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Ion Diffusion in Na Super Ionic Conductors (NaSICON)

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Lithium-ion (Li-ion) batteries are commonly used as energy storage device for both mobile and stationary applications. Even though the Li-ion technology is clearly a huge success story for modern electrochemistry, lately, there has been serious concerns regarding several aspects, e.g., availability and price of lithium raw material [1]. Consequently, the industry is currently and actively looking for alternatives to the Li-ion technology. Here one option might be to simply replace lithium with its neighbour in the periodic table i.e. sodium (Na) [2], which is a more abundant, accessible and less expensive element. A famous group of such compounds is the so-called Na Super Ionic Conductors (NaSICON). One of the materials within the NaSICON family that is known to have highly mobile sodium ions is $\text{Na}_{1+x}\text{Ti}_{2-x}\text{Fe}_x(\text{PO}_4)_3$ [3]. Electrochemical measurements have suggested that substitution of Fe for Ti results in higher capacity and better retention. Finally, our own studies [4,5] have revealed enhancements of the battery performance by introducing a nano-scale coating of carbon onto the submicron-sized NaSICON particles. However, the underlying mechanism for such effect is still partly unknown. In this study we have investigated the microscopic Na-ion self-diffusion in $\text{Na}_{1+x}\text{Ti}_{2-x}\text{Fe}_x(\text{PO}_4)_3$ using the muon spin rotation (μ^+ SR) technique [6,7]. We present values of both activation energy of the diffusion process as well as temperature dependent Na-ion self-diffusion coefficients (D_{Na}).

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