Specific energy storage applications alofi

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Perovskite oxides have garnered substantial attention in recent years due to their diverse and exceptional properties, making them compelling candidates for various applications, especially in the realm of energy storage technology. This class of materials exhibits a distinctive crystal structure characterized by the general formula ABX3, where A is typically an alkaline earth metal, B is a transition metal, and X is an anion4.

In the context of perovskite oxides, alkaline earth-based titanates, particularly those derived from barium (Ba) and strontium (Sr), have emerged as pivotal contributors to advancements in energy storage technologies. The unique combination of their crystal structure and electrochemical properties makes them promising candidates for applications such as supercapacitor electrodes4,5,6.

The MTiO3 series, which includes elements like Mg, Mn, Ni, and others, is of particular interest due to its exceptional dielectric constant and remarkably high-quality factor. These unique properties in perovskite titanates stem from the arrangement of TiO6 octahedra, which are isolated by MO6 octahedra and cation vacancies. Each layer of MO6 octahedra is situated between two layers of TiO6 octahedra, contributing to these distinctive characteristics3,7,8.

The utilization of MgTiO3 extends across various domains, contingent upon the specific modifiers employed. When MgTiO3 is modified with rare earth metals, its applications encompass a wide range of areas, including light-emitting and photovoltaic applications, plasma and flat panel devices, light-emitting and solid-state diodes, and optical devices, among others13,14. Meanwhile, MgTiO3 modified with transition metal ions can be used in microwave, satellite, and terrestrial communication, including radio software, GPS, and DBSTV for environmental monitoring15.

Perovskite materials at the nanoscale exhibit distinctive features, including extensive porous structures, a significant surface area, regulated transport and charge-carrier mobility, potent absorption, and photoluminescence. Additionally, their unique adaptability in terms of composition, morphology, and functionalities candidate perovskite nanocrystals as highly effective elements for energy applications such as photovoltaics, catalysis, thermoelectrics, batteries, supercapacitors, and hydrogen storage systems19,20,21,22.

The electrochemical performance of supercapacitors depends on electrode materials, electrolytes, and potential windows. Metal oxides are extensively employed in energy storage and conversion applications, mainly due to their cost-effectiveness, abundant availability, ease of preparation, multiple valence states, and environmental friendliness. They find applications in various fields, including sensors23,24,25,26, biosensors27,28, lithium batteries29, supercapacitors30,31,32, electrocatalysis, and fuel cells.

The current work aims to fabricate MgTiO3 modified with Li+ to extend their application in energy storage systems, including lithium-ion batteries and supercapacitors. The production of Li-MgTiO3 as a dielectric nanoceramic material for supercapacitors was achieved via the acetic acid sol-gel method, followed by 3-h calcination at 800 ?C to promote crystalline development. This research explores into evaluating the electrical and optical attributes of the resultant Li-MgTiO3 perovskite nano-ceramics, encompassing properties such as impedance, Cole-Cole plot analysis, conductivity, absorbance, and energy band gap.

The electrochemical studies were produced by using impedance and cyclic voltammetry electrochemical techniques. The modified screen-printed electrode exhibited remarkably electrocatalytic properties, proving effective in direct electrochemical applications. Notably, this synthesis approach holds significance for advancing energy storage applications.

This study ensures a comprehensive exploration of the doping mechanisms, contributing valuable insights into the tailored design of titanate-based materials for enhanced energy storage applications.

Initially, the synthesis of MgTiO3 (MT) was carried out using the sol-gel reaction method. All the necessary chemicals were procured from Sigma Aldrich. The procedure commenced by dissolving precise amounts of highly pure magnesium acetate (Mg(CH3COO)2o4H2O) in 15 mL of water and acetic acid with continuous stirring. The required stoichiometric quantities of titanium isopropoxide were dissolved in acetylacetone (CH3COCH2COCH3) and introduced into the previously mentioned solution while maintaining a temperature of 50 ?C.

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