SODIUM-ION CONDUCTING SOLID ELECTROLYTE MEMBRANE AND BATTERY THEREOF

IITM Technology Available for Licensing

PROBLEM STATEMENT

- In the Present era, both the Electric Vehicle (EV) & renewable energy sectors are heavily affected on the **safety issues** due to the use of Li-ion and Na- ion batteries.
- The problem can be resolved by using **solid electrolyte film** in such batteries.
- There are a few prior art solutions disclosed for Na-ion battery, however, could not resolve the issues related to poor mechanical stability, lower ionic conductive issues.
- Hence, there is a need to address said issues in efficient matter.

INTELLECTUAL PROPERTY

IITM IDF Ref. 2309; IN Patent No:414125

TECHNOLOGY CATEGORY/ MARKET

Technology: Solid Electrolyte Film ;
Industry & Application: Automobile & Transportation, ;
Market: The global Solid Electrolyte Film market is projected to grow at a **CAGR** of **15%** during **2024-2030.**

TRL (TECHNOLOGY READINESS LEVEL)

TRL-4, Proof of Concept ready, tested in lab.

TECHNOLOGY

- The present invention describes a room temperature rechargeable **sodium-sulphur battery** configured with a novel **solid electrolyte film.**
- The battery includes **an anode** comprising **sodium metal**, **a solid electrolyte film** comprising sintered $Na_3Zr_2Si_2PO_{12}$(**NZSP**) infiltrated with poly(vinylidenefluoride-co-hexafluoropropylene) (**PVDF-HFP**) polymer.
- The polymer comprises **12-20%** of the weight of the film.

IMAGE

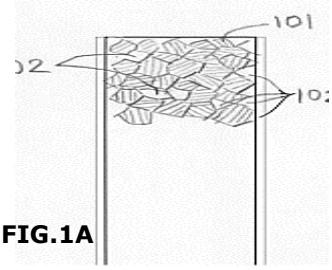

FIG.1A


FIG.1B

FIG.1A illustrates a schematic representation of NZSP solid electrolyte film;
FIG.1B illustrates image of fresh sodium metal.

- The polymer is configured to **absorb** a **solution of 1.5M NaClO4** in tetraethylene glycol dimethyl ether (TEGDME) to produce **a gel conductive of Na+ ions,** the electrolyte film is placed in contact with the anode, the **solid electrolyte film** has a ionic conductivity of ~**0.4 mS/cm²**.
- The battery further includes a cathode, said cathode comprises of carbon in contact with a catholyte prepared by dissolving stoichiometric amounts of **sodium sulfide (Na_2S)** & **sulpher** in **1.5M NaClO4/TEGDME**.
- The **sulphur** content is configured to be **0.1 mg µL-1 or lower**;
- The **sodium sulphide battery** further includes a **current collector**, coated with **95% acetylene black** & **5% PVDF-HFP** on a carbon fiber fabric laminated on the NSZP electrolyte film configured to **enhance interfacial contact** between cathode & the electrolyte.
- Further, a **method** of making a solid electrolyte film for sodium ion batteries is disclosed in **Fig. 2.**

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TECHNOLOGY

- Said method comprising following steps :

1st step states that synthesizing $Na_3Zr_3Si_3PO_{33}$ (NZSP) powder by a sol-gel method comprising formation of a sol & a gel;
2nd step states that dispersing the $Na_3Zr_2Si_2PO_{12}$(NZSP) powder in water with 5wt% polyvinyl alcohol to form a NZSP slurry;
3rd step states that tape casting the NZSP slurry over a sacrificial layer on a carbon fiber fabric substrate to form a NZSP sheet;
4th step states that heating the NZSP sheet to about 600°C to separate the sheet from the substrate;
5th step states that sintering the sheet at about 1000°C; & finally, infiltrating a sodium ion conducting polymer on to the sheet to **obtain** the polymer infiltrated solid electrolyte film.

