evs 27

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EUROLIS - European lithium sulphur cells for automotive applications

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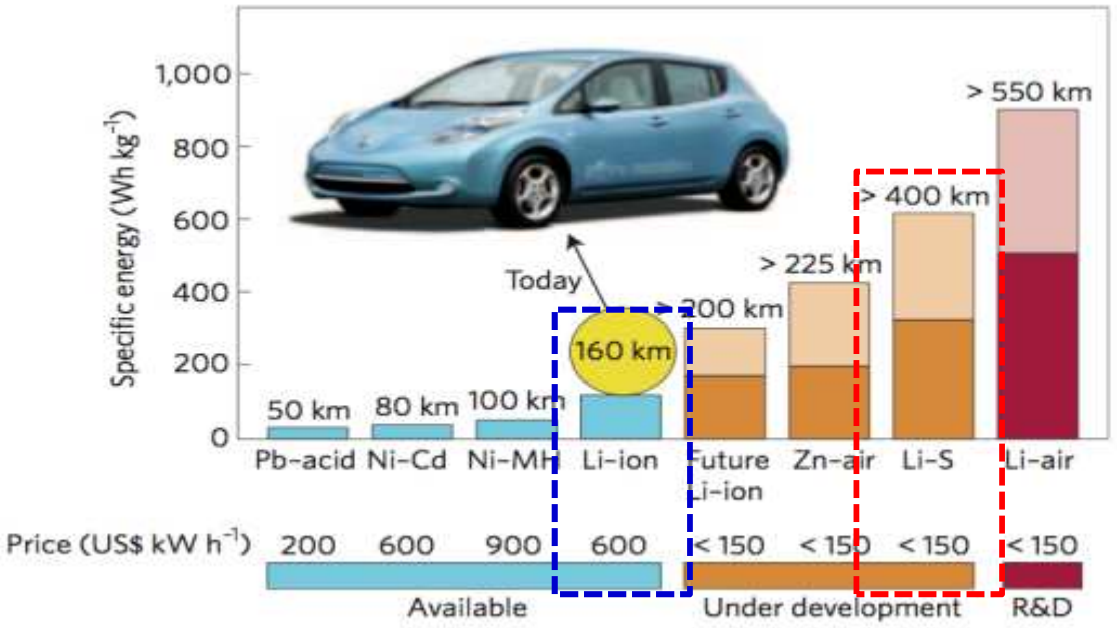
Why Li-S batteries?



