

Recent electrode and electrolyte developments for Lithium-Sulfur prototype cells and their present and future applications

S. Dörfler^{1*}, H. Althues¹, T. Boenke^{1,2}, F. Schmidt^{1,2}, M. Fiedler^{1,2}, F. Reuter^{1,2}, S. Kirchhoff^{1,2}, A. Korzhenko³, P. Härtel¹, B. Schumm¹, T. Abendroth¹, S. Kaskel^{1,2}

¹Fraunhofer Institute for Material and Beam Technology IWS, Dresden, Germany

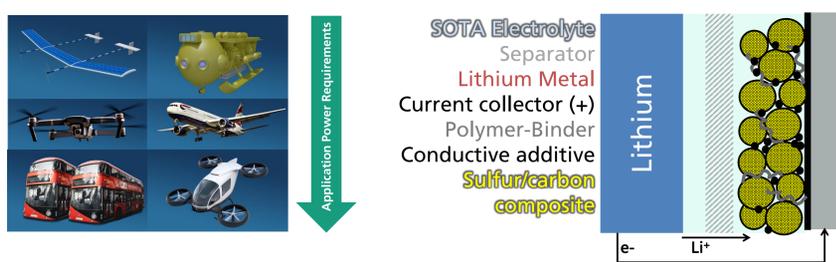
²TU Dresden, Chair for Inorganic Chemistry I, Dresden, Germany

³Arkema France, Groupement de Recherche de Lacq, Lacq, France

*Corresponding author: susanne.doerfler@iws.fraunhofer.de

Motivation

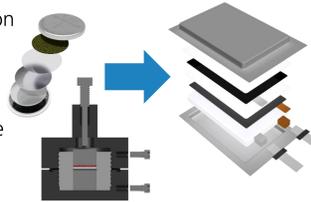
- Recent Li-S battery prototype cells: 400 – 470 Wh/kg
- Various applications are discussed
 - High specific energy is mostly required
 - Future applications require high power density



Challenges

- Increasing of energy density (gravimetric & volumetric)
- Evaluation of components in prototype cells

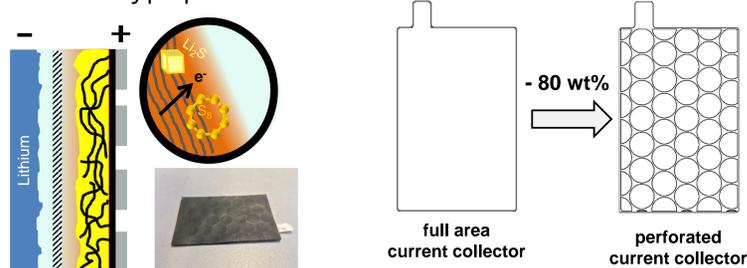
- Pressure distribution
- Lithium and electrolyte excess
- Areal electrical contact of electrode
- Powder distribution
- Thick SE layers
- Pressure application while cycling
- High material quantity & R2R processing
- Electrolyte filling / cathode swelling
- Processing of thin solid state separator layer
- Welding and cutting processes



IWS solutions

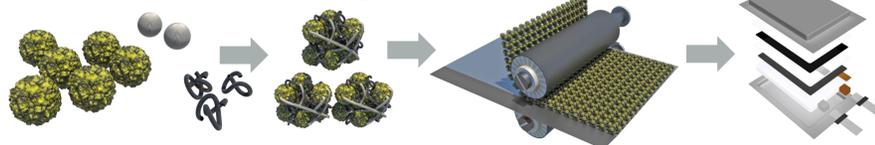
High power freestanding cathodes

- Perforated current collector on thin, highly conductive CNT Buckypaper cathodes

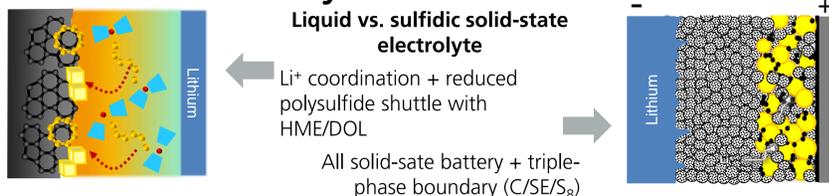


High energy solvent-free dryfilm cathodes

- Solvent-free R2R electrode processing via proprietary DRYtraec® technology



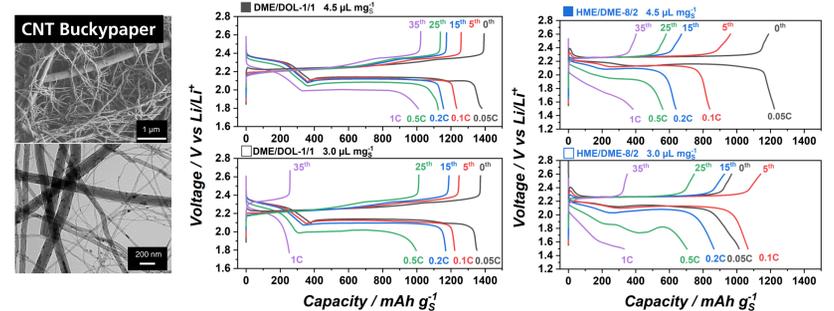
Electrolytes with sparing polysulfide solubility and sulfidic solid electrolyte



