# $Na_2SeO_3$: A Novel Na-Ion Battery Cathode Material with High Capacity

Bizhe Su, Jiaolong Zhang, Denis Y. W. Yu
*School of Energy and Environment, City University of Hong Kong, Hong Kong, China*

E-mail: *subizhe@outlook.com*

Sodium ion batteries (SIBs) is a potential alternative to LIBs for large-scale energy storage system because of the advantages of Na in terms of cost and abundance. However, one of the challenges of SIBs is that the capacity of typical sodium-ion battery cathodes is low. In the case of LIB, its capacity can be increased to more than 200 mAh $g^{-1}$ by utilizing both the cationic and anionic redox processes in the material (i.e. Li-excess materials). Similar Na metal oxides such as $Na_2RuO_3$[1] and $Na_2IrO_3$[2] were also recently suggested to involve oxygen participation during charge and discharge. This raises hope that high-capacity Na-ion cathodes can be found. In this work, we study the possibility of using $Na_2SeO_3$ as cathode material for SIB. $Na_2SeO_3$ has a monoclinic (P 1 21/c 1) structure with 1D ion-channels for Na transport. Theoretical study has also shown that the $O_{2p}$ electrons predominate the vicinity of the Fermi level in the material, which makes it possible to provide anionic redox [3].

Experimentally, commercial $Na_2SeO_3$ is made into electrode and tested at 10 mA $g^{-1}$. When the electrode is first charged to 4.8 V, a voltage plateau near 4.5 V *vs*. $Na/Na^+$ with a capacity of 98 mAh $g^{-1}$ is observed (see Fig. 1a). When it is discharged to 1.5 V, a capacity of 52 mAh $g^{-1}$ is obtained. This indicates that the material is electrochemically active. The capacity is found to depend on particle size. 1st discharge capacity is increased to 158 mAh $g^{-1}$ after ball milling with 400 rpm for 4h. By substituting Ti into $Na_2SeO_3$, 1st discharge capacity is further improved to 171 mAh $g^{-1}$. Despite the high capacity that is achieved, reversibility is still poor. We are in the process of studying the effect of different parameters such as particle size, electrolyte, surface coating, and chemical composition etc. on the cycle performance of the material. In addition, characterizations such as XPS and XRD are being conducted to understand the charge-discharge mechanism of the material. These will be presented at the meeting.

**References:**

[1] M. Tamaru et al. Electrochem. Commun. 33 (2013): 23-26.
[2] A. J. Perez et al. Chem. Mater. 28.22 (2016): 8278-8288.
[3] www.materialsproject.org

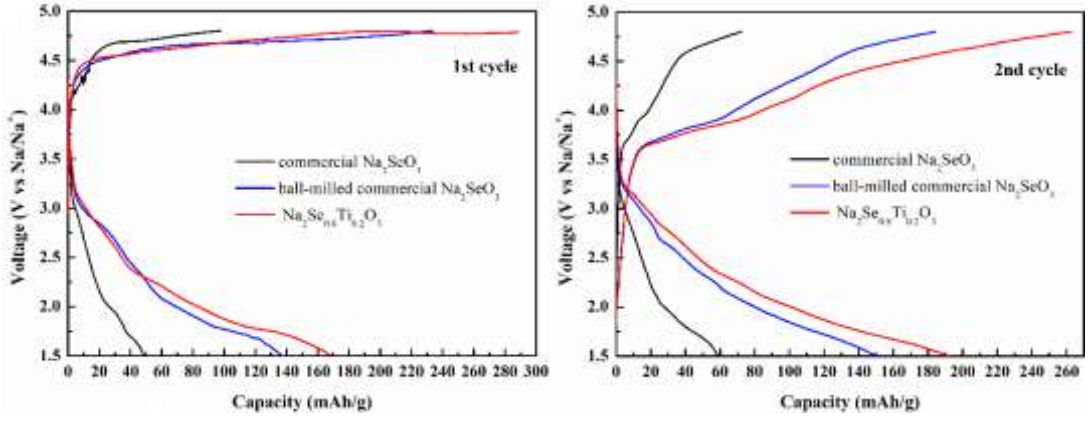


Fig. 1. First and second charge/discharge curves for commercial $Na_2SeO_3$, ball-milled commercial $Na_2SeO_3$, $Na_2Se_{0.8}Ti_{0.2}O_3$ samples in the voltage range of 1.5-4.8 V at 10 mA $g^{-1}$.