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SOLAR RAIN DROP POWER GENERATION

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Abstract:

Tapping into the water cycle and producing strength from rainy days will be one manner to grow our renewable power use. Till now, scientists have been not able to get water droplets to supply a huge quantity of energy - however we may additionally subsequently have a step forward. At the same time as we're still an extended manner from umbrellas that double up as generators, the contemporary technique indicates there might be a way to get power from rain showers at a degree of efficiency that makes these systems realistic. New studies have discovered a way that might generate enough electricity from a single droplet of rain to mild up less than a hundred led bulbs. It truly is a massive leap ahead in efficiency, inside the region of several thousand times.

"our research indicates that a drop of one hundred micro liters of water released from a top of 15 centimeter's [5.9 inches] can generate a voltage of over 12v, and the energy generated can mild up a hundred small led lights. Silicon-based solar cell is by far the most set up solar cell generation. The surface of a si sun cellular is usually protected by means of a layer of obvious material to defend the tool from environmental damages/corrosions. Right here, we changed this safety layer through a transparent tribo electric nano generator (TENG) or piezo electric generator or thermocouple Peltier junction, for simultaneously or personally harvesting sun and raindrop electricity whilst both or both of them are available in our living surroundings. The Teng is made from a particularly processed polytetrafluoroethylene (PTFE) film, an indium tin oxide (ITO) and a polyethylene terephthalate layer. Under solar mild irradiation (12 w/m²) in a wet day, the fabricated excessive-efficiency sun cellular presents an open-circuit (voc) of zero.43 v and short-circuit cutting-edge density (JSC) of four.2 a/m². And the TENG designed for series of raindrop power offers an ac voc of 30 v and JSC of

4.2 ma/m² whilst impacted by using water drops at a dripping rate of 0.116 ml/s. In wet days, the performance of sun cellular reduced greatly, while TENG can be an awesome reimbursement as for inexperienced strength harvesting. From those results, we are able to see that the hybrid cell shaped by way of a sun mobile and a water-drop TENG have incredible ability for concurrently/in my opinion harvesting

each sun electricity and raindrop electrostatic energy under special weather situations, especially in raining season.

I. INTRODUCTION

Strength disaster and environmental pollution have been the main challenges for a sustainable development of the sector. Harvesting energy from the natural environment together with sun, wind, biomass power, mechanical vibration and wasted warmth, has attracted tremendous interest in educational research inside the past decades. Silicon based solar cells regularly grow to be the most extensively used business technology for large scale harvesting of sun power due to its low fee and advanced performance. However, low conversion performance remains the principle limiting thing for modern-day technologies. A large part of strength loss in the course of solar-cellular operation is attributed to the lack of incoming light by using mirrored image. To reduce the mirrored image loss, surface texturing such as fabrication of various surface pyramid systems is regularly used to enhance mild trapping through multiplying the inner reflections. However, the solar mobile panels need to be located in ambient harsh environment with contaminations, corrosions, and varying climate conditions.

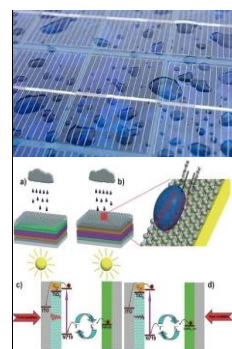


Figure1. rain drop charge distribution

In sunny days, solar cells can provide a great deal power via photovoltaic outcomes. But in wet days/season and night, the output of solar cells perhaps in large part suppressed or even vanished. Presently, triboelectric nanogenerator (Teng) based totally on contact electrification and electrostatic induction impact has been advanced to convert various kinds

of mechanical electricity within the environment into electricity. Whilst cloth surfaces with contrary triboelectric polarities are periodically contacted and separated, a periodic capability distinction among the 2 electrodes on their backs varies, which drives electrons to glide via the external circuit and generate an ac electric output. Recently, triboelectrification at the water/solid and water/air interfaces are used to increase a brand-new type of Teng, which demonstrates promising packages for harvesting energy from ocean wave, tide, and rain water in the surroundings. In realistic applications, the surface of a solar cellular is normally protected through a layer of obvious cloth to defend the tool from environmental damages/corrosions. Considering the fact that a

