

# A new era in batteries: Polymer Lithium Sulphur

ENGINE EXPO 2012



Next Generation Battery Power

*Safe, affordable high energy batteries, powering  
the revolution in transportation*

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Customer Brand Manager*



# Introduction

- OXIS has been a leading player in the evolution of the next generation of battery technology since 2004.
- Recently announced a \$24 million investment by Sasol
- Developed Polymer Lithium Sulphur - extremely lightweight and safe.



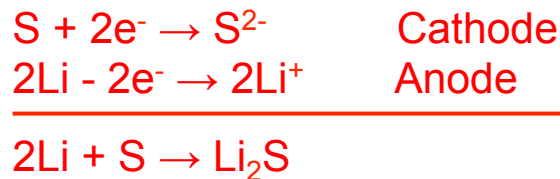
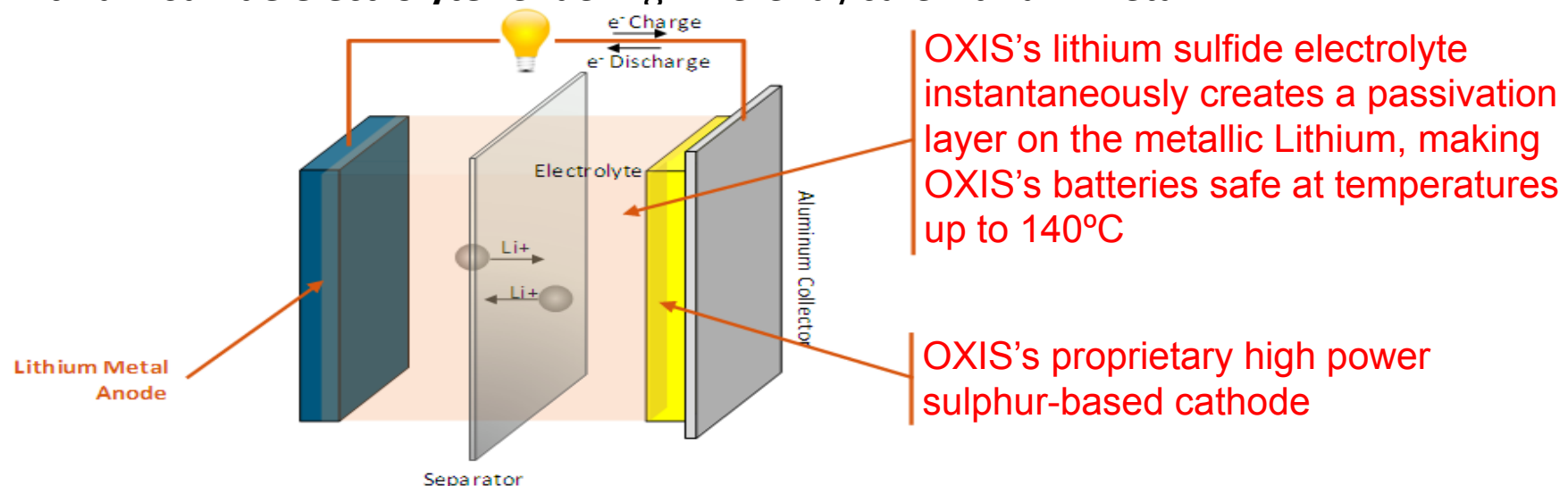
# Technology

