



Contribution ID: 51

Type: **not specified**

Innovative Technology for ${}^6\text{Li}$ Enrichment using Electrodeialysis with Lithium Ionic Conductor

Monday, 17 September 2018 16:00 (20 minutes)

Tritium needed as a fuel for fusion reactors is produced via neutron capture by lithium-6 (${}^6\text{Li}$). However, natural Li contains only about 7.8% ${}^6\text{Li}$, and enrichment of ${}^6\text{Li}$ up to 90% is required for adequate tritium breeding in fusion reactors. In Japan, lithium isotope enrichment methods have been developed to avoid the environmental hazards of using mercury. However, the isotope separation coefficient and efficiency is too low to meet the practical need of large mass production of ${}^6\text{Li}$.

Therefore, new Li isotope separation technique using a Li ionic superconductor functioning as a Li isotope separation membrane (LISM) have been developed. First of all, I investigated the ionic mobility of lithium isotopes in ionic superconductor. Combining the first principle and the kinetics Monte Carlo simulation, I calculate the diffusion constant of ${}^6\text{Li}$ and ${}^7\text{Li}$.

Furthermore, examinations of Li isotope separation using LISM with electrodeialysis were performed. Because the mobility of ${}^6\text{Li}$ ions is higher than that of ${}^7\text{Li}$ ions, ${}^6\text{Li}$ can be enriched on the cathode side of a cell. Using $\text{Li}_{0.29}\text{La}_{0.57}\text{TiO}_3$ (LLTO) as the Li ionic superconductor was prepared. After electrodeialysis, I obtained a maximum of 1.05 for the ${}^6\text{Li}$ isotope separation coefficient. This result showed that the ${}^6\text{Li}$ isotope separation coefficient of this method is the same as that of the amalgamation process using mercury (1.06).

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Session Classification: O1.B

Track Classification: Fuel Cycle and Breeding Blankets