water-drop Teng may be fabricated using exceedingly obvious polymer materials, we ought to simply replace the ordinary safety layer on solar panel the use of a particularly designed and processed transparent polymer layer, to obtain the twin feature of being a safety layer and a Teng. In this paper, we proven a hybrid power mobile that consists of a mainly designed micro pyramidal si solar cellular and a waterdrop Teng for concurrently/in my view harvesting each solar and raindrop electrostatic energy. Experimental phase fabrication of si solar cellular with micro pyramids the si substrate used was a single-crystal, p-type go with the flow-zone substrate with a thickness of three hundred μm . The textured si surface with micro pyramids becomes created with the aid of koh etching. The wafer changed into then wiped clean to remove floor organic and metallic contaminants, followed through pocl3 diffusion to shape the n+- emitter. A ramification temperature of 1133 ok become used to obtain a 65 ω/sq . Emitter. The wafer become then coated with eighty nm sin via a plasma-better chemical vapor deposition reactor. The sin movie serves as a passivation and antireflection coating layer for the tool. After that, the display-printed n+-p-p+ junction solar mobile turned into fabricated. An al paste turned into screen-imprinted on the backside of the si substrate and dried at 473 ok. Ag grids have been then display-printed on pinnacle of the si substrate, observed via cofiring of both the ag and al contacts. An into top electrode with three hundred nm thickness was covered with the aid of pvd 75 rf sputter. Fabrication of the superhydrophobic ptfe thin movie first, microstructures have been fabricated by way of blasting an al foil with sand particles the use of compressed air.

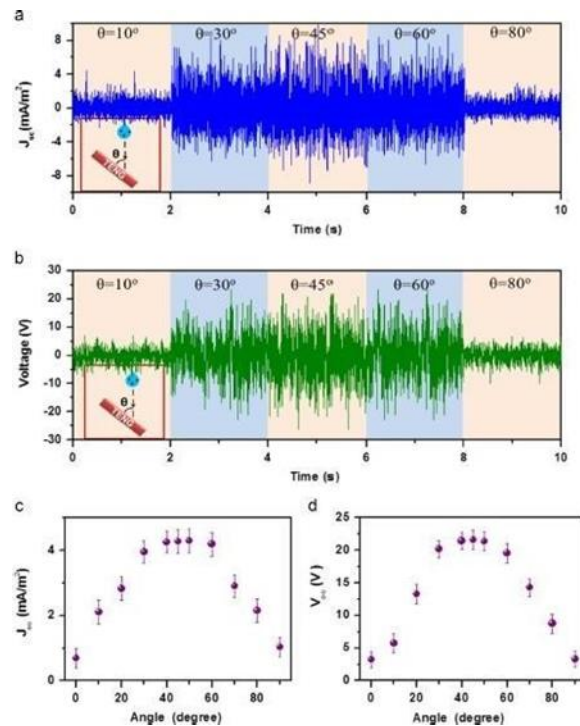
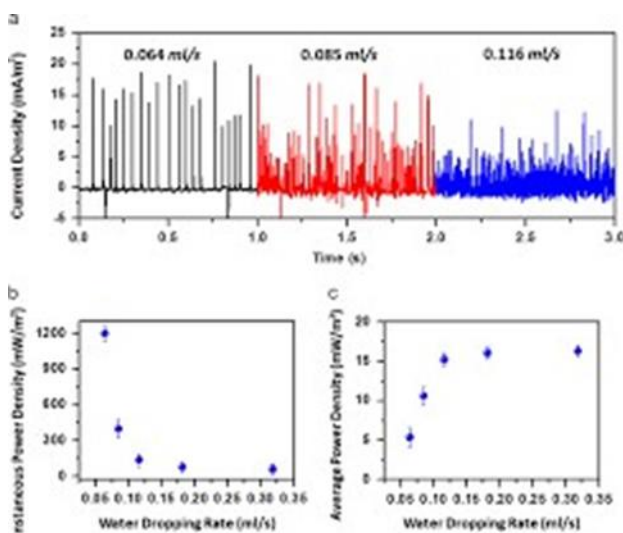


