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Functionality and Process Design of Electrodes for Energy Storage

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In order to realize electrochemical energy storage devices with improved properties, it is necessary to fabricate well-designed electrodes. During the operation of the energy storage device, the demanded electrochemical reactions, electric conduction as well as ionic transportation should proceed coherently while undesired side-reactions and volumetric change would occur. To achieve higher power efficiency, higher energy density and long operation life of the energy device, the elemental steps of whole charge-discharge reactions should be considered as well as the undesirable reactions and phenomena.
On the research to improve the electrochemical energy devices, we have been faced by many issues to be overcome to realize the electrode materials. On designing the micro/nanostructure of the electrodes, new approaches to fabricate the coherent electrodes. Here I will introduce some attempts we proposed for the electrodes.

1. Addition of electric conductivity to highly porous V_2O_5 aerogel

V_2O_5 aerogel is one of the potential candidates for battery cathode, due to its high capacity of energy storage, while the porous structure with fine V_2O_5 frame enhances the resistivity of low conducting V_2O_5, which causes high ohmic resistance during higher current loading. Addition of electric conducting pathway to the V_2O_5 aerogel was considered with the covering the V_2O_5 frame with electric conducting material. Conducting polymer was selected from the view point of ionic permeability and covering process as well as the conductivity.

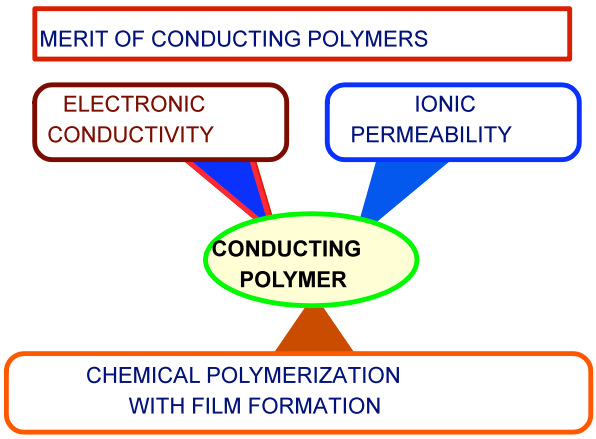

Fig. 1 Addition of electric conductivity to highly porous material.

2. Fabrication of composite material with Si nano-meter size cluster embedded in organic matrix

Based on an idea to fabricate a new material, co-deposition of two phases by simultaneous electroreduction was proposed. The material showed a high performance as an anode for Li battery as the expected properties with the concept of materials design.

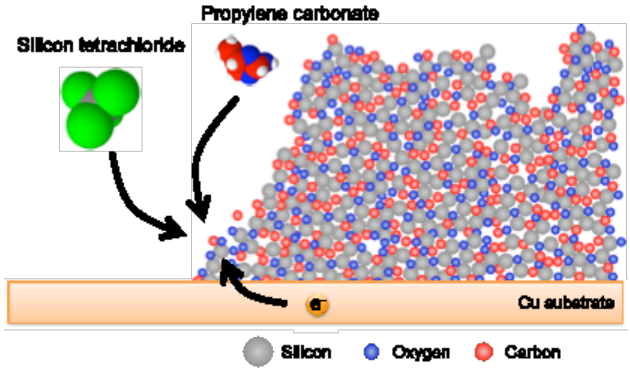

Fig. 2 Process design for composite material produced by electroreduction of organic species and metallic source.

Reference:

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[2] T. Momma, S. Aoki, H. Nara, T. Yokoshima, T. Osaka, *Electrochem. Commun.*, **13**, pp969-972(2011)