## Polymer Lithium Sulphur

# High Power, Low Cost, Inherently Safe Li-S Battery Chemistry

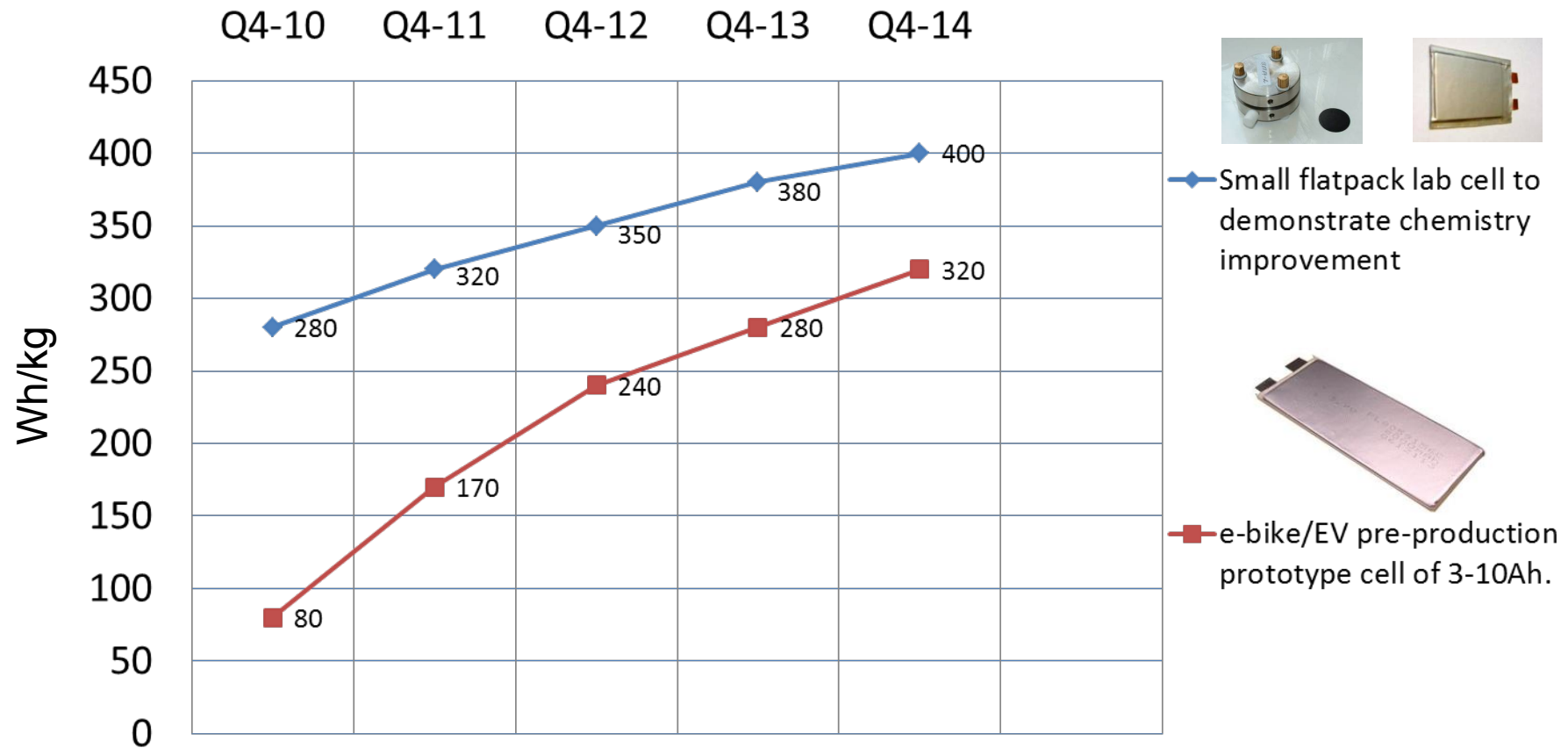
OXIS has successfully developed a Lithium Sulphur (Li-S) based battery technology using:

- **A Lithium Metal anode**
- **A Sulphur-based cathode** (+ carbon and polymer binder), and
- **A lithium sulfide electrolyte** rendering inherently safe Lithium Metal





# Lightweight – superior specific energy



- **Highest energy density** among lithium chemistry: theoretical specific energy >2850 Wh/kg
- **460+ Wh/kg** target in 2016

# The problem with today's battery technology

- An electric vehicle (EV) fire in China occurred in April 2011. What is unusual about this is -  
1<sup>st</sup> it is a production vehicle (Zoyte Automotive) which builds the Chinese version of the Fiat



iron-phosphate (LFP). LFP is popular in EVs.

This vehicle was a taxi carrying two passengers ... Firefighters were helpless; lithium fires can't be extinguished with water and even halon is ineffective.