Figure2 Scattering charge and reproduce voltage

The sand-blasted al foil became in addition anodized in a 0.3 m oxalic acid strategy to acquire an anodic al oxide (aao) template with nanometer sized holes. A sem picture of the aao template is shown in determine s2, where the common diameter of the holes in aao template is set forty-six nm. Then after using a self-assembled monolayer of a heptadecafluoro-1,1,2,2- tetrahydro decyl trichlorosilane (hdfs) to decrease the floor strength of the aao template, ptfe solvent

turned into poured into the aao template and a conventional vacuum method changed into carried out to cast off the air remaining within the nanoholes. After curing on the ambient temperature for at some point, the solvent turned into evaporated and a ptfe thin film become left with hierarchical nanostructures. Ultimately, the ptfe skinny movie changed into peeled off from the aao template through the usage of a obvious double-sided tape. Fabrication of hybrid cellular a commercial into movie with thickness of 100 nm and puppy skinny layer was used as the electrode for water-drop Teng, after which a ptfe thin film was connected onto the into floor, as a result a water-drop Teng changed into fabricated. Then the fabricated water-drop Teng changed into put onto the floor of si-based totally solar cellular. In the end, a few pdms mixture with elastomer and move-linker (sylgard 184, dow corning) mixed in a 10:1 mass ratio changed into used to seal all of the electrodes of the tool to save you it from water. Size of hybrid cell the solar mobile performance became characterized beneath the mild illumination intensity of one thousand w/m2. The i-v curves of si-primarily based solar mobile earlier than and after integrating the water- drop Teng become measured by the use of a keithley 4200 semiconductor characterization device. The spectra transmittance of the Teng changed into measured with the aid of a uv-vis spectrophotometer (v-630). Within the electric output measurement of the Teng, the water drops were sprayed by means of a shower which turned into linked to a family tap and the water dripping rate turned into managed via the knob of the shower. The current meter (sr570 low noise modern-day amplifier, Stanford studies gadget) and voltage meter (6514 gadget electrometers, keithley) were used to measure the electric output of the water-drop Teng.



A sun panel that may generate energy from falling raindrops has been invented, enabling strength to glide even when skies cloud over or the sun has set.

Solar strength installation is soaring globally

way to costs plunging 90% within the past decade, making it the cheapest power in lots of parts of the arena. However, the electricity output can plummet underneath gray skies and researchers are running to squeeze even extra energy from panels.

The new device, proven in a laboratory at Soochow university in china, places transparent polymer

Other researchers have lately created similar devices on solar panels, known as triboelectric nanogenerators (tengs), however the new design is significantly less difficult and greater green as one of the polymer layers acts as the electrode for each the Teng and the sun cell.

“due to our precise device layout, it becomes a light-weight device,” stated sun, whose group’s paintings is posted in the journal *acs nano*. “in future, we are exploring integrating those into cell and bendy devices, such as electronic clothes. However, the output energy efficiency needs to be further improved before practical application.”

Solar said the sphere become developing fast and expects to provide a prototype product in 3 to 5 years. Different scientists in china have extensively utilized tengs on sun cells to harvest a few strengths from the wind, a method solar stated may be added to his tool. The top layer of the Teng is likewise grooved to help attention lighter on the sun cell.

“the idea is interesting – a hybrid tool that harvests kinetic energy from water without destroying the output of the sun cellular for the duration of sunny instances,” said varun sivaram, at the council on foreign family members, us, and author of a brand-new eBook on sun energy. “there’s plenty of great engineering, like using one layer to do double responsibility as a factor of the Teng in addition to trap mild for the sun cellular.”

layers on pinnacle of a solar photovoltaic (pv) cellular. Whilst raindrops fall on to the layers and then roll off, the friction generates a static electricity charge.

“our tool can constantly generate power in any daylight hours weather,” stated Baoquan solar, at Soochow university. “similarly, this device even gives electricity at night time if there’s rain.”

However, varun said the energy the device generates from falling rain needs to be extensively higher to begin making an overall difference to a solar panel’s output. “it’s truly not clear whether that is a huge deal or now not – I suspect it’s not.”

