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Strategic design for oxide-based anode materials and the dependence of their electrochemical properties on morphology and architecture

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Modern technology-driven society largely relies on hybrid electric vehicles or electric vehicles for eco-friendly transportation and the use of high technology devices. Lithium rechargeable batteries are the most promising power sources because of its high energy density but still have a challenge. Graphite is the most widely used anode material in the field of lithium rechargeable batteries due to its many advantages such as good cyclic performances, and high charge/discharge efficiency in the initial cycle. However, it has an important safety issue associated with the dendritic lithium growth on the anode surface at high charging current because the conventional graphite approaches almost 0 V vs Li/Li^{+} at the end of lithium insertion. Therefore, a fundamental solution is to use an electrochemical redox couple with higher equilibrium potentials, which suppresses lithium metal formation on the anode surface. Among the candidates, $Li_4Ti_5O_{12}$ is a very interesting intercalation compound with safe operation, high rate capability, no volume change, and excellent cycleability. But the insulating character of $Li_4Ti_5O_{12}$ has raised concerns about its electrochemical performance. The initial insulating character associated with Ti4＋ in $Li_4Ti_5O_{12}$ limits the electronic transfer between particles and to the external circuit, thereby worsening its high rate performance. In order to overcome these weak points, several alternative synthetic methods are highly required.

Hence, in this presentation, novel ways using a synergetic strategy based on 1D architecture and surface coating will be introduced to enhance the kinetic property of Ti-based electrode. In addition, first-principle calculation will prove its significance to design Ti-based electrode for the most optimized electrochemical performance.

Keywords: Oxide, 1D nanostructure, anode, lithium rechargeable battery