Thin Film Ceramics that Offer Electric and Electrochemical Properties Using Nanopowders of Controlled Compositions

TECHNOLOGY NUMBER: 2018-297

OVERVIEW

A method for producing thin films of Beta"-Al_2O_3 that fosters alternative sodium battery design

- Utilizes metal oxide dopants to produce small nanoparticles in the final ceramic material
- Creation of homogeneously sized nanoparticles allows scaling of manufacturing processes

BACKGROUND

Sodium-ion batteries are a promising alternative to lithium-ion battery technology, especially since lithium is rare and costly to mine. Sodium is abundant and inexpensive to obtain. Sodium-ion batteries also can be fully drained without damaging the component materials and offer better resilience in terms of the number of charge cycles they can undergo. However, sodium-ion batteries are limited in that that they are significantly heavier than their lithium counterparts, and the manufacturing of beta alumina solid electrolytes, a critical component, creates design constraints. Beta alumina solid electrolytes are composed of Beta"-Al_2O_3 and regulate the flow of sodium ions between anode and cathode in batteries during discharge and charging cycles. A need exists for manufacturing processes that create beta alumina useful for sodium-ion batteries.

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Category

Engineering & Physical Sciences

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INNOVATION

Researchers have invented a method for producing thin films of Beta"-Al2O3 that fosters alternative sodium battery design by producing small nanoparticles in the final ceramic and adding metal oxide dopants to the material. These innovations optimize the manufacturing process and improve the physical properties of the final composite. The resulting nanoparticles are homogenous in size, indicating that their production could be readily scaled. The metal oxide dopants reduce the temperatures required for sintering the components into a ceramic material and control the final grain size of the ceramic. This method creates thin films of 20-50 μm thick Beta"-Al2O3 with 96-98% theoretical maximum density, 60-80 weight percent, and ionic conductivities of 3-5 mS cm-1. The films therefore reveal the necessary properties for potential application in battery technologies.

PATENT APPLICATION

Number: 16/980,262

References

1. Yi E, and Temeche E, and Laine RM. , Superionically conducting Beta"-Al2O3 thin films processed using flame synthesized nanopowders J Mater Chem A, 2018, volume 6, issue 26, pages 12411-12419. https://doi.org/10.1039/C8TA02907E