

### HIGHLIGHTS

- Zn<sub>3</sub>V<sub>2</sub>O<sub>8</sub> (ZVO) phosphor were successfully synthesized by a conventional **solid-state approach** for tribo-electric nanogenerator (TENG).
- This work marks an important milestone in this journey by introducing phosphor material (ZVO), into TENG technology for the **first time**.
- The fabricated TENG exhibits remarkable performance, producing an output voltage of **515 V** and a current of **178 μA**, resulting in an impressive power density of **6.9 W/m<sup>2</sup>**.
- We demonstrate the practicality of this innovation by powering **360 series-connected LEDs** and **electroluminescent device** with a simple hand tap.

### Types of Energy Sources

Renewable and non renewable energy sources serve as primary sources of energy, generating valuable forms of energy like heat, or they can be harnessed to produce secondary energy forms such as electricity.

### Working Mechanism of Nanogenerator

A nanogenerator is a compact device that converts mechanical or thermal energy into electricity, serving as an energy harvesting solution for small, wireless autonomous devices.

**Pressed** → **Releasing** → **Released** → **Pressing**

**TENG output**

- Aluminum sheet of 1 μm thickness
- Silicone rubber of 5 μm thickness
- ZVO of 10 nm thickness
- Spacers of 1 cm gap

### Motivation of the Work

**2006**: BaTiO<sub>3</sub>-carbon PDMS of piezoelectric nanogenerator fabricated by mechanical agitation. Output: 3.2 V, 350 nA.

**2008**: With the use of ZnO marking a ground breaking the most compact form of generator 1<sup>st</sup> in world. Output: 9 mV.

**2012**: Nanocomposite Generator. Output: 126 V, Pd = 7 mW/cm<sup>2</sup>.

**2012**: ZnS and OHP laser printing on OHP for boosting the performance of a triboelectric nanogenerator. Output: 420 V, Pd = 3.9 W/cm<sup>2</sup>.

**2017**: Output: 58 V, Pd = 0.78 W/cm<sup>3</sup>.

**2023**: Output: 515 V, Pd = 6.9 W/m<sup>2</sup>.

**2024**: Output: 515 V, Pd = 6.9 W/m<sup>2</sup>.

Generate electricity just move, which lays the foundation for the development of the flexible and collapsible nanogenerator in the future.

ZnO nanowires is strong enough to drive conventional electronic components.

### Synthesis procedure

3 ZnO + V<sub>2</sub>O<sub>5</sub>

### Fabrication Process

Under room light    Under 365 nm

Aluminum    Silicone    ZVO    Aluminum

### Results

**Structural, morphological and optical characteristics:**

### TENG Electrical Characteristics:

Output voltage (V) vs Load resistance (MΩ)

Current density (μA/cm<sup>2</sup>) vs Load resistance (MΩ)

Power density (W/m<sup>2</sup>) vs Load resistance (MΩ)

Output voltage (V) vs Time (s)

Output current (μA) vs Time (s)

Stability test: Voltage (V) vs Time (s)

Effect of spacing (cm) on output

Effect of area (cm<sup>2</sup>) on output

Effect of frequency (Hz) on output

Effect of wavelength (nm) on output

### TENG was connected to the series-connected 360 LEDs

On and OFF state of LEDs in a specific pattern

## INTRODUCTION    MOTIVATION    EXPERIMENT & RESULTS    APPLICATIONS

**Room light**    **Room light**

405 nm    254 nm

540 nm    365 nm

610 nm    375 nm

Visible excitation    UV excitation

**(a)** Green signal for both side

**(b)** Red signal for both side

Speed bump 1    Speed bump 2

Point A    TENG A<sub>1</sub>    TENG A<sub>2</sub>    Point B    TENG R<sub>1</sub>    TENG R<sub>2</sub>

Vehicle A crossed first

**(c)** Again green signal for both side

After Vehicle A crossed the reset button

**(d)** Road safety sensor

Sensor circuit for upward vehicles (IC 7473)

Sensor circuit for downward vehicles (IC 7473)

### Conclusion

- The output voltage of 515 V and a current of 178 μA, resulting in a remarkable power density of 6.9 W/m<sup>2</sup>.
- The observed device stability and durability were confirmed through 4000 test cycles without any significant degradation.
- This groundbreaking research opens avenues for multifunctional applications and harnesses the potential of phosphor materials in energy harvesting and beyond, representing a significant milestone in TENG technology.