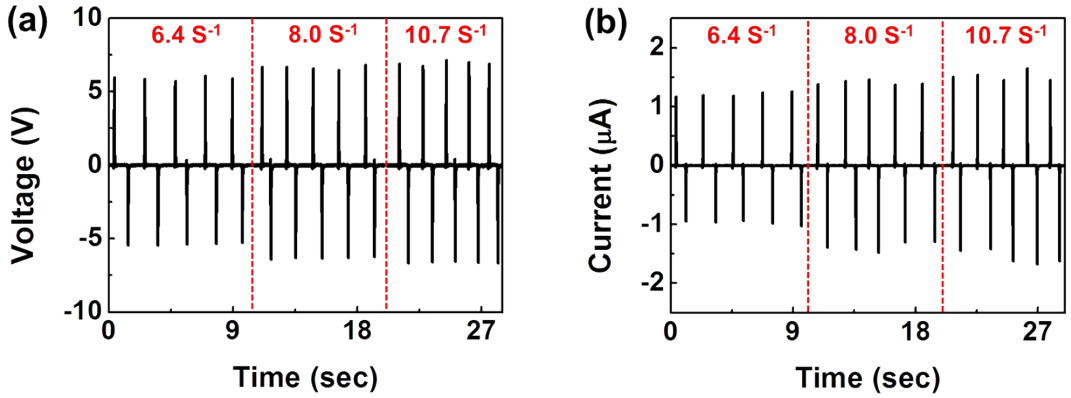


Fig. S5 (a) **O**utput voltage from the PENG (active area: 2 cm × 2 cm) under horizontal travel range of 5 mm. (b) Small output voltage from the depoled PENG by thermal effect. We note



that the device was placed in oven at 85 °C for 1hr.

Fig. S6. (a) Output voltage and (b) current of the PENG (active area of 2 cm × 2 cm) by increasing the deformation speed. The generated output voltages and currents increase up to

~7.3 V and ~1.5 μA at the strain rate of 10.7 S^{-1} and saturated. We note that all measurements were conducted under the deformation frequency of 0.5 Hz.

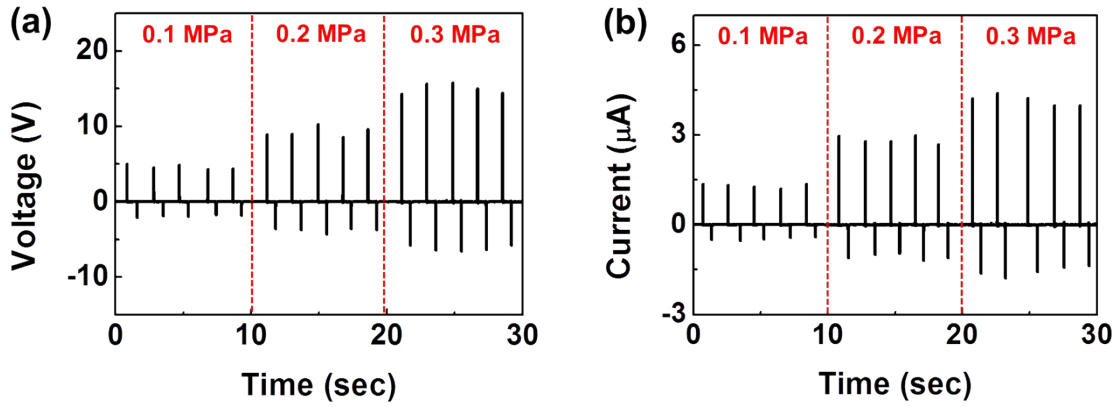


Fig. S7. (a) Output voltage and (b) current of the PENG (active area of 2 cm × 2 cm), measured by varying the applied forces normal to the surface. The generated output voltages and currents increase in proportion to the applied force from 0.1 MPa to 0.3 MPa.