# 首届致远学术节
# 学生科研成果展示

## Silicon anode materials for lithium-ion batteries with high initial Coulombic efficiency and Long cycle life

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**Key words**: lithium-ion battery, silicon anodes, initial Coulombic efficiency, carbon coating

### *Background*

With the rapid development of electronic devices, human society calls severe need for higher energy density batteries that are also durable and economic.

For lithium-ion batteries, silicon have become highly promising because of its high theoretical capacity, relatively low operating potential and abundant amount in nature. However, silicon have its own challenges to overcome. Firstly, during its lithiation and delithiation process, it will have a huge volume change (~300%) leading to its pulverization and then peeling off from the electrodes. Secondly, the huge volume expansion will lead to the fracture of the Solid-Electrolyte-Interphase (SEI) film. Due to these obstacles, the electronic performance will decay rapidly after several cycles. Porous silicon microparticles (pSiMPs) can relieve the huge volume expansion efficiently, but its high surface area also leads to low initial Coulombic efficiency.


### *Goal*

Through developing porous silicon carbon composites, we aim to increase the **cycling stability and initial Coulombic efficiency (ICE)** of silicon anode materials.

### *Method*

We developed a exterior carbon coating method on pSiMPs with pore size of ~2.8nm. The external opening pores can be easily closed by carbon during coating process, which reduce the surface area and prevent surface oxidation. In this method, we also limit the carbon ratio of the composites to 5.8 wt% and decrease its irreversible reactions with $Li^+$, which is a good way to increase the initial Coulombic efficiency and cycling stability of silicon anode materials.

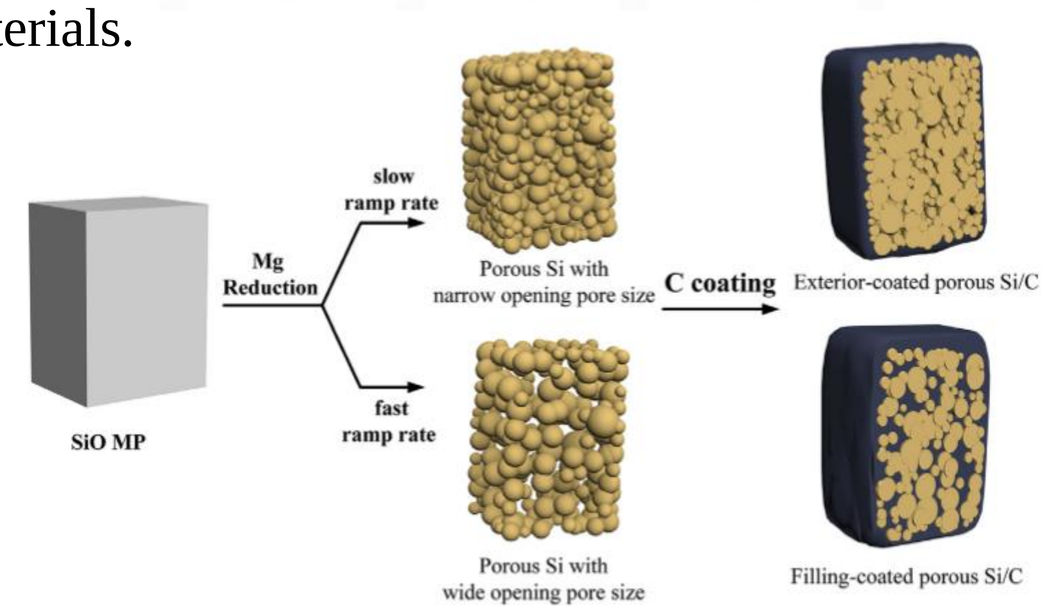



**Figure** Fabrication of carbon-coated Si/C composites through different ramp rate

### *Results*

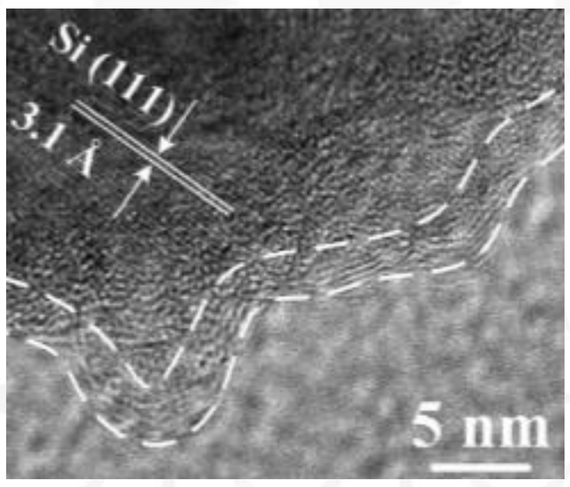
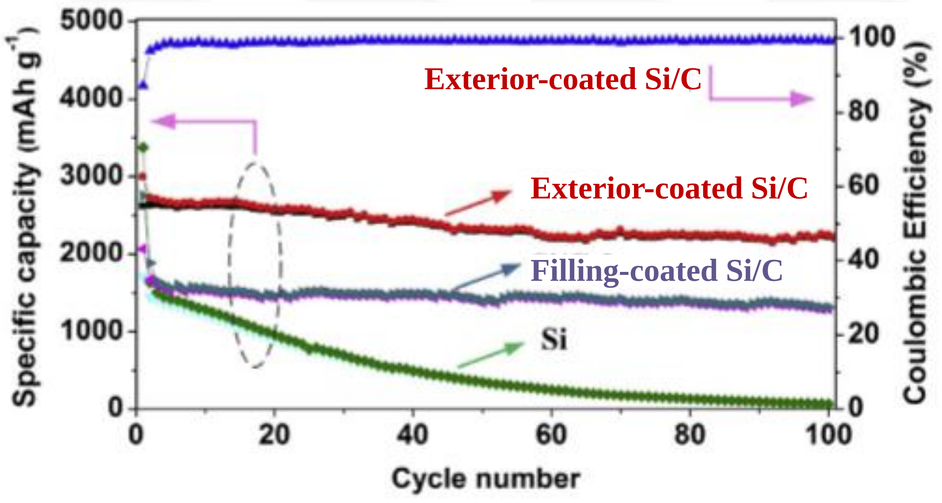



**Figure** TEM image of exterior-coated Si/C



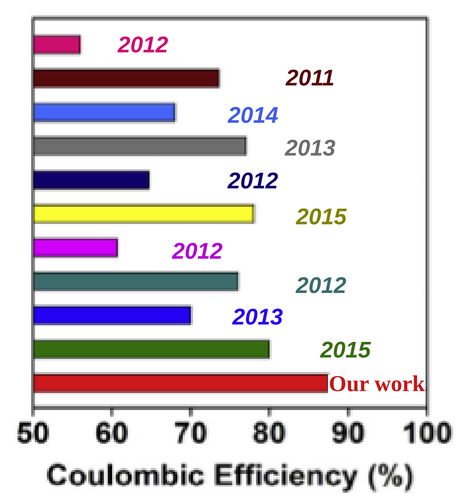




**Figure** Cycling performance of two kinds of Si/C composites and our ICE compared with previous work

The ICE of the exterior-coated Si/C reached **87.5%** with a high reversible capacity of **2242 mAh $g^{-1}$** at 0.4A $g^{-1}$ after 100 cycles and also long-term cycling stability(885 mAh $g^{-1}$ at 2A $g^{-1}$ after 500 cycles).

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