Development of an All-Solid-State Self-Charging Supercapacitor Energized by a Safe, Biodegradable Gel Electrolyte

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Self-powered units, especially energy storage devices with self-charging ability, are considered sustainable power sources for future electronic devices. In this research, a novel supercapacitor device capable of self-charging under visible light illumination has been developed and tested. Such a device is fabricated using low-cost, abundantly available, and highly stable semi-conducting materials, including TiO2 and polyaniline (PANI). The photoanode of the self-charging supercapacitor was prepared using a novel laser-assisted dip-coating technique. The asymmetric supercapacitor was fabricated by joining a TiO2/PANI photoanode with an activated carbon electrode using a locally synthesized biodegradable gel electrolyte. The novelty in using gel electrolytes is to construct a liquid-free, all-solid-state device that significantly enhances the lifetime of the device. The electrochemical measurements of the fabricated device, comprising CV analysis, GCD characterization, and self-charging tests, were performed three times to demonstrate the reproducibility of the experimental results. The device performed very well as a standard supercapacitor by demonstrating 35.4F/g of specific capacitance, calculated through cyclic voltammetry. The device performed efficiently at a high potential window of 1.5V, indicating a relatively large energy density of 20.5Wh/kg and a superior power density of 4.37kW/kg, which is much larger than many recent reports. The device also exhibited self-charging ability under visible light illumination by generating a potential of 378mV without any external source and 0.16mA of photocurrent. Such a device has great potential to be used in portable electronics, specifically wearable electronic devices.

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