Technology Offer

Sustainable High-Performance Energy Storage: The Solar Battery

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The invention relates to a new solar battery half-cell that can be recharged by natural resources like sunlight. Remarkable sustainability is provided by the possibility to use sunlight as a source of primary energy and by solving the problem of low capacity of state-of-the-art battery technologies.

Sustainable solutions for efficient storage of electrical energy are of great importance for the global energy transition and other applications. Typical batteries, however, are often charged using fossil energy sources and are additionally less advantageous due to their low energy density.

Improved properties are provided by the newly developed solar battery, which can be recharged by sunlight directly. This half-cell enables the simultaneous absorption of light and the storage of photo-induced electrons, which can be released in the form of electrical energy.

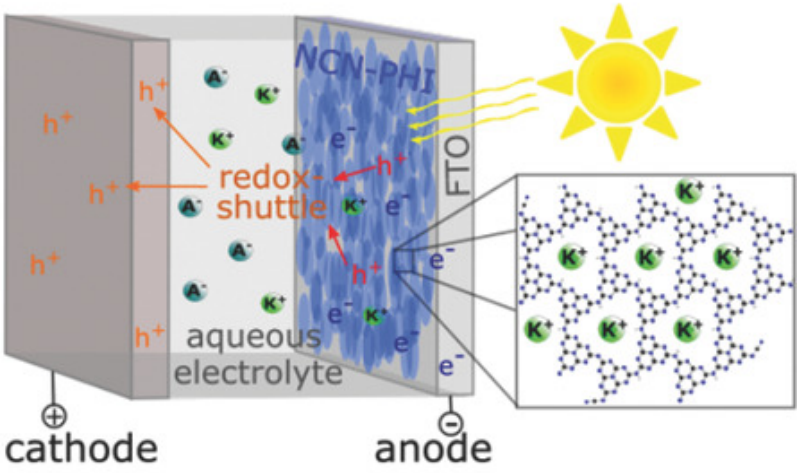

Fig. 1: Illustration of the novel monolithic solar battery. Photoabsorption and electron storage occurs within the same material with holes being extracted to a cathode via an aqueous electrolyte.

Advantages

- Photon harvesting and electron storage at the same time in the same material
- Higher capacity, stability, and lifetime (>500 cycles)
- No need of immediate discharge like solar cells
- Low-cost and abundant electrode materials
- Large scale production possible
- Use within a solar battery with different ions (Na, K, ammonia etc., i.e. not only Li)
- Higher operation voltage due to the high overpotential of the anode material

Applications

- Storage facilities to compensate fluctuations of availability of renewable energy
- Photovoltaic power production
- Mobile applications
- Detectors

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de

Background

Environmental consciousness paired with growing energy demand, sustainable solutions like more efficient and environmentally friendly, earth abundant energy storage systems are a global worthwhile goal. Especially in the important field of battery technology, major challenges still limit the possible applications. Typical low energy densities keep less sustainable alternatives advantageous over batteries with the energy to charge them often still being fossil.

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To overcome the aforementioned shortcomings, an enhanced class of materials for applications in full solar batteries with unique properties has been developed. It combines two core functionalities required for sustained energy conversion in the same carbon-nitride based structure: Light harvesting and electric energy storage that evermore allows electrical discharge on demand. However, charging is not limited to light and can be also realized electrically like in traditional electrodes.
Comparable materials for pure electrical energy storage with higher capacities are CNT nanotubes. However, they are less favorable due to their limited charge storage stability. Note, that so-called '2D cyanamide-functionalized polyheptazine or polytriazine imide' materials still retain about 63% of stored charge after half an hour.
Another great benefit of using such materials is its inability to evolve hydrogen (water reduction) in the absence of a co-catalyst. Due to a high intrinsic overpotential of this carbon nitrides for this chemical reaction that would otherwise discharge the material, the electron storage process is very stable and can be driven beyond the usually limiting water reduction potential. This allows to increase the potential window of aqueous batteries, which usually limits their energy density.
These interesting properties, which are unprecedented in organic based materials, enable new applications for solar batteries in aqueous environments compared to other materials.

Patent Information

PCT *(WO2020143912A1)*, EP, US, JP

Publications

Podjaski et al. *"Toward an Aqueous Solar Battery: Direct Electrochemical Storage of Solar Energy in Carbon Nitrides"*, Adv. Mater. 30 (2018)

Contact

Dr. Bernd Ctortecka
Senior Patent- & License Manager
Physicist
Phone: +49 (0)89 / 29 09 19 - 20
eMail: ctortecka@max-planck-innovation.de

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de