DEPARTMENT OF CIVIL ENGINEERING

TEAM C-HELIX

PRESENTS

HYBRID POWER GENERATION MODEL USING SUNLIGHT AND RAINWATER

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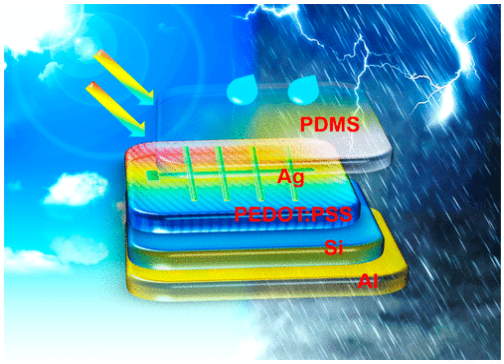
ABSTRACT:

Solar energy harvesting is one of the well- developed and fruitful technologies due to the low cost and superior performance. Solar panels have been undergoing advances in development over the decades. However, solar power is hampered by its inability to efficiently generate electricity in overcast or rainy conditions. To solve this problem, hybrid solar panels are being developed that are functional under rainy conditions. The heart of the new technology used in hybrid-type solar panel is a triboelectric nanogenerator (TENG), and this allows power to be generated by the cell not only when sunlight falls on it but also rain. In practical applications, the surface of a solar cell is usually covered by a layer of transparent material to protect the device from environmental damages/corrosions.

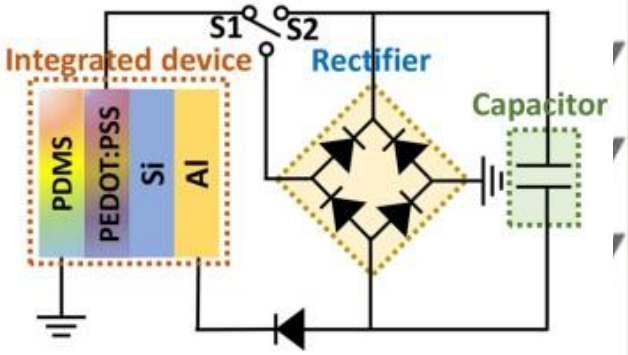
Since a water-drop TENG can be fabricated using highly transparent polymer materials, we could just replace the regular protection layer on solar panel using a specially designed and processed transparent polymer layer, to achieve the dual function of being a protection layer and a TENG. . Assuming the compelling features, such as cost-effectiveness and a greatly expanded working time, the hybrid system renders an innovative way to realize multiple kinds of energy harvesting and as a useful compensation to the currently widely used photovoltaic (PV) panels. Under solar light irradiation (12 W/m2) in a rainy day, the fabricated high-efficiency solar cell provides an open-circuit (Voc) of 0.43 V and short-circuit current density (Jsc) of 4.2 A/m2 . And the TENG designed for collection of raindrop energy gives an AC Voc of 30 V and Jsc of 4.2 mA/m2 when impacted by water drops at a dripping rate of 0.116 ml/s.

WORKING:

- In this hybrid model, heterojunction silicon (Si) solar cells have been integrated with TENG using a mutual electrode of a poly(3,4ethylenedioxythiophene): poly (styrene sulfonate) (PEDOT: PSS) film. Triboelectric nanogenerators (TENG) allows power to be generated by the cell not only when sunlight falls on it but also rain.
- The working mechanism of the TENG is based on a sequential process of contact-electrification and electrostatic induction TENG converts the mechanical energy of a falling raindrop into electricity, by using the friction of the sliding raindrop to knock off some electrons and produce usable electrical charge.