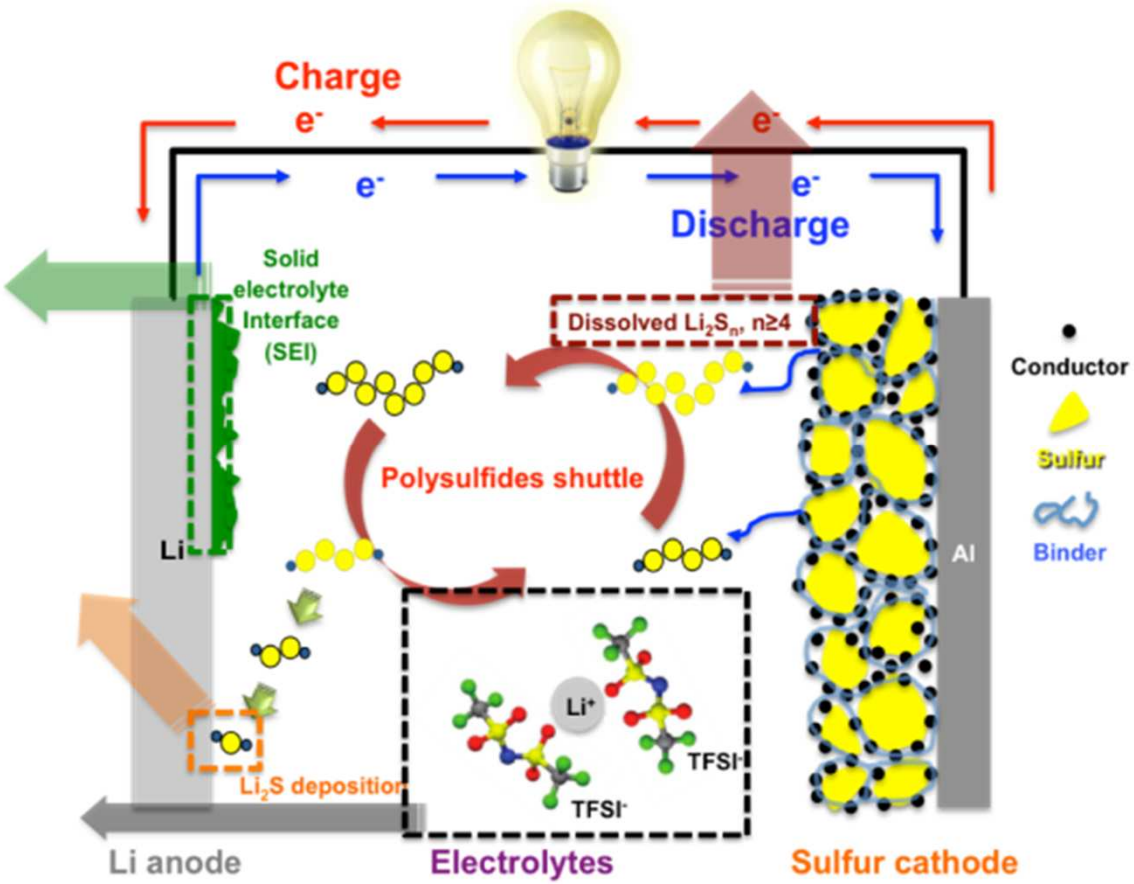
P. G. Bruce et al. Nature materials 11 (2012) 19-29

- Sulphur:
  - 32.06 g/mol
  - 2.07g/cm^3
  - Non-toxic, “green” material
  - Abundant, cheap (28 US$/ton)
  - Theor. Cap.: 1,675 mAh/g

Cathode materials for LiB and Li-S

Material	Theoretical Capacity (mAhg^{-1})	Specific Capacity (mAhg^{-1})	Relative Price
$LiCoO_2$	275	130-140	1
Li-NMC	~270	150-160	0.59
Li-NCA	~270	170-180	0.89
$LiMn_2O_4$	148	100-120	0.26
$LiFePO_4$	170	140-150	0.37
S	1675	200-1200	0.006