Prof Keith barnham, at imperial university London, stated the hybrid device gave an important advantage in making it more compact and efficient. But he said: “wind energy is genuinely the most effective and complementary strength supply to pv – and it works similarly well within the rain!”

Different innovations in sun panel layout include the usage of the mineral perovskite as a flexible and green fabric, the usage of so-known as “quantum dots” and studying synthetic photosynthesis, which uses sunlight to produce liquid and gasoline fuels.

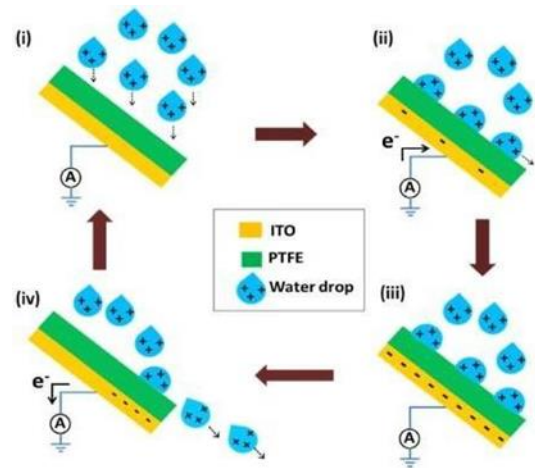


Figure 3 water drop strikes PTER

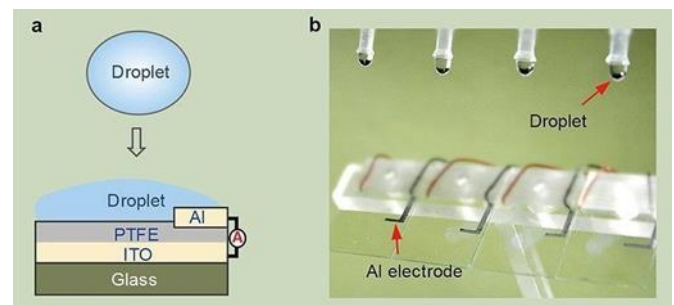


Figure 4 rain drop with semiconductor layer output

The fabricated solar mobile can simplest offer a voc of zero.32 v, jsc of zero.9 a/m² and output electricity of zero.21 w/m², as a consequence we will see that the output performance of sun cell reduced significantly in comparison with the output (160 w/m²) underneath a full sun situation. It's miles really worth noting right here that a complete sun circumstance is a sensible case due to the fact all the solar panels have to make use of normal sunlight at diverse weather situations. While the water-drop Teng under a water dripping price of 0.116 ml/s can offer a median output power of 16.31 mw/m². The theoretical calculation outcomes imply that water- drop Teng can be an awesome electricity supply specifically in rainy day and night time. If the water- drop Teng can be in large part carried out upon the floor of commercial roof solar panels, then without affecting the output performance of solar cellular, a water-drop Teng with surface location of 614 m² underneath a dripping price of 0.116 ml/s can mild up a commercial electricity-saving lamp at a general horsepower of 10 w. Normally speak me, a separate residence in u.s. Regularly has a roof region more than one thousand m². If the roof is protected via included hybrid cell panels, then in idea, a commercial lamp of 10 w can be without problems lighted up by way of water impacting in a heavy rainy night. This performance can be largely stepped forward by way of optimized design and choice of substances. And more importantly, the generated energy by using the water-drop Teng can paintings collectively with the solar cells and may be saved in

batteries for offering constant electricity output. This result shows extraordinary ability of hybrid mobile in actual commercial programs for green strength harvesting.

SOLAR RAIN DROP POWERED INVERTER

Output Waveforms

The switch in the straightforward inverter depicted above produces a square voltage waveform instead of the sinusoidal waveform that is the standard waveform of an AC power supply. Utilizing Fourier examination, intermittent waveforms are addressed as the amount of a boundless arrangement of sine waves. The sine wave that has a similar frequency as the first waveform is known as the basic part. The other sine waves, called sounds, that are remembered for the arrangement have frequencies that are vital products of the central frequency.

