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High-Volume Manufacturing of LiPF_6 , A Critical Lithium-ion Battery Material

Overview

Timeline

- Contract Start: April 16, 2010
- Contract End: April 15, 2013
- 23% Complete

Barriers

- Historically tight supply, global shortage of LiPF_6 in 2008
- Very difficult to produce at required quality, only 3 Asian producers
- Existing suppliers dependent on Chinese raw materials

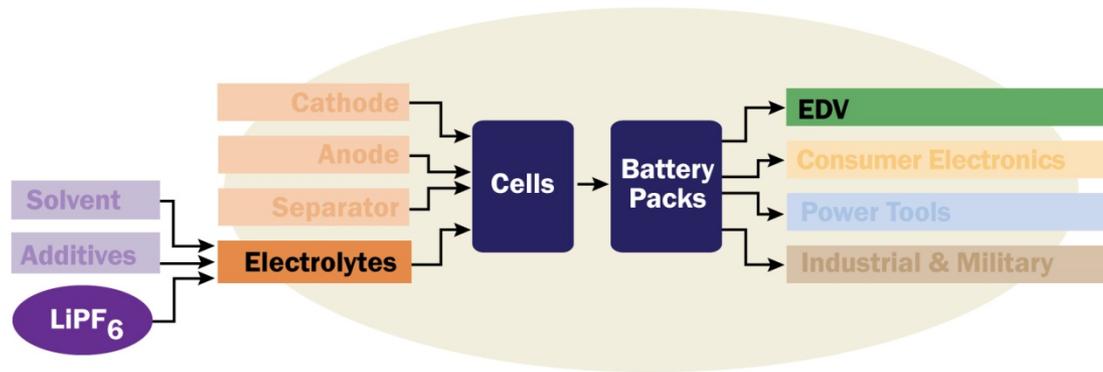
Budget

- Total Project: \$54.9M
 - DOE share: \$27.3M
 - Honeywell Share: \$27.5M

Partners

- Letters of intent from customers representing >50% of global demand
- Fully integrated on key raws

Relevance: All Lithium-Ion Batteries Require LiPF_6



- Build the first world-scale US manufacturing facility for LiPF_6
- Establish cost-effective domestic supply for critical material in the EDV supply chain
- Ensure the US-based lithium-ion battery industry has secure access to the highest quality LiPF_6 to avoid disruptions in supply and/or quality from foreign sources

Relevance

ARRA

- Creates 151 direct engineering and construction jobs as well as additional jobs at U.S.-based suppliers
- Creates 34 long-term professional and manufacturing jobs
 - Highest quality, lowest cost position ensures long-term viability
- All lithium-ion battery manufacturers and their EDV customers benefit from secure and cost-effective supply of LiPF_6

Vehicles Technology Program

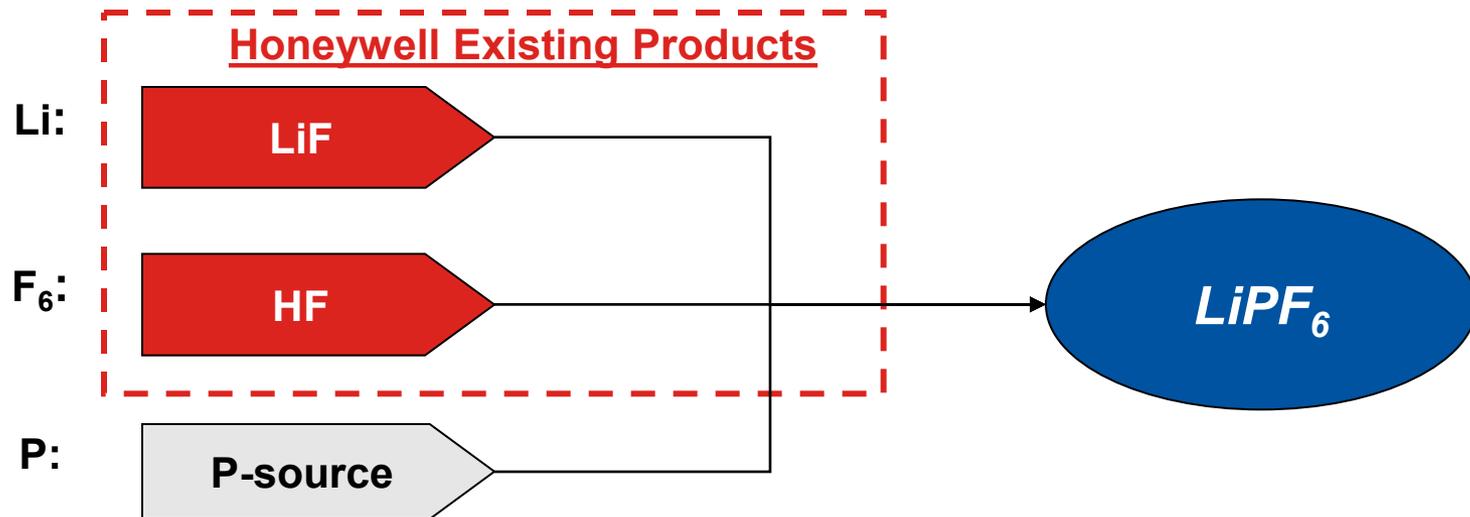
- Reduce petroleum consumption
- Promote energy security
 - Avoid replacing imported oil with imported batteries/battery materials
 - Current Asian LiPF_6 producers dependent on Chinese raw materials