Basics of Li-S batteries

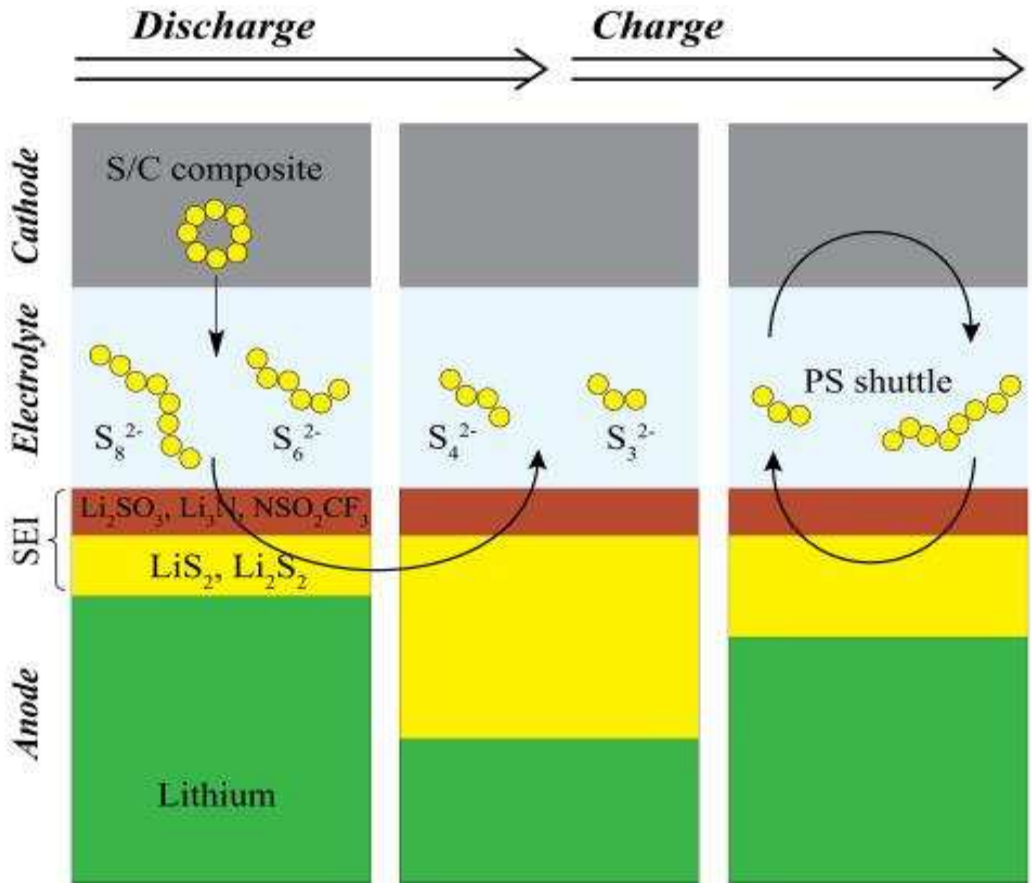


- @ Anode: $2Li \Rightarrow 2Li^+ + 2e^-$
- @ Cathode: $S + 2e^- \Rightarrow S^{2-}$
- Overall: $2Li + S \Rightarrow Li_2S$
- Cell max: 2.15 V

- $Li_{(s)}$: 3,860 mAh/g
- $S_{8(s)}$: 1,675 mAh/g

- => 2567 Wh/kg & 2800 Wh/l
- Today: > 350 Wh/kg (cell)

Problems of Li-S batteries vs. Li-ion batteries



- S an insulator – S/C composites
- Many many reactions…
- How to control the solubilities?
- Low C rates – often C/10

$$S_8 + 16Li^+ + 16e^- \rightarrow 8Li_2S$$

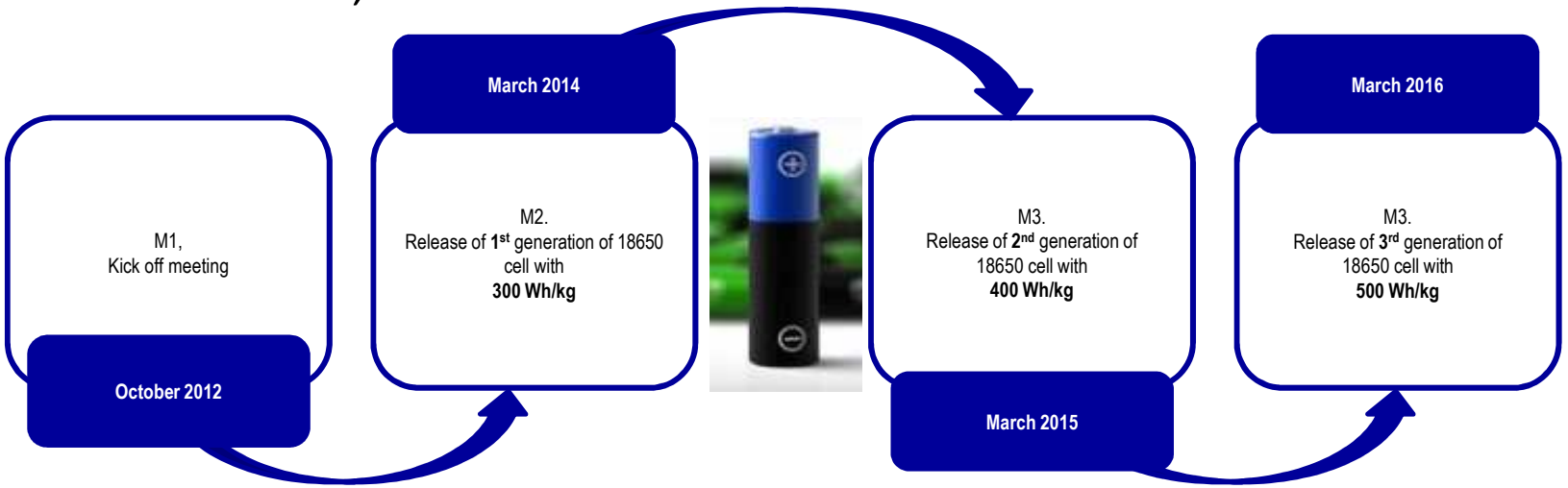
$$4S_8^{2-} \rightarrow 4S_6^{2-} + S_8$$
$$2S_8^{2-} \rightarrow 2S_4^{2-} + S_8$$
$$S_8^{2-} + S_6^{2-} \rightarrow 2S_3^{2-} + S_8$$

