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Review

Recent progress and perspectives of metal oxides based on-chip microsupercapacitors

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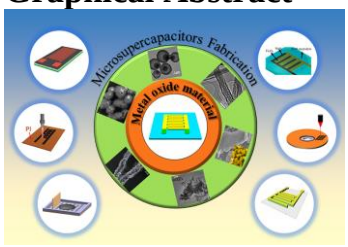
Graphical Abstract



Recent progress on metal oxide nanostructures based on-chip microsupercapacitors was summarized .

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ABSTRACT
The rapid development of portable electronic devices has accelerated the advancement of energy storage devices. On-chip microsupercapacitors (MSCs), as a group of high performance energy storage devices, have remarkable features of miniaturization, high security, and easy integration to build an all-in-one integrated system to meet the request of micro-portable electronic equipments. With the characteristics of high capacities, environmentally friendly and low cost, metal oxides are thought to be ideal candidates for on-chip MSCs. This paper summarizes the recent progress of metal oxides based on-chip MSCs. It starts with the introduction of several common methods for the synthesis of metal oxides nanostructures. The recent developments on the fabrication and electrochemical performance of metal oxides based on-chip MSCs are then highlighted in detail. Finally, the existing challenges and future perspectives of the on-chip MSCs are discussed.

Keywords: Microsupercapacitors Metal oxide Nanostructures On-chip Electrochemical

1. Introduction

With the rapid development of miniaturized portable electronic devices, the requirements for microsized energy storage equipments that can be directly integrated with portable electronic devices are getting higher and higher. However, the currently commonly used energy storage devices, including lithium-ion batteries and supercapacitors, are too heavy and bulky to fit for miniaturized portable electronics [1-7]. Therefore, developing small sized energy storage devices with special structures are highly desired.

Currently, the most commonly used power sources for portable electronics are micro-batteries, which usually store energy either by redox or by expansion-contraction reactions. Unfortunately, micro-batteries often suffer the obvious drawbacks including limited lifetimes and low power density determined by the internal mechanisms of batteries. Microsupercapacitors (MSCs) represent one of the newly developed energy storage devices that can be used as power source for portable electronics. As we know, supercapacitors can provide higher power density than batteries and higher energy density than conventional capacitors, filling the gap between batteries and conventional capacitors [8-10]. They are the promising devices comprising the advantages of fast charge/discharge rates, moderate energy density, long cycling life and so on [11-13]. However, conventional supercapacitors are usually with sandwich structure or a spiral-wound configuration, and are heavy and bulky [14]. Contrary to conventional supercapacitors, MSCs can be directly fabricated into planar structures with on-chip microelectrode fingers with micro- or nano-scale sizes. Due to the short ion diffusion length, MSCs can deliver ultrahigh power densities that are usually many orders larger than that of batteries and conventional supercapacitors [15-19]. Importantly, the compatibility of the MSCs with micro-electronic fabrication techniques ensures the MSCs to be easily integrated with functional microelectronic devices in the electronic circuit [20-28]. With the structural advantages of microelectrodes, MSCs can be efficiently connected in series or in parallel on a single substrate to satisfy the voltage and current requirements of miniaturized portable electronic devices, therefore providing excellent microscale energy storage sources for future portable electronic devices.

This review summarizes the recent progress of metal oxides based on-chip MSCs. The synthetic methods, conditions of metal oxides