PAUL SCHERRER INSTITUT

ELECTROCHEMISTRY LABORATORY

BATTERIES

Dual performance electrodes for Li-S and Li-ion batteries

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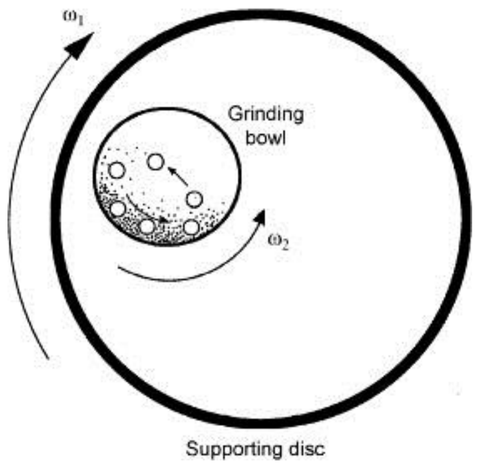
Properties & challenges

- **Lithium-sulfur batteries**, properties & challenges:
  - Safety, low-cost, high energy density
  - Insulating sulfur particles
  - Polysulfide shuttle
- **Lithium-ion batteries**, properties & challenges:
  - Most common energy storage system
  - Low theoretical energy density compared to Li-S and Li-air

Synthesis

Synthesis of:

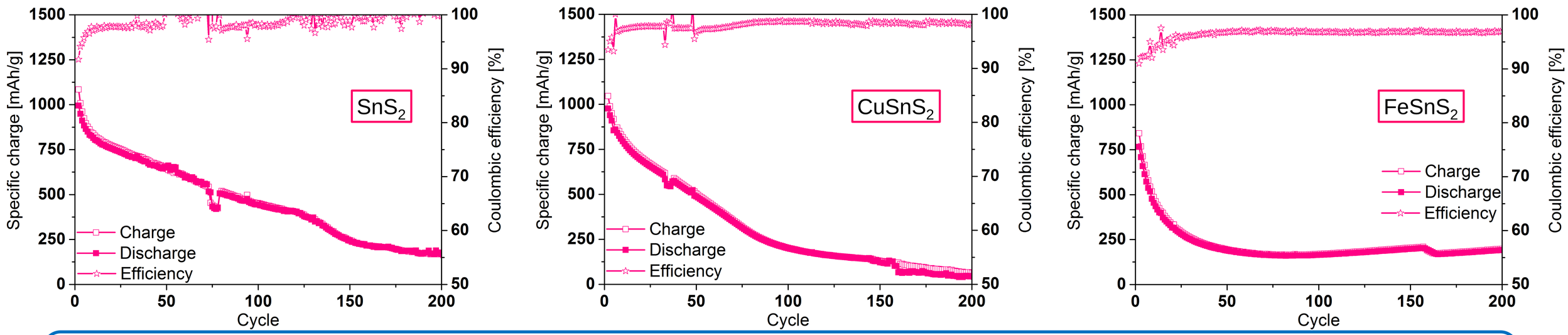
- SnS_2 (reference sample)
- $CuSnS_2$
- $FeSnS_2$



Synthesized by ball milling:

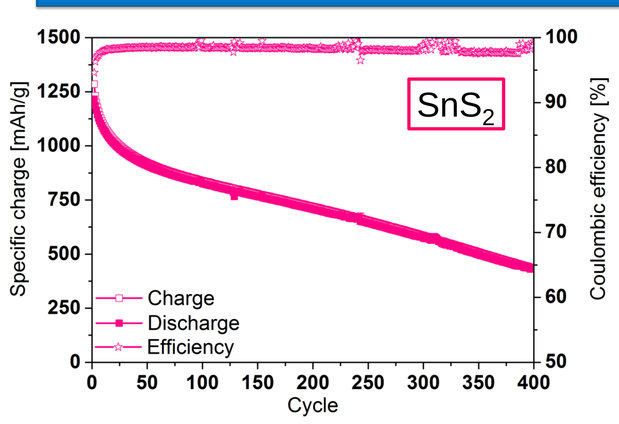
→ Local temperature > 1000ºC
→ Small particles → Materials amorphous
→ Electrode composition 80/10/10 (active material/PEO/Super P)