KEY FEATURES / VALUE PROPOSITION

❖ *Technical Perspective:*

- The Sodium sulphide battery includes a current collector, coated with **95% acetylene black & 5% PVDF-HFP** on a carbon fiber fabric laminated on the **NSZP electrolyte film** configured **to enhance interfacial contact** between cathode & the electrolyte, thereby **ionic conductivity increases.**
- The infiltration of the polymer into the pores of the NZSP sheet provides **mechanical stability**, **enhances ionic conductivity & reduces surface contact resistance** of the solid electrolyte.
- The solid electrolyte has a **thickness** of **0.25 mm** or **less** & **ionic conductivity 0.4 $mScm^{-2}$** or **more.**

❖ *Industrial Perspective:*

- The **solid electrolyte film** finds **many application**, used as **carbon fiber cloth**, **gel electrolyte** & etc.
- The process of making a solid electrolyte film is **cost-effective, safe,** required **less energy** for manufacturing sodium-sulphur battery applicable in India & globally.

IMAGE

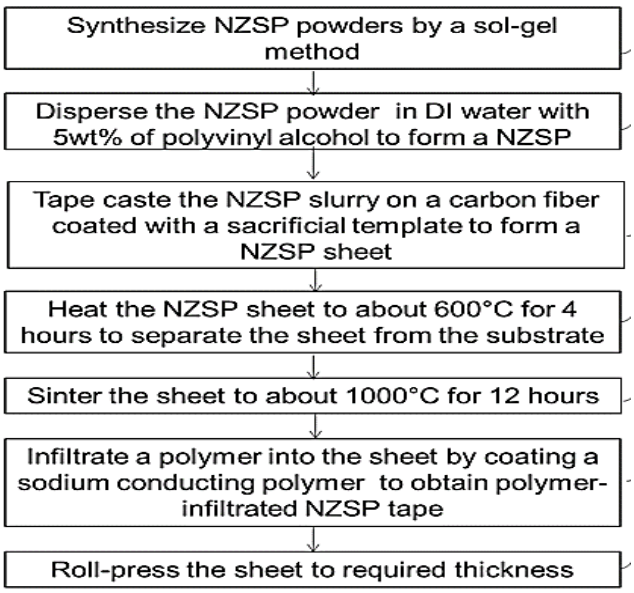

FIG.2 illustrating a flow chart of method of making a solid electrolyte film for sodium ion batteries.

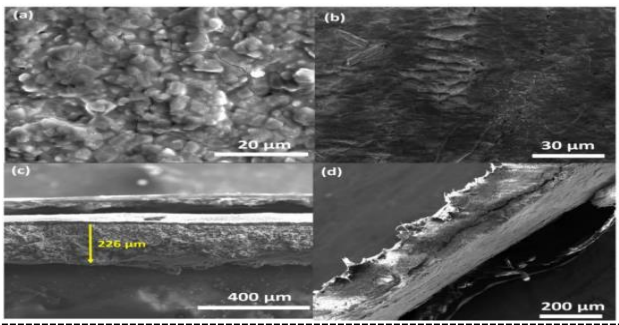

FIG.3 illustrating the X-ray diffraction pattern of polymer solid electrolyte film.

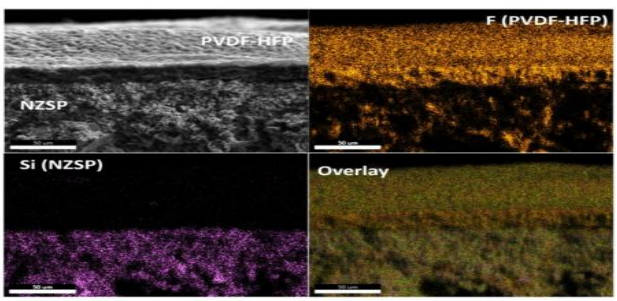

FIG.3 illustrating SEM images and elemental mapping of the solid electrolyte & cross section of NSZP/PVDF-HFP interface.

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