$$S_6^{2-} \rightarrow 2S_3^{\cdot-}$$
$$S_6^{2-} + 2e^- \rightarrow 2S_3^{2-}$$

$$S_3^{\cdot-} + e^- \rightarrow S_3^{2-}$$
$$2S_3^{2-} + e^- \rightarrow S_3^{2-}$$

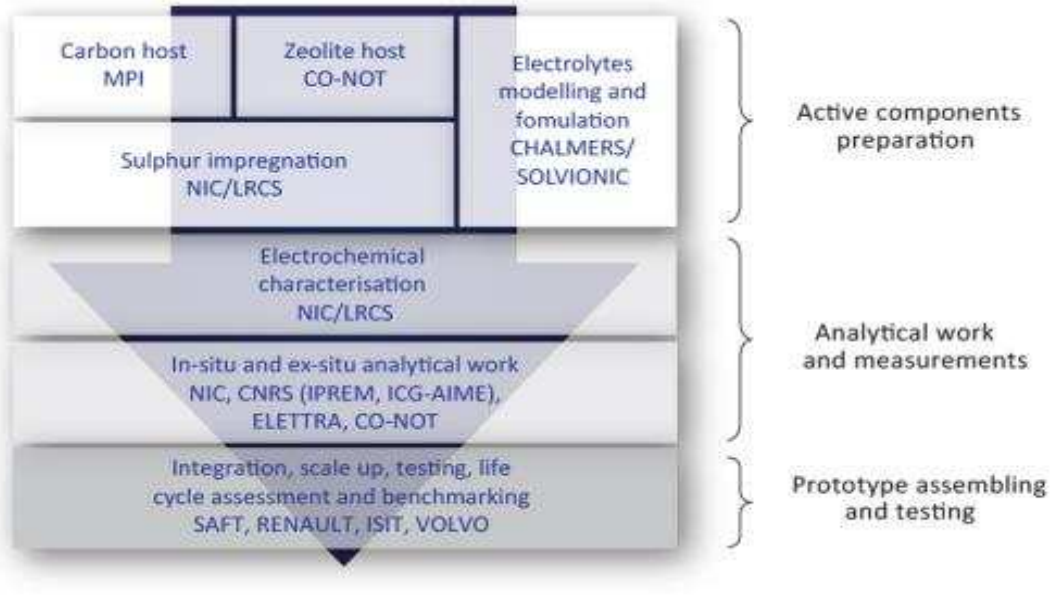
The Eurolis project

- “Advanced European lithium sulphur cells for automotive applications”
- FP7 Program: Theme 4 – NMP – Nanosciences, Nanotechnologies, Materials and New Production technologies
- GC.NMP.2012-1 Innovative automotive electrochemical storage applications based on nanotechnology, FP7-2012-GC-MATERIALS
- 1/10 2012 + 48 months, 3.8 M€



