Conductivity of Lithium Battery Electrolyte under Influence of Milling Time

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Abstract
Research on Conductivity of Lithium Battery Electrolyte under Influence of Milling Time have been done. The electrolyte composite material is a mixed material from windows glasses or soda lime silica as matrix and Lithium Titanium Aluminum Phosphate (LTAP) as filler. Soda Lime Silica Glasses contain Na\(_2\)O 11.6\%, CaO 8.1\% and SiO\(_2\) 58.7\%. LTAP material mixed in the slurry of powder windows glasses with composition of weight percentage 75\%. The temperatures process for sintering of samples is above of glass transition at 600°C. Then samples quenched with liquid nitrogen. The variations of millings time are 0, 12, 24, 36 and 48 hour. On the SEM analyses the visual photos of composite surface give the pictures of particle size decreasing from powder materials. Soda lime silica can more good function as glue in the small particle. The other effects are decreasing of porosity and increasing of ionic conductivity.

Keywords: soda lime silica, LTAP, lithium battery, electrolyte, composite

Introduction
Lithium batteries work with a phenomenon of intercalation process from the transfer of lithium ion. This process occur in process of charging and discharging, like in Figure 1.\(^1\). Intercalation work in the electrodes of lithium batteries. A electrolyte deals of lithium battery is a medium for a migration of lithium ion.

<table>
<thead>
<tr>
<th>Sodium Electrode</th>
<th>Charge</th>
<th>Negative Electrode</th>
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<tbody>
<tr>
<td>Li(_{1-x})Ti(_x)(PO(<em>4))(</em>{3-x})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li(_{1-x})Ti(_x)(Al(_2)O(_3))(PO(<em>4))(</em>{3-x})</td>
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Fig 1: schematic process of charging and discharging in lithium battery.\(^1\)

The used electrolyte of lithium batteries is general in a basic of liquids materials in the market lithium batteries. Lithium per chloride (LiClO\(_4\)) is common used.\(^2\) In the new development of lithium batteries, solid polymer electrolyte (SPE) used as a composite material from ceramic and polymer material.\(^3\) High current capacity of lithium batteries needs high temperature resistant material, because a process of charging and discharging increases batteries temperature that is more quickly with high current capacity. High current batteries is usage in industry of automotive and UPS for communication.

One electrolyte candidate of Li\(_{1-x}\)Ti\(_x\)(PO\(_4\))\(_{3}\) (LTP) have high enough ionic conductivity which is around 10\(^{-3}\) S\(\text{cm}^{-1}\). Because LTP has NASICON crystal structure making its cationic free to move among interstitial place in the network. NASICON crystal structure is shown by Figure 2.\(^4\) This material LTP is basic structure of LTAP (Li\(_{1-x}\)Ti\(_x\)Al\(_2\)O\(_3\))(PO\(_4\))\(_{3-x}\)). In this experiment solid electrolyte is searched for target of above. Solid electrolyte is a composite material from LTAP with glasses metric. The raw material of glasses is windows glasses that are in technical term as Sodium Lime Silica.

Fig 2. Model of NASICON Structure.\(^4\)
Li\(_2\)O is included solid electrolyte base on lithium and have anti fluorite structure able to yield great number of cationic vacancy. Diffusion Li\(_2\)O can be done into structure and only causing a little