The nature of the inverter yield waveform can be communicated by utilizing the Fourier examination information to figure the total harmonic distortion (THD). The all-out consonant twisting is the square base of the amount of the squares of the symphonious voltages isolated by the principal voltage:

$$THD = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \dots + V_n^2}}{V_1}$$

Eq.1 Total Harmonic Distortion

The quality of output waveform that is needed from an inverter depends on the characteristics of the connected load. Some loads need a nearly perfect sine wave voltage supply in order to work properly. Other loads may work quite well with a square wave voltage.

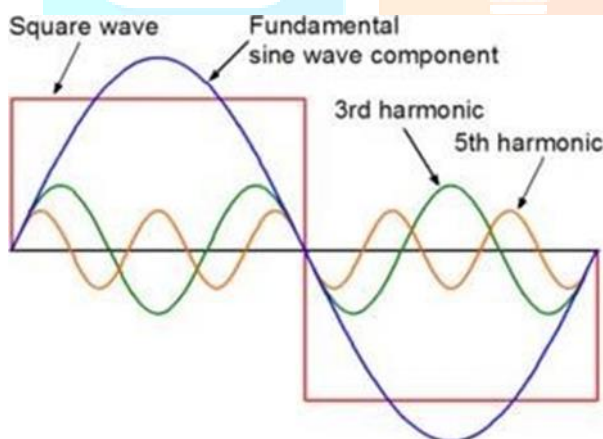


Fig.5 Square waveform with fundamental sine wave component, 3rd harmonic and 5th harmonic

More Advanced Solar rain drop powered inverter Designs

There are many exceptional electricity circuit topologies and control strategies used in inverter designs. Exclusive design processes are used to deal with numerous issues that can be extra or less critical depending at the manner that the inverter is supposed for use.

The difficulty of waveform exceptional may be addressed in lots of approaches. Capacitors and inductors can be used to clear out the waveform. If the design consists of a transformer, filtering may be implemented to the primary or the secondary side of the transformer or to both aspects. Low-skip filters are carried out to permit the essential aspect of the waveform to pass to the output while proscribing the passage of the harmonic additives. If the inverter is designed to provide strength at a set frequency, a resonant clear out may be used.

For an adjustable frequency inverter, the filter needs to be tuned to a frequency that is above the maximum fundamental frequency.

In view that maximum masses contain inductance, comments rectifiers or anti-parallel diodes are frequently connected across each semiconductor transfer to offer a route for the height inductive load

present day while the semiconductor is turned off. The anti-parallel diodes are quite much like the freewheeling diodes used in ac/dc converter circuits. Fourier evaluation well-known shows that a waveform, like a rectangular wave, that is anti-symmetrical about the one hundred eighty diploma point includes handiest strange harmonics, the 3rd, 5th, 7th and so forth. Waveforms which have steps of sure widths and heights cast off or "cancel" extra harmonics. For example, by way of inserting a zero- voltage step among the effective and negative sections of the rectangular-wave, all the harmonics which might be divisible via three can be eliminated. That leaves best the fifth, 7th, 11th, 13th and so on. The desired width of the steps is one 0.33 of the periods for every of the positive and negative voltage steps and one sixth of the period for each of the 0- voltage steps.

Changing the square wave as described above is an instance of pulse-width modulation (pwm). Modulating, or regulating the width of a rectangular- wave pulse is often used as a method of regulating or adjusting an inverter's output voltage. While voltage control isn't required, a set pulse width may be decided on to lessen or dispose of selected harmonics. Harmonic elimination strategies are normally implemented to the lowest harmonics because filtering is greater effective at high frequencies than at low frequencies. Multiple pulse-width or provider based totally pwm control schemes produce waveforms which are composed of many slender pulses. The frequency represented by the quantity of narrow pulses per 2d is known as the switching frequency or service frequency. These manage schemes are regularly utilized in variable-frequency motor manipulate inverters due to the fact they allow a wide variety of output voltage and frequency adjustment even as additionally enhancing the exceptional of the waveform.