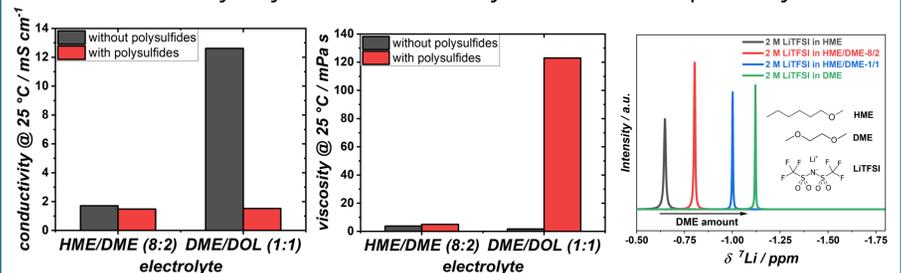
Cell design adaption

High power CNT cathodes

- Rate capability of CNT cathode in ether-based electrolytes strongly depend on electrolyte excess

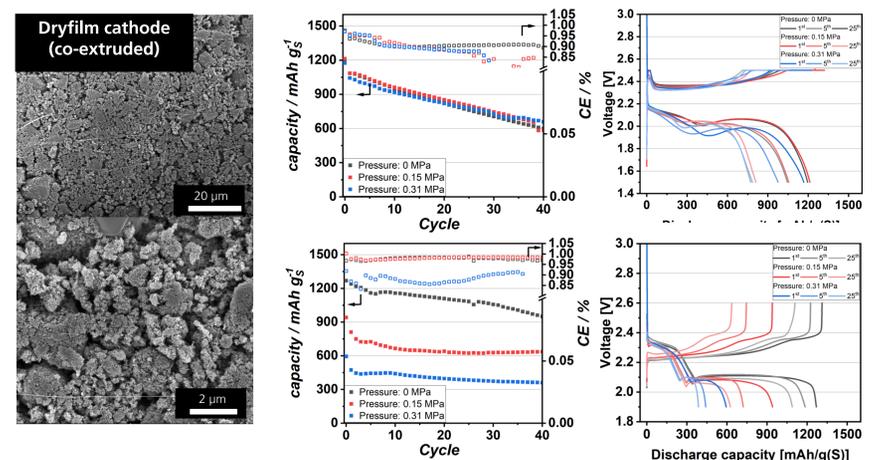


- The amount of polysulfides that can be dissolved in the respective electrolyte affects strongly the ionic conductivity, dynamic viscosity, and rate capability



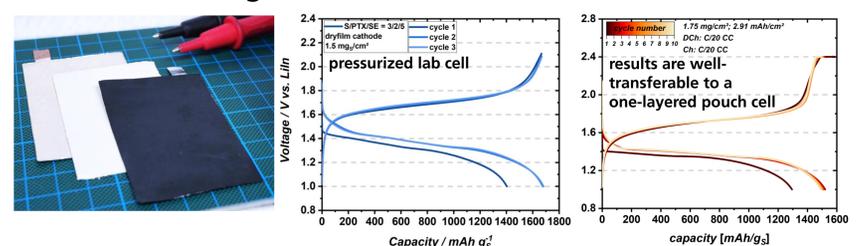
Dense dryfilm cathodes for high energy densities

- The performance of co-extruded high-density cathodes (Printex XE2B, 0.9 g/cm³) strongly depends on polysulfide solubility of ether-based electrolytes when different uniaxial pressures are applied



All solid-state Li-S batteries with thiophosphate-based electrolyte

- Dryfilm cathodes with high reversible discharge capacity > 1600 mAh/g-S at low E:S ratio (1.6)



F. Schmidt et al. Journal of Physics: Energy 2022, 10.1088/2515-7655/ac4ee3

S. Dörfler et al. Energy Technology 2020, 10.1002/ente.202000694

T. Boenke et al. Batteries and Supercaps 2021, 10.1002/batt.202100033

This work has received funding from the Federal Ministry of Education and Research (BMBF), support code HiPoLiS (03XP0178A), LISA (GA814471), SoLiS (03XP0395A), SkaLiS (03XP0398C).