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Can Na^+ Transport Faster Than Li^+ inside Zn-Sb Intermetallic Nanomaterials?

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Triggered by the recent exploration of alternative technologies to Li-ion batteries, sodium has strongly broken into energy storage research field thanks to the natural abundance and environmental benignity of sodium resources[1, 2, 3]. These advantages make Na-ion battery an attractive and potential alternative to the well established Li-ion battery. However, the development of Na-ion battery is currently a challenge because of potential disadvantages, including larger size of Na^+ and higher redox potential of Na/Na+ compared to Li analogues.

Here, an in-depth comparative study between the electrochemical de/lithiation[4] and de/sodiation of Zn_4Sb_3 nanowires has been conducted by using *in situ* transmission electron microscopy. Surprisingly, we found that sodium ions transport can be 10~100 times faster than lithium ion inside individual Zn_4Sb_3 nanowires. In addition, the cracks were often observed in the first few cycles during de/lithiation of the Zn_4Sb_3 nanowire. However, there was no crack formed even after dozens of cycles during their de/sodiation. Our *in situ* study indicates that the Zn_4Sb_3 nanowires exhibit much better rate capability and cyclablility in Na-ion battery compared to Li-ion systems. The underlying reason has also been addressed from the thermodynamic and kinetic aspects of ions transport in Zn-Sb intermetallics.

Reference:

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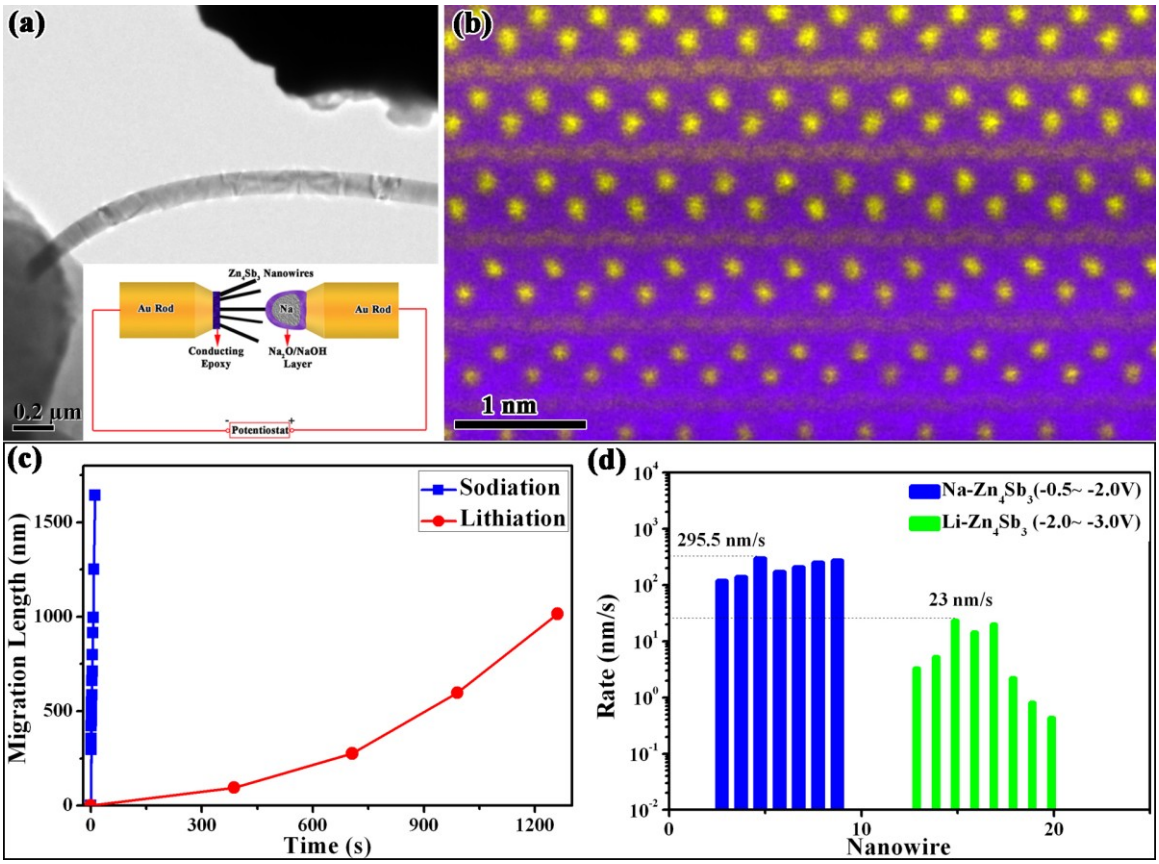

Figure 1. (a) Low-magnification TEM image of the *in situ* electrochemical testing setup and a schematic depiction of the nano-battery. (b) Atomic scale HAADF image of Zn_4Sb_3 nanowire taken with the [1-10] zone axis. (c) Typical reaction front travel distance *vs* time curves for sodiation and lithiation, respectively. (d) Comparison of sodiation and lithiation rates of Zn_4Sb_3 nanowires. Sodiation rates of Zn_4Sb_3 are about 10~100 times faster than their lithiation rates.