PAUL SCHERRER INSTITUT

ELECTROCHEMISTRY LABORATORY

BATTERIES

IMERYS Graphite & Carbon

Electrochemistry of Carbon/Silicon Electrodes

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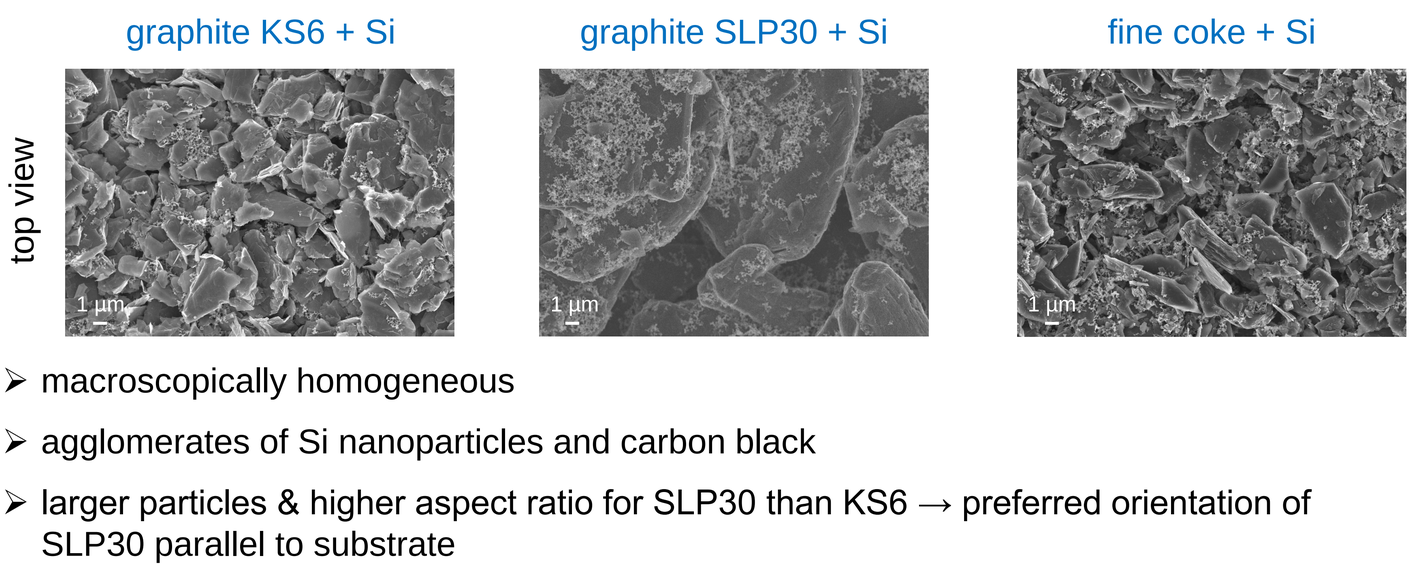
Motivation / Targets

- develop carbon based anode material with specific charge > 450 mAh/g by addition of small amounts of silicon
- compatibility with common industrial processes
- understand influence of different electrode components

Experimental

- 4.75 wt% Si, 90.25 wt% intercalating carbon, 1 wt% SuperC65, 4 wt% binder
- for comparison: 95 wt% intercalating carbon, 1 wt% SuperC65, 4 wt% binder
- 20 mA/g first cycle, following 50 mA/g between 5 mV and 1.5 V vs. Li^+/Li
- 1M $LiPF_6$ in EC/DMC 1:1 (w:w) unless stated otherwise

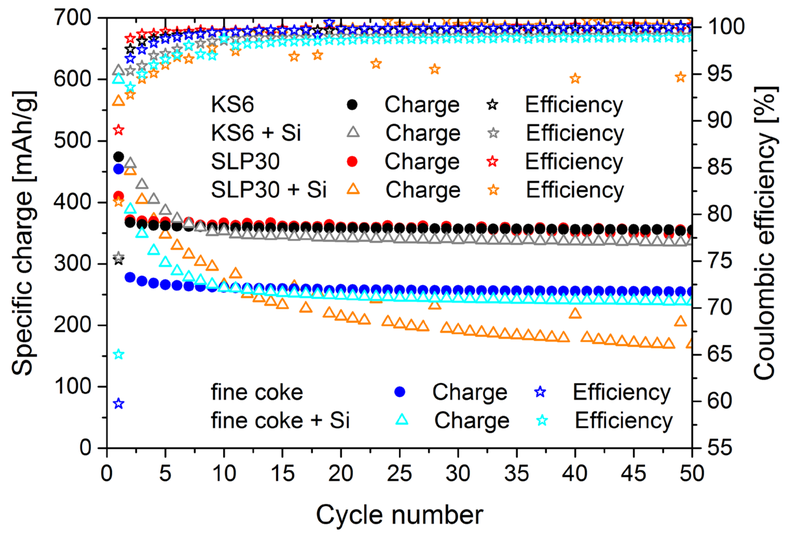
Morphology



- ➢ macroscopically homogeneous
- ➢ agglomerates of Si nanoparticles and carbon black
- ➢ larger particles & higher aspect ratio for SLP30 than KS6 → preferred orientation of SLP30 parallel to substrate