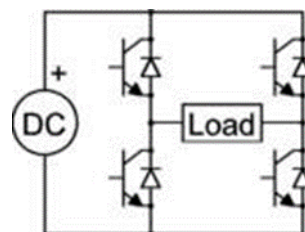


Fig.6 H-bridge inverter circuit with transistor switches and anti-parallel diodes

Sun rain drop powered inverter is a tool to converter 12 volts dc electricity to 110 volts ac electricity. This can be used to strength a pc on your car. Due to the fact that this time i have been amazed at the makes use of a electricity inverter could have. One power inverter may be as useful in day by day existence as say a automobile is. Here are only some of the uses i have discovered for a power inverter.

Scientific strength solar rain drops powered inverter: medical devices can be powered through power inverters. A few clinical gadgets require proper sine wave electricity inverters whilst others will paintings with changed sine wave electricity inverters. In case you are uncertain about your tool, name the producer and ask for his or her pointers. Maximum

scientific gadgets are endorsed to be run on actual sine wave power inverters inverter.

Home energy solar rain drop powered inverter: power inverters are precious around the house. Even though most home electricity inverter users are starting to use our portable power packs as opposed to inverter most effective choices. Our transportable strength gadgets offer terrific power from a battery the usage of a power inverter. Strength inverters make amazing backup energy answers for emergency electricity and having energy where it's far inconvenience to run extension cords.

Automobile power sun rain drop powered inverter: car power inverters are splendid gadgets. Those gadgets when hooked up for your automobile will let you run maximum household devices. This will be a

terrific manner to hook up a television on your car or maybe charge a virtual digital camera or camcorder. The possibilities are limitless. Is your car, automobile or truck rigged with the state-of-the-art and greatest. You then need an electricity inverter. Energy inverters sincerely can entire that cellular workplace. These strength inverters are the most commonplace installed in cars, vans and cars.

Marine power inverter / inverters: the marine customers can discover the precise power conversion device they need to meet their electric requirements that degrees from one hundred fifty to 4000 watts, and instrumentation and add-ons for both the marine oem and aftermarket. The marine power inverter inverters chargers are built to resist the rigors of the marine environment and lots of carry ul and ce approval listings.

Latest Power Demands

All the latest requirements of the common people & industry require two basic demands that are:

uninterrupted strength supply: an uninterruptible electricity delivers (solar rain drops powered inverter), uninterruptible electricity source or every now and then called a battery backup is a tool which maintains a continuous supply of electric electricity to linked device through imparting energy from a separate source when application strength isn't always to be had. A solar rain drop powered inverter is inserted between the source of electricity (usually industrial software strength) and the burden it's miles defensive. While a energy failure or abnormality happens, the solar rain drop powered inverter will efficiently transfer from utility electricity to its very own electricity source almost right away. Whilst not constrained to safeguarding any unique kind of gadget, a sun rain drop powered inverter is normally used to protect computers, telecommunication gadget or other electrical system

in which an unexpected strength disruption ought to reason accidents, fatalities, extreme business disruption or facts loss. Solar rain drop powered inverter devices are available sizes ranging from units in an effort to lower back up a unmarried computer without monitor (around 200 va) to gadgets so as to electricity whole records facilities or homes (numerous megawatts). Large sun rain drops powered inverter units commonly work together with generators.

stabilized frequency: the mains frequency is the frequency at which alternating cutting-edge (ac) is transmitted from an energy plant to the stop consumer. In India it's far typically 50 hz. Locations that now use the 50 hz frequency generally tend to apply 230 v, and people that now use 60 hz tend to use 117 except specific by the producer to function on both 50 or 60 hz, appliances won't operate successfully or even properly if used on apart from the meant supply frequency.

The frequency of huge interconnected power distribution systems is tightly regulated so that, over the path of an afternoon, the average frequency is maintained at the nominal cost inside some hundred elements according to million. While this lets in easy electric powered clocks, primarily based on synchronous electric powered vehicles, to keep accurate time, the number one cause for accurate frequency manage is to allow the waft of alternating modern strength from more than one turbine via the network to be managed.