Electrochemical behavior: 5 mV-2.7 V

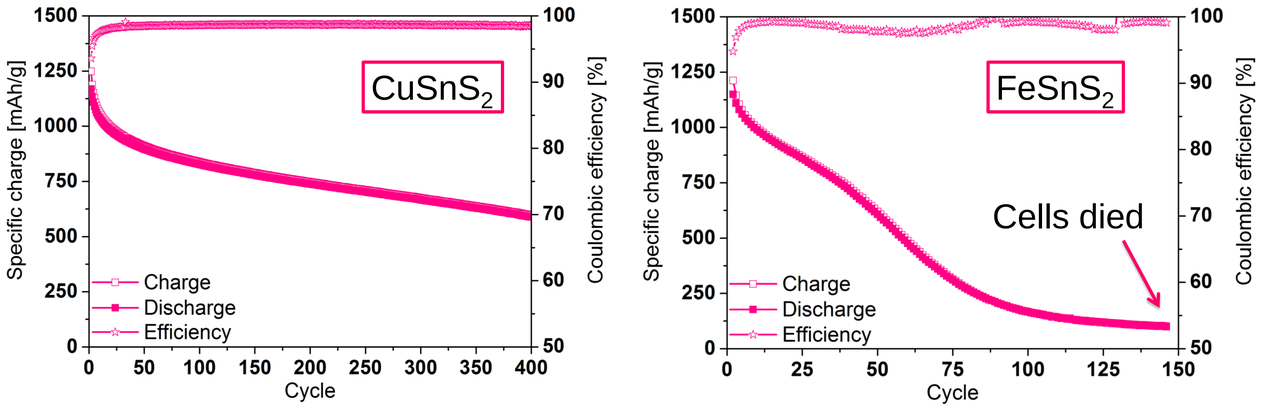


→ Electrodes cycled with LP30 electrolyte @ 1-C rate
→ Strong fading, due to i) polysulfide dissolution in the electrolyte, ii) volume change of lithiated Sn
→ **Strategy**: cycling Sn in its active potential window with LP30 and sulfur in its active potential window with LiTFSI

Electrochemical behavior: 5 mV-1 V

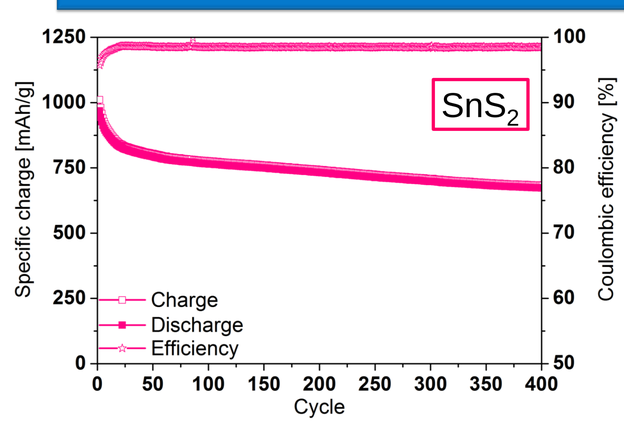


→ Electrodes cycled with LP30
→ Specific charge calculated by active mass of Sn

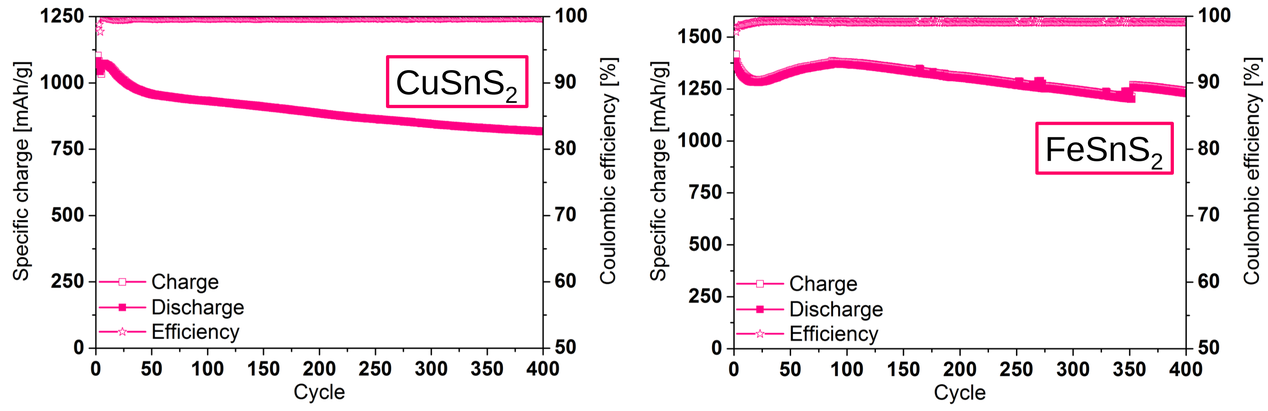


→ Coulombic efficiency > 98%
→ Significant fading for $FeSnS_2$, Fe buffers less volume change?
→ Less possibility to have intermediate phase with Fe?

Electrochemical behavior: 1.2 V-2.7 V



→ Electrodes cycled with LiTFSI
→ Specific charge calculated by active mass of S



→ Coulombic efficiency > 98%
→ More fading for SnS_2 and $CuSnS_2$
→ Fe helps to stabilize polysulfides shuttle?

@ C-rate	SnS_2		$CuSnS_2$		$FeSnS_2$	
Cycle N°	1st	200th	1st	200th	1st	200th
[0-2.5 V]	**1500**	**250**	870	50	870	200
[1.2 V-2.5 V]	1000	750	1100	850	**1450**	**1200**
[0 V-1 V]	1200	700	**1250**	**750**	1250	-

Conclusions

Sulfur/composite electrode:
→ Impressive specific charge in Sn window; volume change buffered
→ Sulfur window: stable charge; polysulfide dissolution rate decreased

Acknowledgments

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