

## Silicon nanocomposites induced highly conductive matrix as anode materials for Li-ion batteries

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For the last two decades, Li-ion batteries have been the predominant power sources for electronic mobile devices, and have been widened their application to electric vehicles and power storage unit. Among various materials, silicon and tin based alloys have attention as candidates of anode materials for Li-ion battery. Especially, silicon has been intensively investigated as anode materials for lithium ion batteries because of its higher theoretical capacity than the current commercialized anode materials. The large capacity of silicon comes from the alloying reaction between lithium and silicon, which is up to a composition of  $\text{Li}_{3.75}\text{Si}$  at room temperature. However, these alloy-based materials suffer from drastic volume changes during alloying-dealloying reaction, which lead to the loss of electrical contact between the active materials and current collector. To solve this issue, various attempts have been pursued and some notable improvements were achieved including active-inactive matrix concept.

In this study, highly conductive inactive matrix is induced to provide electrical pathway to active materials of silicon during lithiation and delithiation. Also, inactive matrix was finely dispersed and provided wide contact area by mechano-chemical synthesis.

Fig. 1a shows the X-ray diffraction (XRD) patterns of silicon composite milled with commercial TiN. Fig. 1b and 1c show the XRD patterns of mechano-chemically synthesized composite and simple mixture, respectively. From XRD results, the crystal size of Si phase decreased and N-precursor phase decomposed during the mechano-chemical reaction, which meant that Ti-precursor reacted with N-precursor and fine distributed TiN matrix was formed. Through the thermodynamic calculation, it was confirmed that the reaction between Ti-precursor and N-precursor was more active than that of Si with Ti-precursor or N-precursor.

Fig. 2 shows the voltage profiles of Si nanocomposite at various rates. The first coulombic efficiency at 0.1C was ca. 80% and the rate capability of discharge capacity (2C/0.2C) was about 96.7%. The electrochemical performance indicated that highly conductive inactive matrix was well-distributed within Si nanocomposite and provided good electrical path to active Si phases.

### Reference

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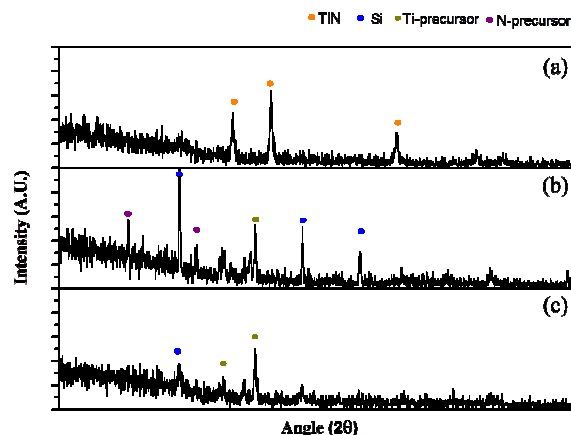


Fig 1. X-ray diffraction patterns of (a) Si/TiN, (b) simple Si mixture and (c) Si nanocomposite.

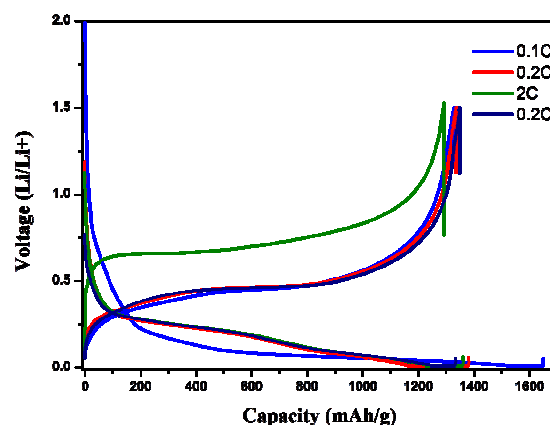


Fig 2. Voltage profiles of Si nanocomposite at various rates.