Eurolis Aims & Layout

- 500 Wh/kg & 1000 W/kg for normal operation.
- Charge eff. > 95 % (cycle life) & temp. range -25 - +80 deg. C
- Durability for automotive industry; 5 years and 1000 cycles
- Safety standards and low costs: i.e. a maximum 150€/kWh



Eurolis Partners

- Coordination – NIC Slovenia
- Battery – SAFT
- Vehicles – Renault, Volvo

- Basic research & development – materials focus

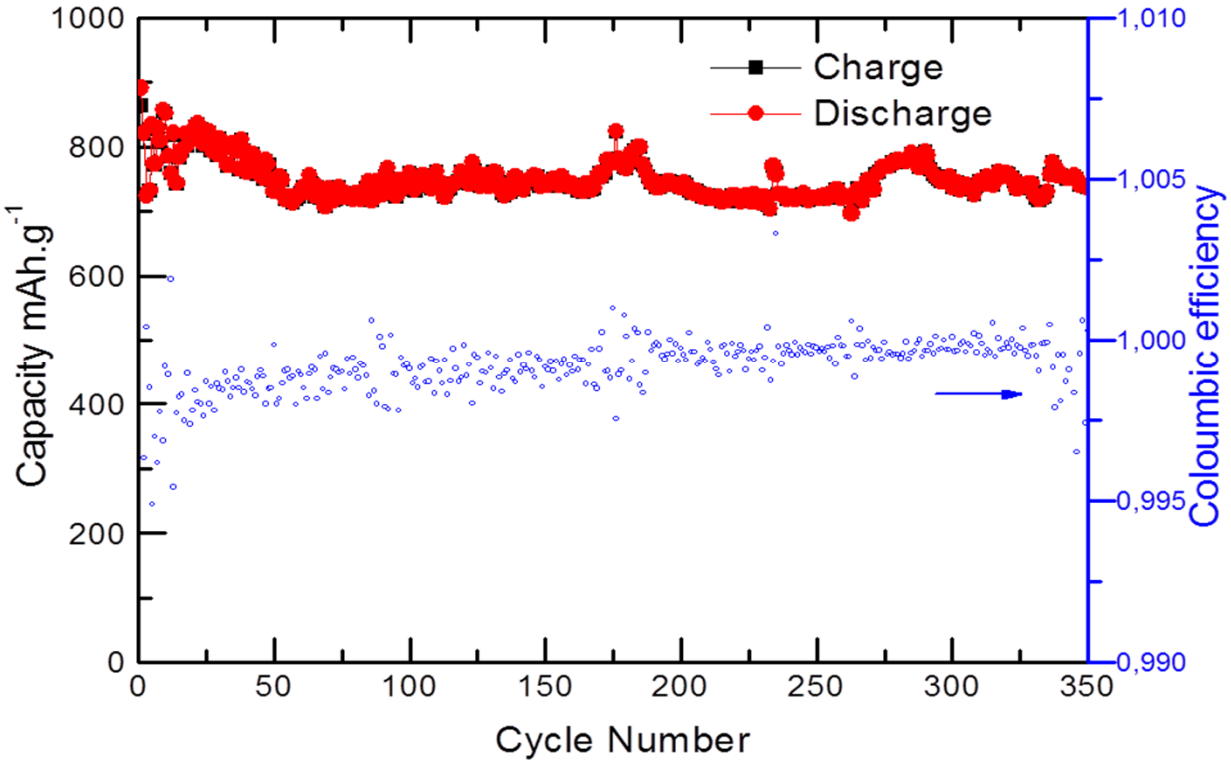
Eurolis Approach to Li-S

- Composite cathodes to disperse S, high surface area of mesoporous C
- Functionalization of outer surface of C particles
- Alter the PS solubility via polymeric solvents and ionic liquids
- Look at life-cycle analysis, re-cycling and eco-design issues

- Create new analytical techniques for reliable monitoring of Li-S batteries
- Develop simulation approaches to Li-S electrolytes
- Aim at understanding the mechanisms needed for stable battery operation
- Compare alternative configurations of Li-S batteries