Vehicle Type	Battery Size (kWh)	Annual Production	LiPF_6 (MT)
HEV	2	100,000	30
PHEV	15	100,000	200
EV	23	100,000	310

Critical Li-ion Battery Component – LiPF_6

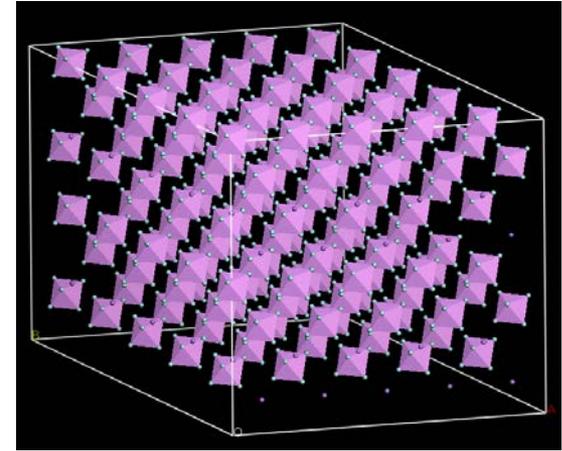
Why Honeywell?

- Developed novel process to deliver highest purity LiPF_6 at the lowest cost
- Multiple letters of support confirming Honeywell's quality
- Fluorine (HF) is ~50% of the raw material cost in LiPF_6
 - Honeywell is the world's largest producer of HF
 - 50+ years experience in developing and scaling up new F-based molecules
 - Existing LiF supplier to Li-ion battery industry



Approach

- Honeywell has developed novel process to deliver highest purity with the lowest cost
- Leverage synergies unique to Honeywell
 - Existing know-how and assets to bring LiPF_6 to market quickly
 - Key raw materials on site
 - Qualified operations and management teams in place
 - Existing permits
- Phase 1 – Build LiPF_6 plant at Buffalo, NY facility
 - Fastest path to provide material for customer qualification
 - Team that invented process located on-site
- Phase 2 – Planned construction of world-scale LiPF_6 plant



LiPF_6 Molecule

Buffalo Plant

LiPF₆ Plant



- Developed and scaled up all new fluorine-based products since 1980s
- Existing production, safety and utility infrastructure
- Key personnel on-site

Technical Accomplishments and Progress

- Environmental reviews complete
 - Buffalo site received Categorical Exclusion CX designation
 - Illinois site Finding of No Significant Impact issued Sept 2010
- Job Creation
 - 23.4 jobs created in 2nd half of 2010
 - 22.8 jobs created in 2011
- Reporting
 - In compliance with all DOE and ARRA reporting requirements
- Completed Milestones
 - Basic engineering
 - Detailed design and procurement
 - Mechanical completion of Buffalo plant
- Future Work
 - Complete customer sampling and qualification
 - Complete detailed design of world-scale plant
 - Complete construction of world-scale plant



In May of 2010, the DOE, Honeywell leaders and Buffalo officials commemorated Honeywell's acceptance of the \$27.3 million ARRA grant to produce LiPF₆ for vehicle batteries.

Pictured: Tien Duong, Department of Energy; David Franczyk, Buffalo City Council President; Andreas Kramvis, President and CEO of Honeywell Specialty Materials; Byron Brown, Mayor of Buffalo; U.S. Rep. Brian Higgins; and Jay Kelly, Honeywell Site Leader.

Summary

- All lithium-ion batteries need LiPF_6
- Secure supply of highest quality LiPF_6 is critical to success of DOE's Battery Manufacturing Initiative
- Honeywell is uniquely positioned to deliver US production of LiPF_6
- Honeywell is meeting the goals of the ARRA and the DOE Vehicle Technologies Program
 - 22.8 jobs created in 2011
 - \$14.2M spent to date