Photo-capacitor

Prelims: *Current events of national and international importance*

Why in News?

Recently, Indian scientists have developed a photo-capacitor that simultaneously captures and stores solar energy.

- **Solar energy systems –** Enable *direct conversion of sunlight into stored electrical energy*, viz., electricity or heat.
- **Components –**
  - Solar panels for energy capture.
  - Batteries/supercapacitors for energy storage.
  - Power-management electronics to regulate voltage and current mismatches.
- **Supercapacitor –** A supercapacitor is a high-capacity energy storage device that bridges the gap between conventional capacitors and rechargeable batteries.
- **Photo-capacitor –** It is an ***innovative sunlight-powered supercapacitor using a single device*** that integrates solar energy harvesting and energy storage.
  - **Type –** Photo-rechargeable supercapacitor.
- **Developed by –** *Centre for Nano and Soft Matter Sciences (CeNS)*, Bengaluru.
- **Nodal Authority –** Department of Science and Technology (DST), Ministry of Science & Technology.
- **Working Principle –** The device simultaneously absorbs sunlight and stores the generated electrical charge.
- This is done ***using $NiCo_2O_4$ nanowire electrodes grown on nickel foam.***
- **Key Features – Integrated Architecture –** Combines sunlight harvesting and charge storage in a single device, eliminating the need for separate solar panels and storage units.
- **Electrode Material –** Binder-free nickel-cobalt oxide ($NiCo_2O_4$)

nanowires uniformly grown on nickel foam using an in-situ hydrothermal process.

- **Nanostructure Design –** Highly porous, conductive three-dimensional nanowire network with nanometre-scale diameter and micrometre-scale length.
- **Photo-Enhanced Performance –** *Capacitance increased by 54% under illumination*.
- **Durability & Stability – *Retained 85% capacity after 10,000 charge-discharge cycles.***
- And, asymmetric device retained 88% capacitance after 1,000 photo-charging cycles.
- **Voltage Output –** Delivered a stable output voltage of 1.2 V in an asymmetric photo-supercapacitor configuration.
- **Operational Flexibility –** Operated efficiently under varying light conditions, from low indoor illumination to intense sunlight,
- **Applications –** Portable electronics, wearable devices, off-grid technologies.
- As self-charging power systems for remote regions without access to electrical grids.
- **Benefits –** Reduced system complexity and cost.
- Minimized energy loss with long-term stability.
- Self-charging capability and reduced dependence on conventional batteries.
- **Significance –** Represents a paradigm shift in renewable energy storage by enabling self-sustaining, clean energy systems.
- It supports India's clean energy ambitions through innovative, photo-responsive energy storage technologies.

Reference

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