Some 1st results…

- ΔV=1.5 V, C/10 rate, ion selective separator:

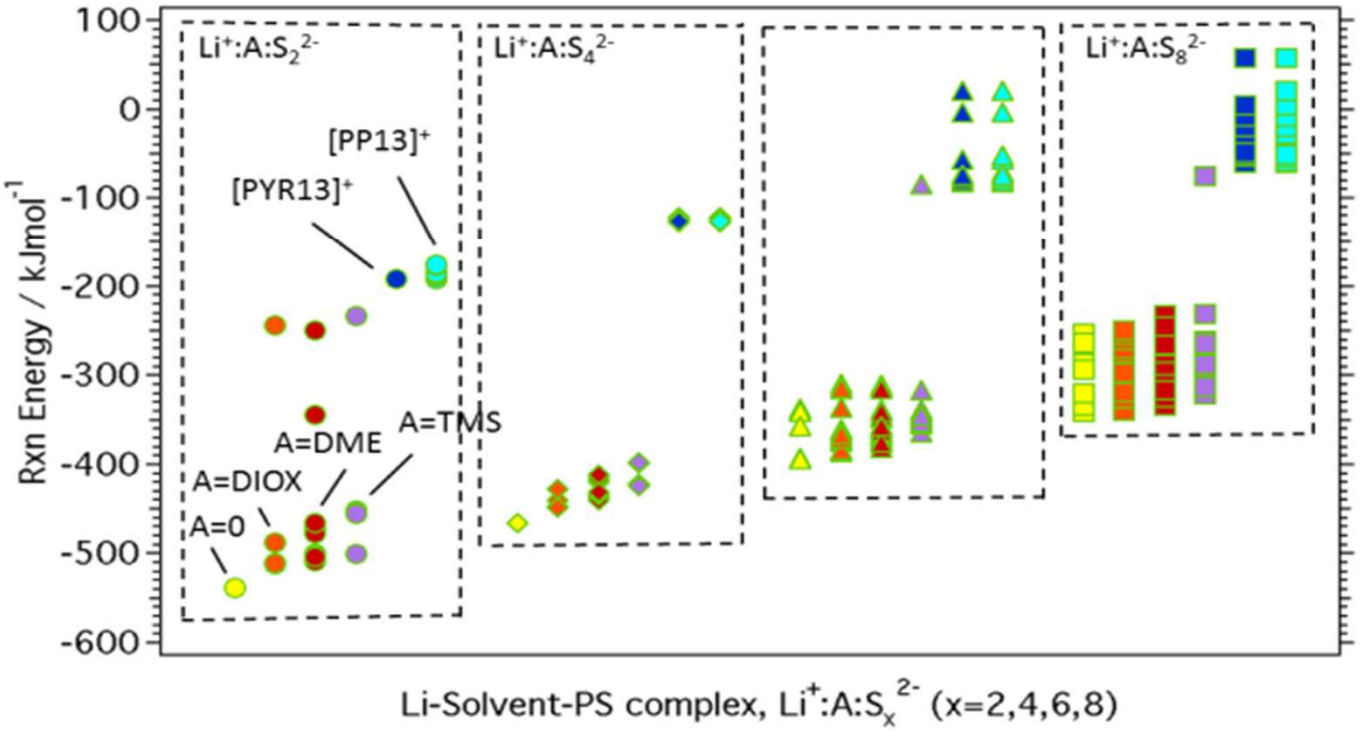


Some 1st results…

Interactions of solvent-PS complexes ($A:S_x$) with Li^+

$Li^+:TFSI^- + A:S_x^{2-} \rightarrow Li^+:A:S_x^{2-} + TFSI^-$; A = DIOX, DME, TMS

$Li^+:TFSI^- + A^+:S_x^{2-} \rightarrow Li^+:A^+:S_x^{2-} + TFSI^-$; A = PYR13, PP13



- Modelling development – pretty far from EV application…

Questions & More information

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