PAUL SCHERRER INSTITUT

ELECTROCHEMISTRY LABORATORY

BATTERIES

Si/C Composite as Additive to Graphite for High-Energy Li-Ion Batteries

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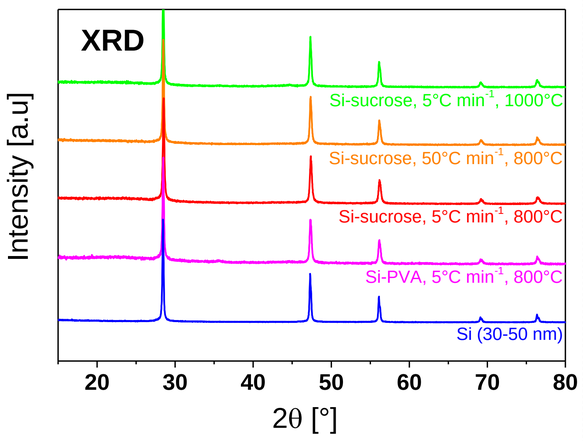
Background of the Study

- Silicon (3580 mAh/g) is a promising candidate to upgrade graphite (372 mAh/g) in negative electrodes.
- **Si/C composites** were prepared from ball-milling of silicon with a carbon precursor, followed by carbonization for 2h in argon flow.
- Si/C were used as **additive to TIMREX® KS6 graphite** electrodes.

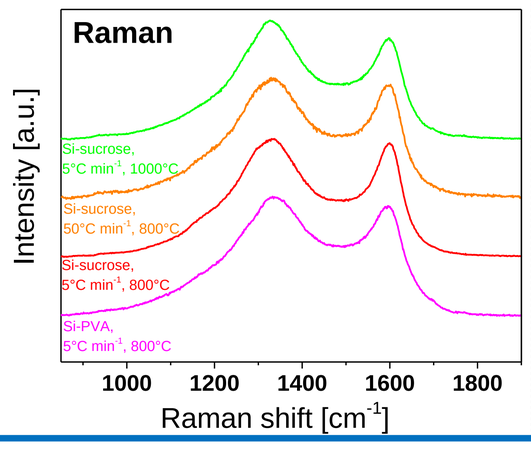
Color	Carbon source	Temperature	Heating rate
	Polyvinyl alcohol (PVA)	800° C	5° C/min
	Sucrose	800° C	5° C/min
	Sucrose	800° C	50° C/min
	Sucrose	1000° C	5° C/min

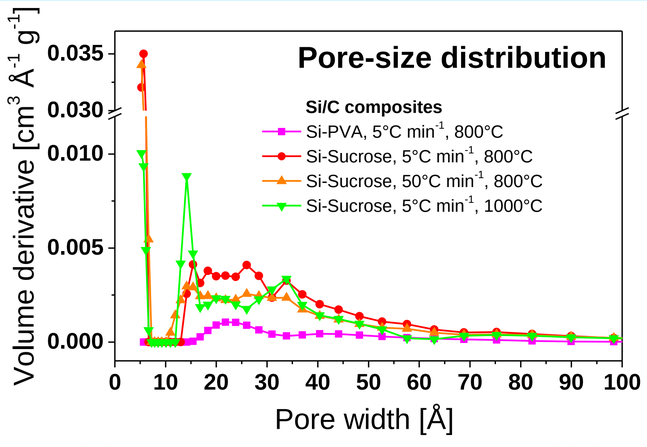
Si/C Composite Properties



- Si crystallinity maintained during synthesis process
- No remaining precursors

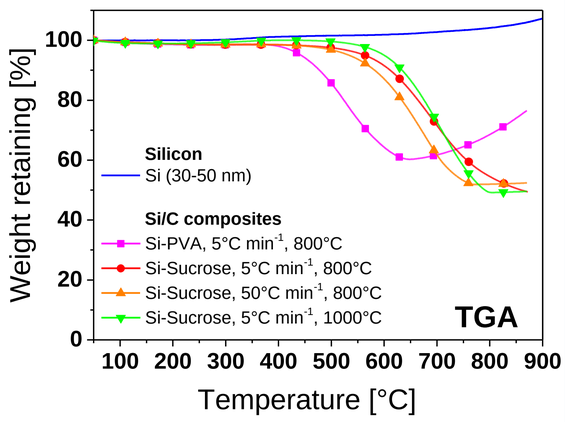
- Amorphous carbon with nanocrystalline graphitic domains
- At 50° C/min: lower carbon coverage



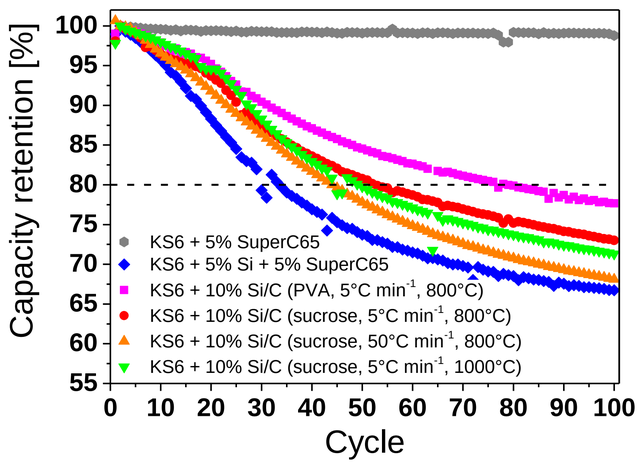


- With sucrose: mesopores and bi-modal micropore distribution; small micropore collapse at 1000° C
- With PVA: few pores, no small micropores

