GS EL LLZO

Cubit Garnet type $Li_7La_3Zr_2O_{12}$ (LLZO) Solid Electrolyte for All Solid State Lithium Ion Battery

The battery capacity of currently used lithium ion battery is approximately 100 - 240 Wh/kg and rechargeable battery with higher capacity is expected. Furthermore, safer battery should be created since lithium ion battery is flammable due to its flammable electrolyte. In this regard, all solid state lithium ion battery is ideal since it can be robust and safe. The most important technology for this all solid state lithium ion battery is the creation of solid electrolyte in which lithium ion can move and transfer efficiently between cathode and anode during electrochemical reaction.

There are mainly two types of solid electrolyte and the one is the organic polymer based and the other is the inorganic type. In view of safety and robustness, inorganic solid electrolyte is ideal although the research history of inorganic solid electrolyte is not long compared to organic one and its safety, detail reaction mechanism is still unknown. However, due to its robustness, inorganic solid electrolyte is more favorable and aggressively challenged to be developed by many researchers. Solid electrolyte can be largely classified into sulfide based and the oxide base materials. There are numbers of research reports that sulfide based inorganic solid electrolyte based battery can possess higher capacity than oxide one although sulfide will cause toxic hydrogen sulfide when exposed to ambient air. Therefore, battery needs to be hermetically sealed and that manufacturing cost would be not economically friendly.

Thus, Green Science Alliance has been focusing on oxide based solid electrolyte because they are more stable, robust, manufacturing scalable than sulfide one. Oxide solid electrolytes mainly includes $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$(LATP) as NASICON type, $La_{0.34}Li_{0.51}TiO_3$ as perovskite type and $Li_7La_3Zr_2O_{12}$(LLZO) as garnet type. Especially LLZO exhibits high conductivity from 10^{-4} to 10^{-3} Scm^{-1} (theoretical value) even at room temperature. In addition, LLZO is the only stable oxide based solid electrolyte against Li metal. LLZO is cubic structure and conductivity is not that high at room temperature. However, it can be higher by doping with small amount of metal such as Al, Nb, and Ta, by stabilizing cubic structure. In this regard, Green Science Alliance Co., Ltd. has been successfully synthesizing Al doped LLZO which possess even higher conductivity.

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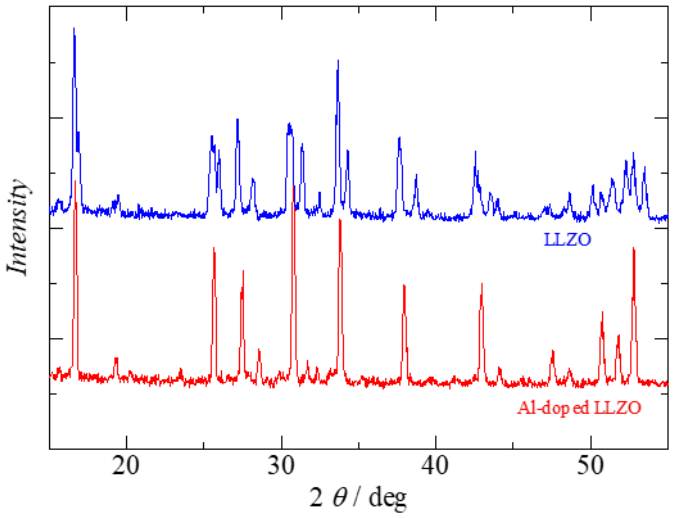
Green Science Alliance also synthesize various type of electrodes and can prepare small testing scale lithium ion battery internally in the company for our electrochemical measurement. So that various type of electrodes and ionic liquid based electrolyte which can be synthesized on our own, and combining with currently developed LLZO, we will try to further create next generation lithium ion battery including all solid state lithium ion battery. We will also analyze materials and prepared battery with analytical procedure such as electrochemical measurement, X ray diffraction pattern and electron microscopy etc…

This time, we will start supplying sample of LLZO powder, inks. The size of LLZO powder is larger than several micro meter at the synthesis although they can be as small as 200 - 300 nm with our nano size dispersion technology. We will further challenge to prepare even smaller LLZO. Please consult with us including technical detail anytime.

XRD : X-Ray Diffraction Pattern

It can be confirmed that Al-doped LLZO has also cubic garnet type structure.



AC Impedance

One can confirm that Al-doped LLZO has lower resistance (higher conductivity) than undoped LLZO. Measured conductivity is lower than theoretical value (10^{-4} から10^{-3} Scm^{-1}) with our technical data. However, this doesn't mean that our LLZO powder has lower conductivity. It could be suggested that lower conductivity is due to our immature technique of preparing LLZO pellet sample for accurate measurement.

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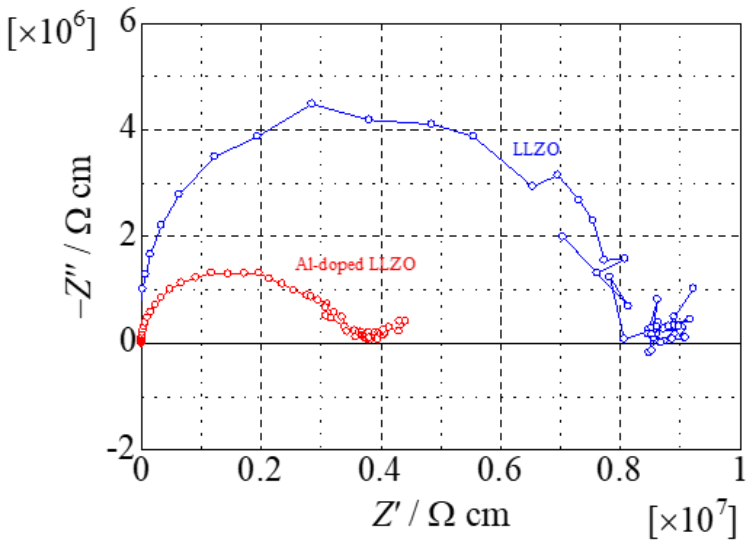

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