Frequency of the machine will range as load is introduced to the gadget or as generators are close down; different mills are adjusted in pace so that the average device frequency stays nearly constant. At some point of a extreme overload caused by failure of mills or transmission traces, the strength device frequency will decline. Loss of an interconnection sporting a large amount of strength (relative to machine overall technology) will purpose system

frequency to upward push. Special safety relays in the power device network sense the decline and might automatically provoke load shedding or tripping of interconnection strains, to hold the operation of as a minimum a part of the network. Quite small frequency deviations, say zero. Five hz on a 50 hz or 60 hz community, will result in automated load shedding or other control movements to restore gadget frequency. Smaller electricity systems, no longer substantially interconnected with many generators and masses, might not preserve frequency with the same degree of accuracy. Sun cell based solar rain drop powered inverter utilizes sun electricity to rate the battery additionally to provide supply to load ,solar strength is transformed into electric strength this electric power is converted into dc voltage with the aid of sun rain drop powered inverter and charge the battery concurrently it deliver the electricity to the weight .

At some stage in night or in cloudy day the dc voltage from battery is converted via the solar rain drop powered inverter into ac supply and directed to the weight. Right here we're using microcontroller to govern the various operation like sensing whether the principle deliver is on or off, display the messages on the liquid crystal display for higher expertise through consumer and the main function of microcontroller is to generate the voltage sign frequency of 50 hz. As the frequency is generated by microcontroller so it is going to be reliable and not shifted an excessive amount of and for this reason provide consistent 50 hz ac deliver.

Electricity era Sun strength:

Solar strength is the era of power from daylight. This can be direct as with photovoltaics (pv), or indirect as with concentrating sun energy (csp), in which the Solar's power is centered to boil water

that's then used to provide electricity. Sun energy has the capability to provide over 1,000 times total global energy intake in 2008, although it supplied only zero.02% of the full that 12 months. If it continues to double in use every two to

three years, or much less, it would come to be the dominant strength supply this century. The most important sun electricity flowers, like the 354 mw segs, are concentrating sun thermal flowers, but currently multi-megawatt photovoltaic plant life had been constructed. Finished in 2008, the 46 mw Moura photovoltaic power station in Portugal and the forty mw waldpolenz solar park in Germany are function of the trend towards larger photovoltaic strength stations. A good deal large one is proposed, inclusive of a hundred mw citadel % solar farm [citation needed], the 550-mw topaz solar farm, and the 600-mw rancho cielo solar farm.

Terrestrial solar energy is a predictably intermittent strength source, which means that at the same time as solar electricity is not available at all times, we are able to are expecting with a superb diploma of accuracy while it'll and will no longer be available. Some technologies, which include sun thermal concentrators have a detail of thermal storage, which include molten salts. Those keep spare sun energy inside the shape of heat which can be made made available in a single day or throughout intervals that solar strength is not to be had to produce power. Orbital solar energy series (as in sun electricity satellites) avoids this intermittent trouble, however requires satellite launching and beaming of the gathered strength to receiving antennas on the earth. The accelerated intensity of sunlight above the environment also will increase era efficiency.

Advantages

- highest performance: panel efficiency of 18.1% is the highest commercially to be had for residential packages
- attractive layout: unique layout combines excessive efficiency and a fashionable, all- black look
- extra power: promises up to 50% extra electricity in keeping with unit area than conventional sun panels
- reliable and strong design: confirmed substances, tempered the front glass, and a robust anodized body permit panel to perform reliably in a couple of mounting configurations.

Precept of solar electricity technology: the principle of electricity generation in the back of the sun cells includes the output contemporary density of 350 a/m² below a mild intensity of one thousand w/m². And the Teng designed for collection of raindrop strength offers a voc of 30 v and jsc of four.2 ma/m² when impacted by means of water drops at a dripping fee of 0.116 ml/s. The obvious Teng cannot best be a safety layer of solar cell, but also a superb complementary power harvester. The dependence of the output overall performance of water-drop Teng on incident angles were studied, indicating that the Teng may be applied in extensively-used roof solar panels with tilted degree. The connection between the output energy and rainfall precipitation become additionally studied, showing that a surface place of 614 m² of hybrid cell can theoretically light up a business lamp at a horsepower of 10 w best by using rain dripping. Although the output strength is still low, this sort of hybrid mobile paves a brand-new manner to simultaneously/in my view harvest multimode energies together with sun and raindrop electrostatic energy. As for harvesting inexperienced electricity from the natural environment, this prototype of hybrid cellular has great capacity programs in commercial roof solar cell panels inside the close to future.

utilization of the photovoltaic impact of semiconductors. Whilst the sort of cellular is uncovered to light, electron-hole pairs are generated in share to the intensity of the mild. Sun cells are made by way of bonding collectively p-type and n-kind semiconductors. The negatively charged electrons flow to the n-kind semiconductor whilst the undoubtedly charged holes flow to the p-type semiconductor. They accumulate at each electrode to form a ability. When the two electrodes are linked by means of a wire, a cutting-edge flow and the electric power as a result generated can be transferred to an outdoor application.

