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Flexible Thin Battery with Fast and Sensitive Voltage Control by a Simple Mechanical Bending: No Energy without Working

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Abstract

The competition among scientists in providing the best need of mobile energy in society has been spread worldwide. This short communication shares a newly simple invention about thin battery with its voltage control simply adjusted by bending it. The changing in battery voltage is quite fast only in few seconds and very sensitive according to the mechanical bending treated into it. Furthermore, the thin battery was fabricated to be water resistant so that it can be applied under water with special technology purposes. This invention is a new beginning for flexible thin battery (FTB) technology which can be implemented in many different activities of daily life such as integrated technology use, medical energy supports, and education smart tools.

Keywords: Flexible Thin battery (FTB), Mechanical bending, Fast and sensitive, Voltage control.

The invented contribution: A novel flexible thin battery (FTB) with a fast and sensitive voltage control using a simple mechanical bending into it.

SHORT COMMUNICATION

Since the first report on a conceptual elastics nanobattery by Elim, *et al.* in June

2019 [1] based on the deepest former nanobattery developments [2-7], the competition among scientists in providing the best need of mobile energy in this current

Society 5.0 has been blowout everywhere. The following systematic wisdom and knowledge as well as understanding of nanotechnology by the use of only a very small energy with incredible sensitive optical, mechanical, and electrical responses [3] such as the advanced developments of frontier Li ion battery (LIB) [8-16], the energy storage system in battery [17-22], the Li ion hybrid technology [23-26], the temperature battery influence [27-30], the creative material structures and its composition [31-39], the style of circuit and interface in battery [40-43], the nanoelectrode quality fabrication [44,45], the mechanical engineering system [46-48], the improvement of cathode materials [49,50], the impedance contributions [51-58], and the tools analysis [59,60] has made a significant advanced progress in this 21st century multitasking technology. Even though such excellent improvements in nanobattery research and breakthrough have developed the applications in interdisciplinary nanotechnology, there is still opportunity to a novel idea for flexible energy storage with multitasking impacts for another technology and engineering system.

In this paper, we, for the first time, introduce flexible thin battery (FTB) with fast and sensitive voltage control by a simple mechanical bending. Such interesting thin battery was fabricated using a very simple technique and the raw materials were from any natural garbage such as used woods, peeled fruit skins of Maluku galoba (*Amomum sp.*), peanut (*Canarium communis*) and coconut (*Cocos nucifera*). Therefore, the cost of such flexible thin battery can be extremely cheap and very useful for many different poor countries consisted of thousands of small islands such as Indonesia, Philippines, Thailand, many nations in Pacific areas, and so

forth. This invented battery can be developed to improve its stability of high current and voltage through an extended research on its high energy density, design flexibility, and convenient handling compared to another types of both conventional batteries and sophisticated nanobattery. In addition, **present flexible battery may trigger the solution for the main 2 disadvantages of a novel storage device using worldwide LIB technology such as the limitation of suitable electrodes and electrolytes, and the complicated tasks in controlling the electrode-electrolyte interfaces.** As a matter of facts, FTB requires both highly conducting and stable confinement thin and flexible solid electrolytes. Based on its simple fabrication technique, there was no need to use a vacuum glove box like in the LIB fabrication technique.

Fabrication technique for this FTB as the output was depicted in **Fig. 1** had been through a very simple technique. Firstly, the garbage from the used woods, peeled fruit skins of Maluku galoba (*Amomum sp.*), peanut (*Canarium communis*) and coconut (*Cocos nucifera*), respectively were dried under the sun rays for few weeks. Secondly, the dried raw materials were burned on air with the temperature over 500 °C until they become char like-coal. Thirdly, the char was crushed in few simple steps to be a powder. Furthermore, the thin electrodes made by thin structures of copper (²⁹Cu) and aluminum (¹³Al) were prepared. Finally, the FTB was fabricated in a special technique covered by a transparent water resistant material. Such smart and brief fabrication method is shown and explained part by part in **Fig. 1**.

Figure 1. The transformation procedure of simple fabrication technique in realizing a FTB.

Figure 2. The as fabricated FTB has a voltage control via a simple mechanical bending. According to the shown experimental data, the changing voltage due to such different angle of bending was from 0 mV to 319.9 mV in just 29 s. The voltage of such FTB will automatically return to zero volt when there is no mechanical energy applied to it.

Figure 2 shows that through a mechanical bending implemented into FTB, the voltage in FTB can be adjusted or controlled. Here, the basic principle of physics in nature is that without work (W) or a force (F) that moves something in a certain distant (ΔS), there will be no energy (E) observed [61]. In order to test the water resistant ability of FTB, in **Fig. 3** has been depicted a basic test inside an aquarium for the FTB. Such novel discovery of FTB simple technology is widely applicable in various different activities of daily life such as integrated technology use for special purposes in any mobile electronics devices, medical energy supports, and education smart tools.

Figure 3. Water resistant test of flexible thin battery in the research center of nanotechnology and innovative creation (PPNRI) at Pattimura university, Ambon, Indonesia.

In conclusion, the as fabricated **FTB** with thickness of 1.225 mm with its voltage control adjusted by a simple mechanical bending took about 29 s with the total voltage of 319.9 mV. Such achievement of storage energy can be improved dramatically by either enlarging the battery material density with nanobattery materials, and flexibility design, or by making large surface for faradaic reaction and short distance for mass and charge diffusion system in the battery. This thin battery system may

have worldwide multitasking applications after extensive development and collaboration in the near future.

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Conflict of Interest

The researchers involved in this nanobattery technology research declare that there was no any conflict personally in their detail works both ideas and financial support.

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