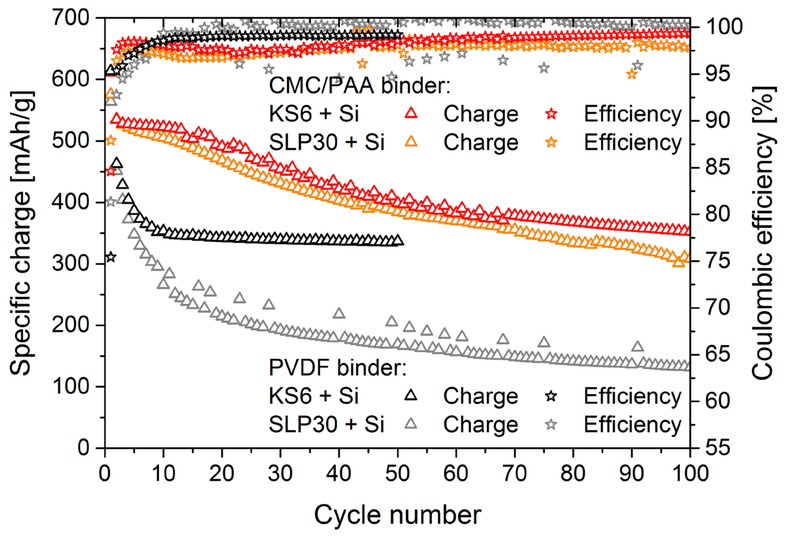
Role of carbon material

PVDF binder



- ➢ only carbon contributes towards specific charge after ~10 cycles
- ➢ SLP30/Si electrodes: Si negatively affects cycling of graphite part

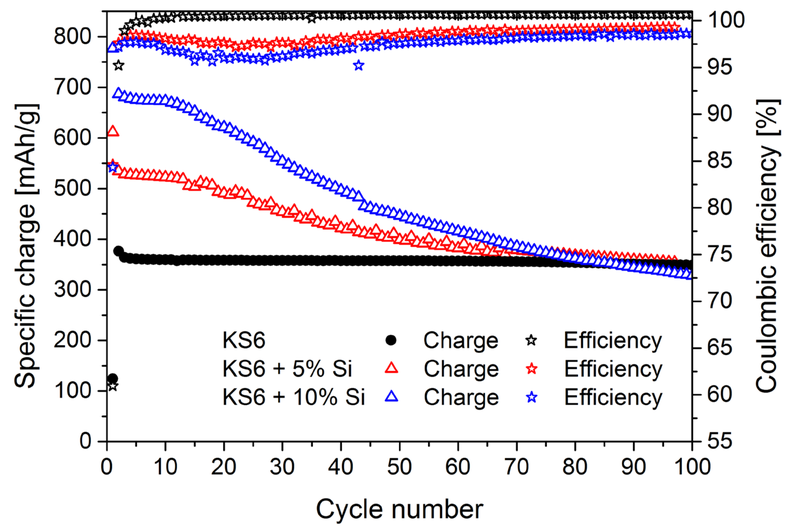
Binder influence



- ➢ using CMC/PAA: improved cycling stability for both KS6 and SLP30 based electrodes containing Si

Graphite/Si ratio

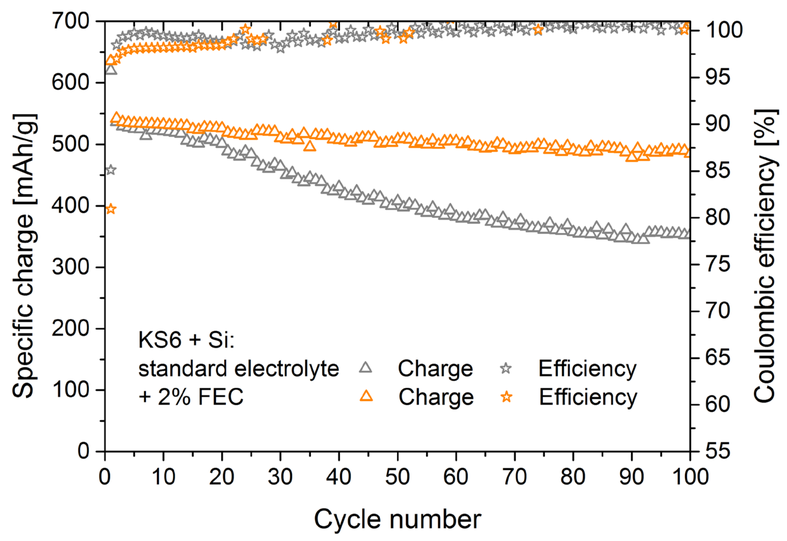
CMC/PAA binder



- ➢ higher specific charge for first cycles with 10 % Si – but stronger fading

FEC electrolyte additive

CMC/PAA binder



- ➢ enhanced cycling stability in presence of fluoroethylene carbonate (FEC)

Conclusions

- ➢ KS6: best of the different types of intercalating carbon for combination with Si
  - better cycling stability than SLP30 based electrodes
  - compared to fine coke, less Si is needed to obtain same specific charge
- ➢ binder and electrolyte have strong influence on cycling stability

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