

【Grant-in-Aid for Scientific Research (S)】

Broad Section D



Title of Project : Dynamics of Composite Electrodes in All-Solid-State Ionics Devices

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Research Project Number : 18H05255 Researcher Number : 50137238

Keyword : Composite electrode, Ionic conductor, Solid interface, Mechanical properties

【Purpose and Background of the Research】

All-solid-state ionics devices are attracting attention. Among them, the inorganic solid electrolyte-type all-solid-state batteries are the ultimate energy storage device having high safety, high energy density, high output and long life. Beginning with the commercialization of all-solid-state batteries coming in the near future, the arrival of all-solid-state ionics device era such as all-solid-state capacitors and all-solid-state air batteries is predicted. With respect to the construction of the solid-solid interface, which is a problem unique to all-solid-state ionics devices, there are many problems that have not yet been dissolved. We have found "a phenomenon of room temperature pressure sintering" so far and succeeded in constructing a favorable solid-solid interface. On the other hand, there are almost no academic approaches to various problems associated with mechanical phenomena occurring during device operation despite its high importance. Currently, it is only an understanding of phenomena caused by substance alone such as volume change of the electrode active material itself, and the essence of dynamics in the entire electrode composite is not understood at all.

In this research project, we aim to establish an academic foundation on the solid interface, which is a common problem of all-solid-state ionics devices, such as clarification of tasks related to composite electrode dynamics and suggesting solutions from the viewpoint of materials research.

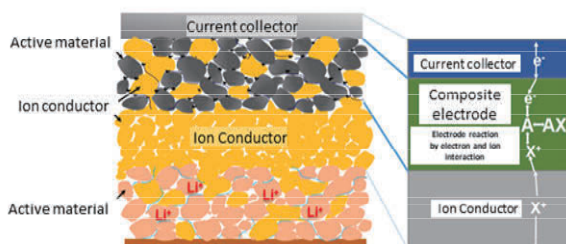


Fig. 1 Conceptual diagram of all-solid ionic device and the composite electrode.

【Research Methods】

We engage with the development of a method for quantifying the relationship between the structure and the electrical properties for the composite electrode, and the construction of a foundation for the properties of elastic and plastic regions of the composite electrode. Furthermore, we aim to create rubber elastic ionics materials and self-healing solid interfaces by plastic ionics materials. Mobile ions are not limited to lithium ion, but also sodium ion and the other ions. Also, we do comprehensively conduct research that contributes to solving common problems of electrode composites of all-solid-state devices, without limiting material types.

【Expected Research Achievements and Scientific Significance】

We are aiming to establish the foundation for "the construction and maintenance of the solid-solid interface" which is a common problem of all-solid-state ionics devices. These research on composite electrodes are an unexplored research field and thus the knowledge obtained here is extremely useful for a wide range of disciplines of engineering and other fields including material engineering and electrochemistry.

【Publications Relevant to the Project】

- A. Sakuda, A. Hayashi, M. Tatsumisago, "Sulfide Solid Electrolyte with Favorable Mechanical Property for All-Solid-State Lithium Battery", *Sci. Rep.*, 3-2261, 1-5 (2013).
- A. Hayashi, A. Sakuda, M. Tatsumisago, "Development of Sulfide Solid Electrolytes and Interface Formation Processes for Bulk-Type All-Solid-State Li and Na Batteries", *Front. Ener. Res.*, 4:25, 1-13 (2016).

【Term of Project】 FY2018-2022

【Budget Allocation】 143,400 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www2.chem.osakafu-u.ac.jp/ohka/ohka2/english/index.html>