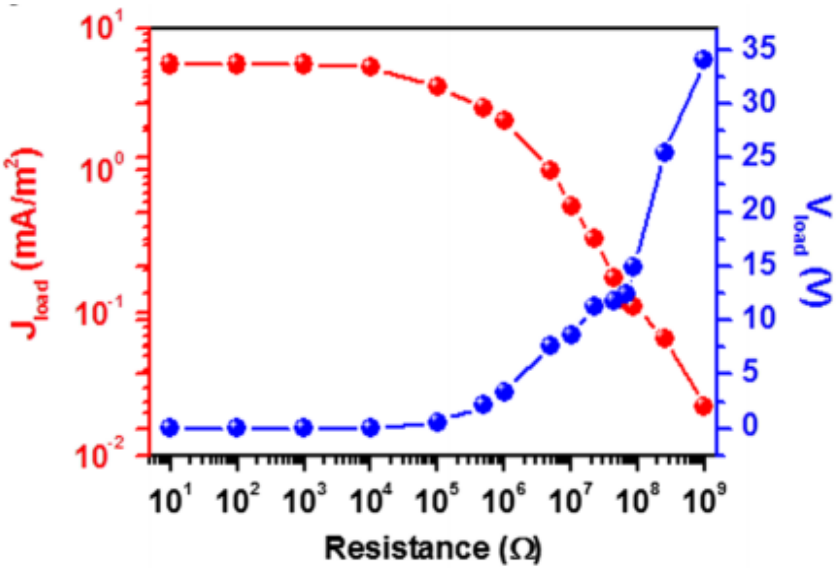
- Once raindrops hit the topmost layer it loses an electron and becomes positive, while the surface of the PDMS film becomes negative. This leads to the buildup of differential charge between the negative surface and the positive raindrop, which can be trapped and conducted to the lower layer by the nanogenerator.
- As more of the imprinted PDMS comes into contact with the rain drops, the TENG output goes up, peaking at about 33 nA short-circuit current, and at 2.14 V at peak open-circuit voltage. This provides both the high level of current that is generated by a solar cell with the high voltage produced by a TENG, which optimizes energy gathering efficiency under a range of weather conditions.



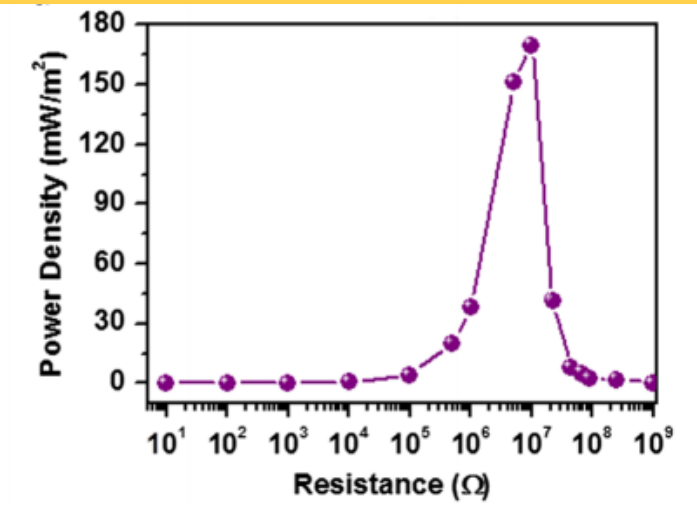
COMPARISON:

SPECIFICATIONS	NORMAL SOLAR PANELS	HYBRID SOLAR PANELS
Size	230 x 300 x 22 mm	230 x 300 x 22 mm
Efficiency	15-18 %	18-21%
Power	8.78 Watts	9.37 Watts
Cost	Rs. 900	Rs. 1630
Effective Working Conditions	These are effective during Sunny conditions.	These are effective during Sunny as well as Rainy conditions. They can also generate electricity during rainfall at night.

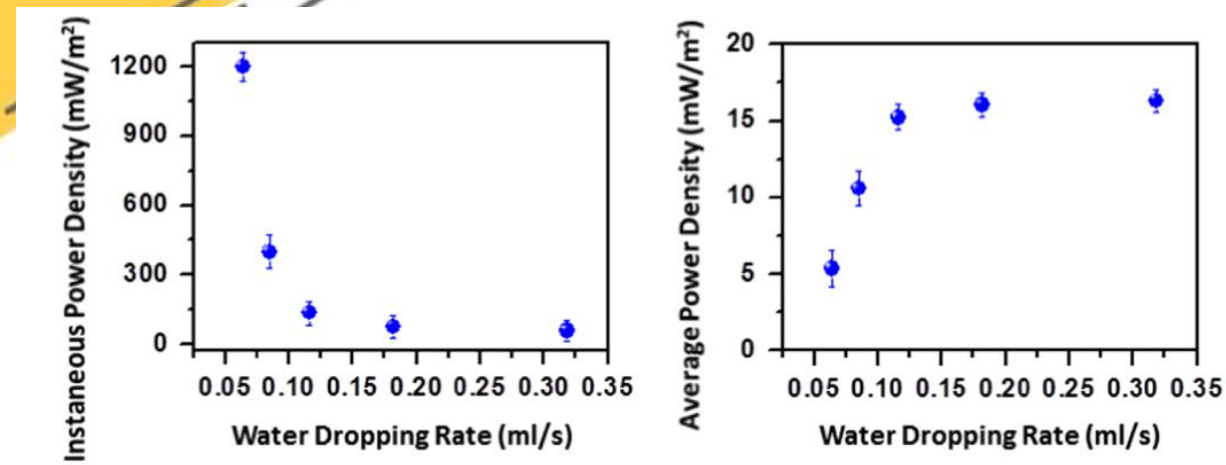
GRAPHS:



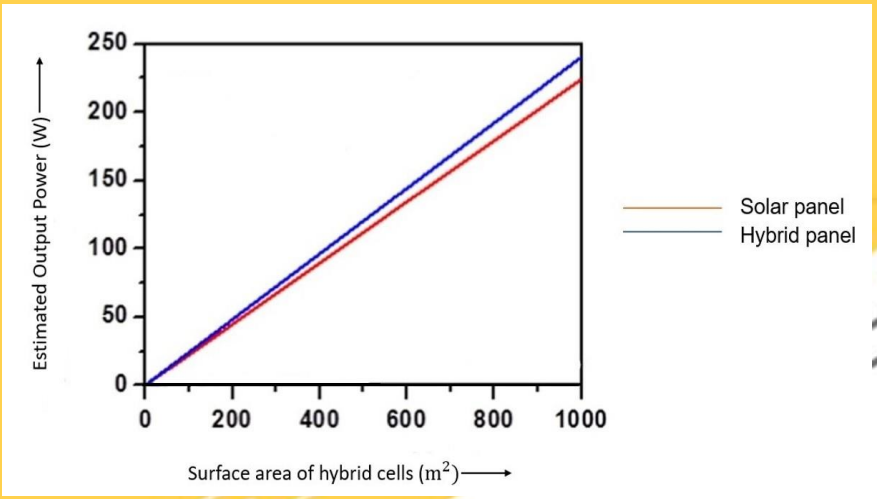
The dependences of output voltage (blue), output current density (red) on the resistance of the external load. Here the output current decreases with the increase in resistance value of load.



The corresponding output power density at each resistance was calculated using $P/A=I_{load}V_{load}/A=J_{load}V_{load}$, where A is the surface area of the water-drop TENG and J_{load} is the current density generated from water TENG.



The instantaneous and average output power density of the water-drop TENG under different water dripping rate is calculated by $P/A=I^2R/A$ and $P_{AV}=\int I^2 Rdt/\Delta tA$. The instantaneous output power density decreased while the average power density increased .These results are due to the increase of amount of water drops and the increase of frequency of contact and removal of water drops on TENG surface.



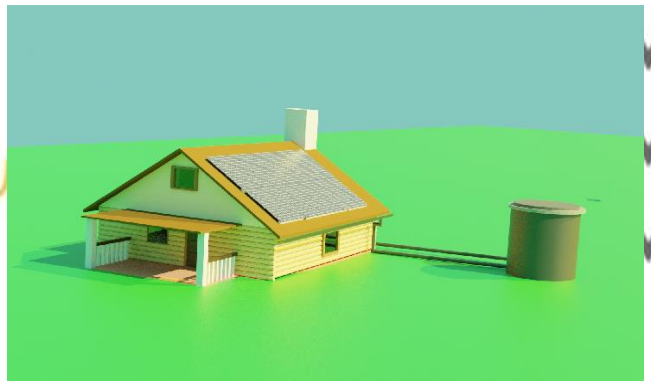
The above graph shows the variation of estimated output power with surface area of panels for both normal solar panels and hybrid solar panels.

LEARNING OUTCOMES:

1. Efficient energy generation is possible using solar cells, even during rainy or overcast weather conditions.
2. Mechanical energy of falling raindrops can be conserved to produce usable electrical charge.
3. The advantages of the high current level of a solar cell and the high voltage produced by a TENG device can be combined, to optimize the energy harvesting efficiency in solar power projects.

SOCIAL BENEFITS:

1. This model will solve the problems faced in generation of solar energy in overcast or rainy weather conditions. The ability to produce electricity using rain even at night, will help in making solar projects more sustainable and self-sufficient.
2. This model can make solar power an efficient clean-energy solution even in less sunny areas that aren't currently considered ideal for solar-energy collection.
3. Compared to normal solar panels, these hybrid panels can harvest energy more effectively under diverse weather conditions.



4. Combined with different energy harvesting models, this technology can drastically affect the present approach towards energy harvesting.

ADVANTAGES:

1. Solar power generation is possible even during rainy or overcast weather conditions.
2. The model even generates electricity when rain falls at night.
3. Energy can be efficiently harvested in different weather conditions.
4. Solar power can be made an efficient clean-energy solution even in less sunny areas that aren't currently considered ideal for solar-energy collection.