Applications

This sun cell based online sun rain drop powered inverter machine has many packages. A number of them are as follows-

1. It could be used at domestic.
2. It's far used in the industry. Three. It's far utilized in shops.

Future upgrades

The deigned architecture may be further improved for higher energy / voltage ratings and more advertisements uses with some more fee delivered

functions like pure sine wave output the use of virtual sign processing techniques. Surge electricity & starting surge shipping may be greater by way of using extra effective batteries and functions like shut down on opposite polarity at enter battery, overload can also be delivered.

Conclusions

In precis, we've advanced a novel hybrid energy cell that includes a especially processed si-based totally solar mobile and a unique water-drop Teng, which can be used to concurrently/in my opinion harvest each sun and raindrop electrostatic strength. The bottom solar mobile tool changed into designed by way of using a si micro pyramid n+-p-p+ junction, that may provide an output voltage of zero.6 v and

References

- [1] S.M. Lele, World Dev. 19 (1991) 607–621.
- [2] H. Meyar-Naimi, S. Vaez-Zadeh, Energy Policy 43 (2012) 351–361.
- [3] B. Tian, X. Zheng, T.J. Kempa, Y. Fang, N. Yu, G. Yu, J. Huang, C.M. Lieber, Nature 6 (2007) 885– 890.
- [4] J.H. Oh, H.C. Yuan, H.M. Branz, Nat. Nanotechnology. 7 (2012) 743–748.
- [5] P. Devine-Wright, Wind Energy 8 (2005) 125– 139.
- [6] M. Hoogwijk, A. Faaij, R. van den Broek, G. Berndes, D. Gielen, W. Turkenburg, Biomass Bioenergy 25 (2003) 119–133.
- [7] X. Chen, S. Xu, N. Yao, Y. Shi, Nano Lett. 10 (2010) 2133–2137.
- [8] G. Zhu, Z.-H. Lin, Q.S. Jing, P. Bai, C.F. Pan, Y. Yang, Y.S. Zhou, Z.L. Wang, Nano Lett. 13 (2013) 847–853.
- [9] Y. Yang, W.X. Guo, K.C. Pradel, G. Zhu, Y.S. Zhou, Z.L. Wang, Nano Lett. 12 (2012) 2833–2838.
- [10] W.S. Liu, X. Yan, G. Chen, Z.F. Ren, Nano Energy 1 (2012) 42–56.
- [11] C.F. Pan, Z.X. Luo, X. Chen, J. Luo, R.R. Liang, G. Zhu, W.Z. Wu, W.X. Guo, X.X. Yan, J. Xu, Z.L. Wang, ACS Nano 5 (2011) 6629–6636.

- [12] A.J. Moule, K. Meerholz, Appl. Phys. B – Lasers Opt. 86 (2007) 721–727.
- [13] Y. Liu, A. Das, S. Xu, Z.Y. Lin, C. Xu, Z.L. Wang, A. Rohatgi, C.P. Wong, Adv. Energy Mater. 2 (2012) 47–51.
- [14] W.L. Min, B. Jiang, P. Jiang, Adv. Mater. 20 (2008) 3914–3918.
- [15] S.L. Deisenhofer, G. Vecchio, R.E. Algra, A. Hartsuiker, O.L. Muskens, G. Immink, E. Bakkers, W.L. Vos, J.G. Rivas, Adv. Mater. 21 (2009) 973–978.
- [16] F.R. Fan, Z.Q. Tian, Z.L. Wang, Nano Energy 1(2012) 328–334.
- [17] S.H. Wang, L. Lin, Z.L. Wang, Nano Lett. 12 (2012) 6339–6346.