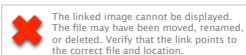
Statement of the National Highway Traffic Safety Administration On  
Formal Safety Defect Investigation of Post-Crash Fire Risk in Chevy  
Volts

(Nov 2011)

**Bloomberg**

**A123 Says Batteries for Fisker Have  
Potential Safety Issue**

(Dec 2011)



United States Postal Service no longer handle mail carrying mobile computers, ebook readers and other electronics with lithium batteries to overseas customers.

Safe under barrage of thermal, mechanical and electric abuse tests:

- Nail penetration
- Bullet penetration
- Thermal stability
- External short circuit

**100% Discharge:** No damage to cells and get all energy from cells (unlike most chemistries)

**Overcharge protection:** Internal chemical mechanism protects cell

**Storage and Calendar life:** Can be left for long period off time (charge or discharged) without damaging cells (unlike most chemistries)

**Temperature tolerance:** Operation at elevated temperature: ( $> 50-60^{\circ}\text{C}$ )

**Cycle stability:** 1,000+ cycles achievable

**Reduced cooling requirements:** Preliminary data shows small temperature reduction during discharge.

And more ...

**Manufacturing compatibility:** Polymer Li-Sulphur uses 70% similar production machinery to Li and Li-polymer batteries

**Environmental issues:** biodegradable chemistry inside

**Battery pricing:** low cost

We continue to improve

## Methods to improve OXIS's Polymer Li-S

There is limited potential for Li-S improvement based on the commercially available off-the shelf materials

New improvements in Li-S will come from the development of new materials. The key among them are:

- Polymer binders
- Carbon materials
- Electrode substrates
- Electrolyte Li salts

**OXIS is collaborating with World Class Chemical Companies**

# Collaborations

1. Collaboration with major European car manufacturer
2. Collaboration with INDUCT
  - innovative French company
  - Modulgo (City vehicle)
  - Cybergo (autonomous driverless vehicle)







- ✓ QWIC are the No1 provider of electric scooters in the Benelux
- ✓ Developing the WESP, an innovative electric scooter
- ✓ Specifically designed for the urban environment
- ✓ High range
- ✓ Lightweight
- ✓ Indestructible
- ✓ No charging required during storage when left for extended periods.



In January 2012:

- ✓ OXIS Wisper battery demonstration: 5Ah, 36V; max current 15A
- ✓ Controlled by OXIS Battery Management System (version 1)
- ✓ LED indication: charging, discharging, overload, overheating



=> Now developing production prototype for Jan 2013



Engbo is developing the electric propulsion system with specially designed high efficiency motors and new innovative bus-based control systems

## Successfully passed 1<sup>st</sup> interim reporting

Data presented:

1. Energy density at cell-level inc. temperature range
2. Energy density for “series and parallel” pack
3. Safety tests witnessed by Defence Sector representatives
  - 3.1 Short circuit test
  - 3.2 Nail penetration test



Defence Sector was particularly pleased with what they observed - (they found safety testing ‘truly boring’)

**Next Phase is now approved + underway to optimise cells into current battery packs**



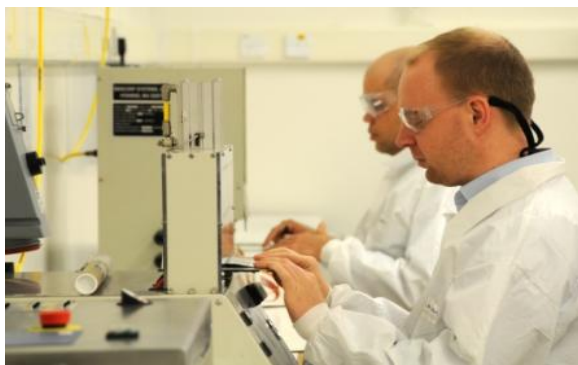
And more ...



