Albemarle Corporation and Lithium

ARPA-E IONICS Review

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Attractive Growth Opportunities Across Our Businesses

**Catalysts**
- FCC for Resid & Max Propylene
- FCC for VGO
- Hydroprocessing
- Isomerization
- Organometallics

**Lithium**
- Curatives
- Alkylation
- Chemical Catalysts
- Li Metals
- Li Foils, Components
- Li Salts (LiOH, Li2CO3)
- Li Organometallics
- Mg Organometallics

**Bromine Specialties**
- Fire Safety Solutions
- Oilfield Products
- Mercury Control
- Water Treatment

**Fine Chemistry Services**
- Growing APIs
- Intermediates for Pharma/Ag Innovators
- Customer-focused During Entire Product Lifecycle
- Innovative Chemistry for New Markets
Albemarle’s Diverse Lithium Resources

**Brines**
*Pumped from Salars*
- Salar de Atacama, Chile *(Production)*
- Clayton Valley, U.S.A. *(Production)*
- Antofalla, Argentina *(Exploration)*

**Minerals**
*Mining of Spodumene*
- Greenbushes, Australia *(Production)*
- King’s Mountain, U.S.A. *(Exploration)*
- Wodgina Project, Australia *(Exploration)*

**Recycling**
*Battery Materials*
- Demonstrated feasibility on pilot scale
- Commercial viability likely >10 years away
Albemarle Lithium Product Tree
Examples of Advanced Lithium Materials from Albemarle

Patented lithium-based materials to enable long cycle life

Li$_2$S - key ingredient in next frontier solid separators

Lithium metal foils for next frontier anodes

Leading cathode and battery producers are seeking suppliers with ability to partner on next gen technology
Albemarle Lithium Metal Production

Metal production by melt electrolysis of LiCl/KCl eutectic

Albemarle General Specification:

<table>
<thead>
<tr>
<th>Element</th>
<th>ppm</th>
</tr>
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<tbody>
<tr>
<td>Li</td>
<td>&gt;99.8</td>
</tr>
<tr>
<td>Na</td>
<td>max 200</td>
</tr>
<tr>
<td>K</td>
<td>max 100</td>
</tr>
<tr>
<td>Ca</td>
<td>max 200</td>
</tr>
<tr>
<td>N</td>
<td>max 300</td>
</tr>
</tbody>
</table>

1 Lower Ca impurity under development

- Foils - primary lithium battery anode used in consumer, industrial and military applications
- Thin Foils - <75 micron thick foils used in specialty applications and rechargeable lithium battery development
- Alloy Foils - Li/Mg and Li/Al foils for high temp. battery applications in oil well drilling and exploration.
- Laminates - foils with Cu or Ni strips, or wires, primary lithium battery anode used in military and industrial applications.
- Alloy Powders - Li/Al and Li/Si powders used in thermal reserve batteries for military applications.
- Anodes - stamped lithium pieces used as the anode in implantable medical devices such as pacemakers.
Albemarle BG Lithium Metal Product Tree