- With sucrose: ca. 50% Si
- With PVA: difficult estimation due to strong Si oxidation; earlier C combustion



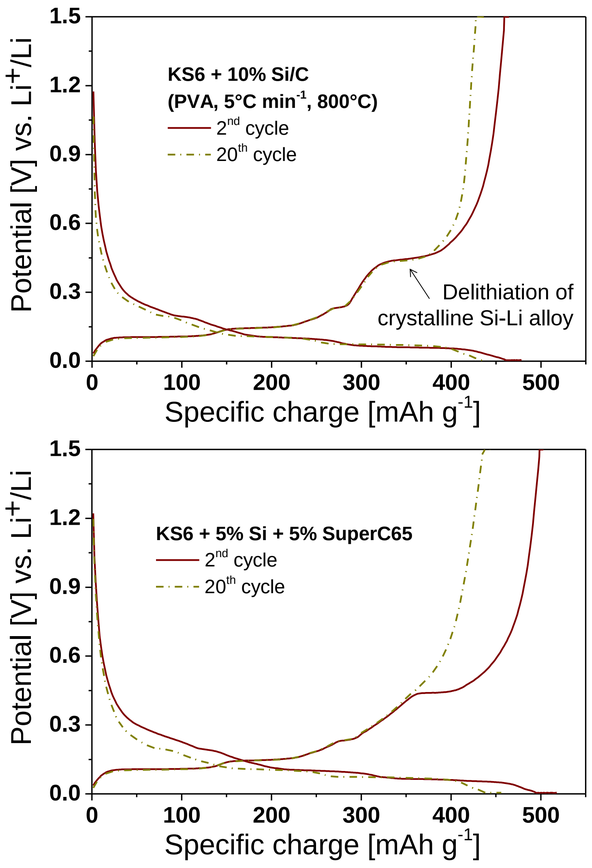
Cycling Performance and *ex-situ* Cross-Sectional SEM

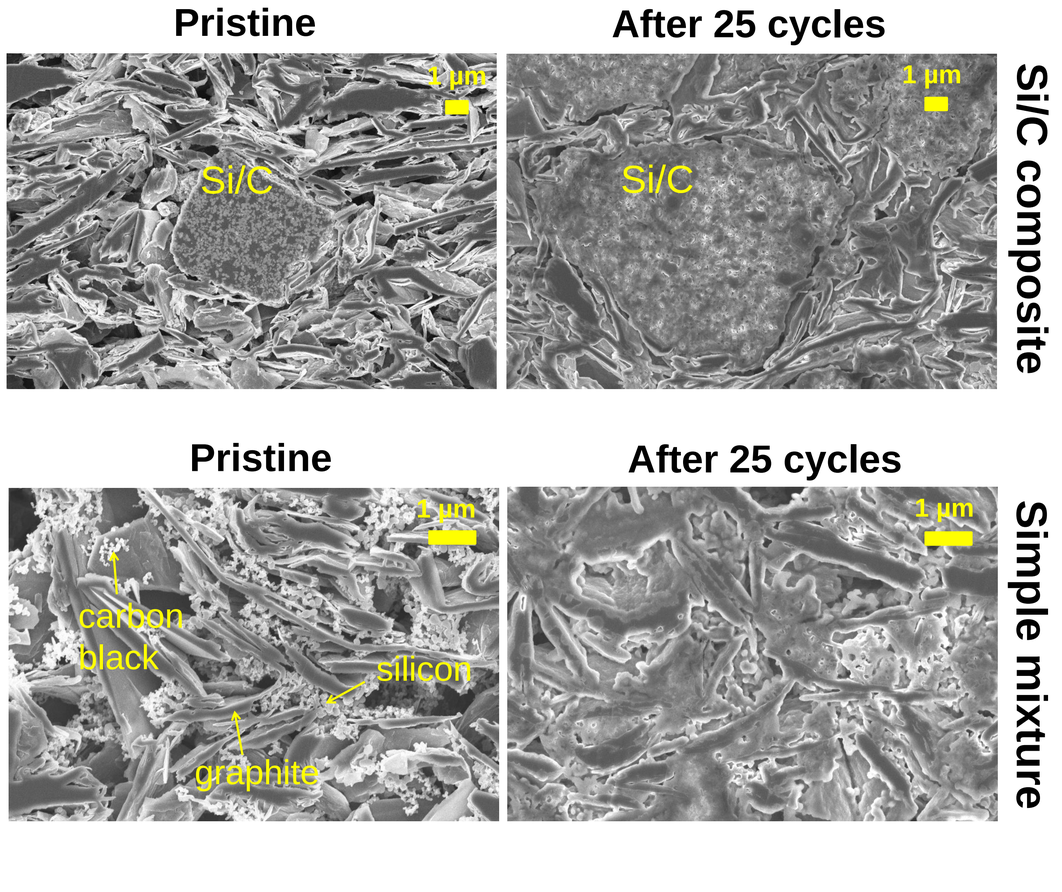


With Si/C-containing electrodes

- Better capacity retention, depending on C matrix properties
- Full lithiation of Si achieved for several cycles

thanks to better maintained contact between Si and C





Conclusions

- **Si/C properties can easily be tuned** by varying the synthesis conditions.
- Embedding Si in a C matrix allows the **preservation of the electrical contact** within the electrode despite volume changes occuring upon cycling.
- The use of **PVA as carbon source** leads to the longest cycle life.

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