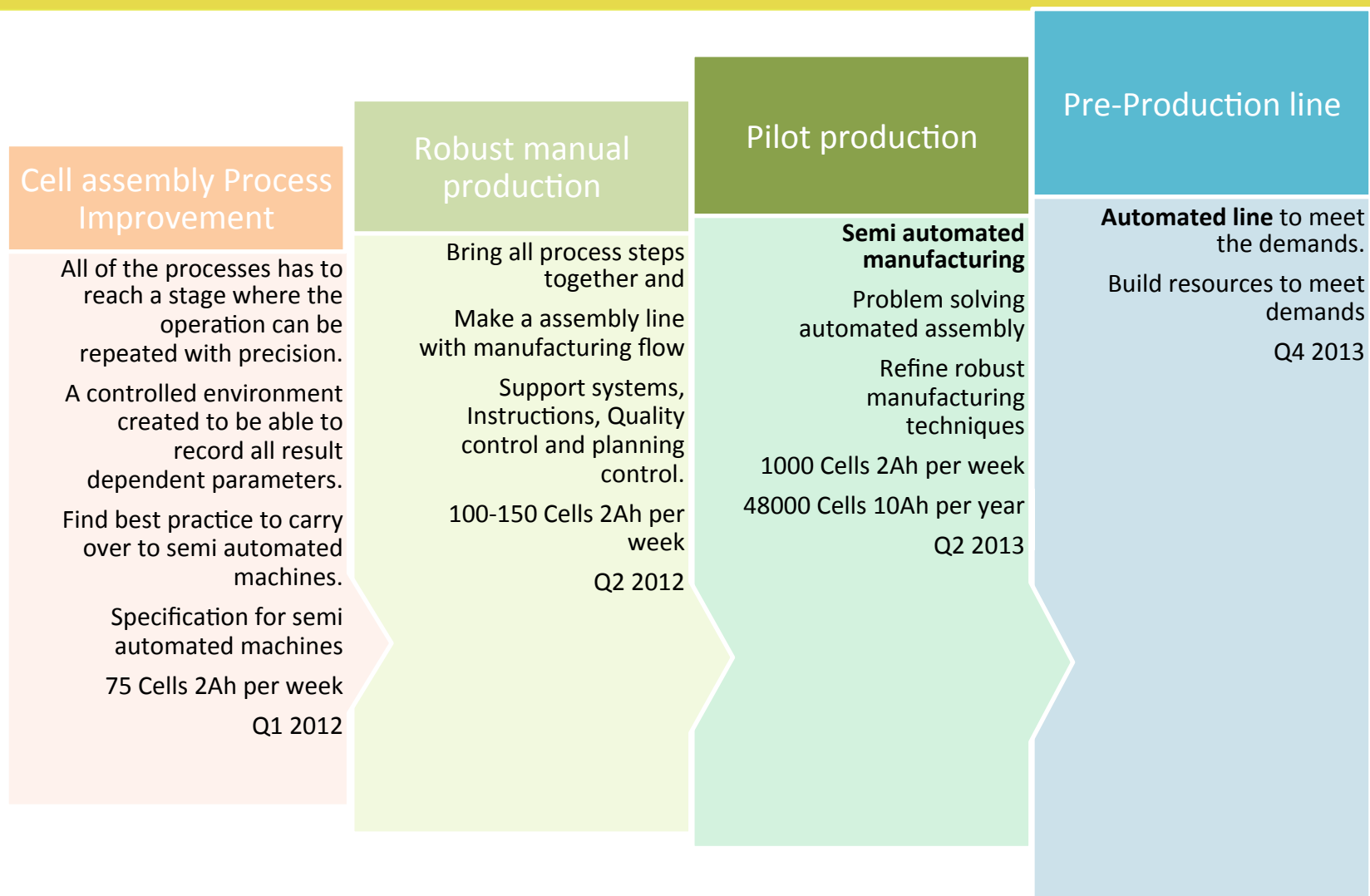
# Delivering

# OXIS's Technical Facilities

- Electrochemical lab and battery test facilities
- Pilot plant for cathode, electrolyte production and cell assembly
- New production area in 350 sq m of Dry Rooms
- The most highly specified Dry Room facility in Europe
- Over 40 employees with 12 Ph.D.s



# The road map towards commercial production





Thank you!

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