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A Frontier 2D Nanobattery: “Improving Challenges (*Hotumese*) and Development”

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Abstract

A brief conceptual challenges improvement (*hotumese*) and development of nanobattery is explained in a wide insight of intuition idea and technology planning for a better future human kind life particularly in their needs of mobile effective energy.

Keywords: Nanobattery, Nanoelectrolyte, Nanoelectrode, *Hotumese*, Development.

CONCEPTUAL

Nanobattery with the size and its fantastic structures of about 1000 times smaller than the diameter of human being hair is very attractive due to its large energy storage in nm size as well as stable thermal and mechanical properties because of its inner confinement effects [1-3]. A brief history of nanobattery with its 18th and 19th century inventors is depicted in Fig. 0. Moreover, the idea of building better battery up to nanometer size and structure has been in very intensive efforts during the last two decades [4-11]. Beside such incredible works, many collaborative researches from interdisciplinary talented scientists have shown so many different aspects in the improvement and development focused on commercial **lithium ion battery (LIB)** [12-55]. Such scientific findings contributed in at least 3 advantages points of the **LIB** as follows [4-55]: (1). High energy density, (2). Design flexibility, and (3). Ease of handling compared to other conventional batteries. While another 2 disadvantages of a novel storage device using worldwide **LIB** technology are (1). The limitation of suitable electrodes and electrolytes, and (2). Complicated tasks in controlling the electrode–electrolyte interfaces. On the other hand, the next sophisticated nanobatteries need an on-target improvement and development particularly in all creative solid-state assembly

contributed and supported by both highly conducting and stable confinement solid electrolytes.

Figure 0. Brief history of nanobattery with the background of 18th and 19th century inventors who did various pioneer ideas and prototypes of both capacitor and battery.

Another view of improving challenges (*hotumese* in Ambon, Indonesia language) in conjunction with **nanotechnology storage mobile nanobattery (SMN-B)** for future energy sources is about a great hope in order to develop nano-electrode and nano-electrolyte materials with excellence conductivity in a dynamics field based on gold nanoparticles [56] or gold nanorod [57], and carbon nanomaterials such as fullerene derivatives [58], carbon nanotubes (CNT) [59], and another complex nanostructure materials, for instance proposed by L. Dupont [60], and U. Weisner [61,62] with their unique physical behaviors. Nanocrystals electrolyte made by a well-known electrolyte [1-62] can solve at least the following 3 problems: (1). Large energy storage capacity, (2). Effective charge-discharge kinetics system, and (3). Cyclic instabilities which can be protected by making large surface for faradaic reaction and short distance for mass and charge diffusion.

In present paper, a dream anti-crack and elastic nanobattery system is proposed as shown in **Fig. 1**. The conceptual idea expanded as earlier mentioned in **Ref. [63]** is possible to be realized by fabricating the best nanomaterials consisted of an integrated system using nanoelectrodes-electrolyte structure attached with a very thin 2D graphene like materials. However, a further *hotumese* and development of unique anti-crack and slightly elastic nanobattery requires **excellent nanohybrid materials** to proceed negative and positive nano-electrodes with precise interface with nano-electrolyte grains. Currently, the best positive electrode nanomaterials so far for **LIB** is **lithium iron phosphate (LFP)** [30-31,34] due to its 5 remarkable characters as follows: (1). Stable structure, (2). Less susceptible to degradation over cycles, (3). Good durability of calendar life, (4). Low preparation cost, and (5). Stability over full de-lithiation and environmental benignity. Even though **LFP** has good safety in use because of its stability in high temperature without the produce of oxygen, the weakness of **LFP** was obtained due to its low intrinsic electrical conductivity, which could be overcome by developing suitable architectures

such as carbon coating [15-20]. On the other hand, a good partner of **LFP** to improve a better nanobattery can be **lithium lanthanum titanate (LLTO) inorganic solid electrolyte** that exhibits desirable lithium ion conductivities with its bulk conductivity of $10^{-3} \text{ S cm}^{-1}$ and a grain boundary conductivity of $10^{-5} \text{ S cm}^{-1}$ in a room temperature [22]. This value is as large as those counter parts of liquid electrolytes [24-29]. In spite of its goodness, the **LLTO** has thermal expansion and grain boundary problems as well as unstable against lithium metal with higher redox potential, and poor cyclability with most of the coupling electrodes [23,26]. Therefore, a dramatically *hotumese* and development of nanoelectrolyte must be carried out and achieved by fabricating nanocrystals electrolyte with admirable 3 important points: (1). Large energy storage capacity, (2). Exceptional charge-discharge kinetics system, and (3). Cyclic stabilities which protects nanobattery by making large surface for faradaic reaction and short distance for mass and charge diffusion. Such thought is a main part of all creative solid-state assemblies contributed and supported by both highly conducting and stable confinement solid electrolytes.

In summary, we believe that by a careful *hotumese* and development of anti-crack and slightly elastic 2D nanobattery the most sophisticated future nanobattery can be attained for worldwide multitasking applications.

Figure 1. Illustration of conceptual future 2D nanobattery that has anti-crack and good elasticity with unique electrical behaviors.

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Conflict of Interest

All the scientists declare that they have no any conflict in their works both financial and ideas.

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