Lithium –Air Batteries: The Search for a Better Electro-catalyst

Prof. Dr. Galen D. Stucky Chemistry Department
Dr. Young-Si Jun Post-Doc researcher with Stucky group
Ricardo Vidrio UC LEADS at UCSB
The answer to a very inconvenient problem: Lithium – Air batteries

<table>
<thead>
<tr>
<th>Energy Density, watt hours per kilogram</th>
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<tr>
<td>Gasoline: 1700</td>
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<tr>
<td>Lithium-air: 1700</td>
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<tr>
<td>Zinc-air: 350</td>
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<tr>
<td>Lithium-sulfur: 370</td>
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<tr>
<td>Lithium-ion: 160</td>
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<tr>
<td>Nickel-metal hydride: 50</td>
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<tr>
<td>Nickel-cadmium: 40</td>
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<td>Lead-acid: 40</td>
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Diagram taken from E&E PUBLISHING, LLC article “ENERGY STORAGE: IBM partners to develop lithium-air batteries for cars”
How these cells function

Electrons flow from anode to cathode if battery is discharging

Electrons flow from cathode to anode if battery is charging

\[ Li + O_2 \leftrightarrow Li_2O_2 \]
Back to Square One...

• Problems concerning batteries involve:
  • Cyclability – how well can this thing “run” as it’s expected to
  • Rechargeability – how “well” can this battery be recharged and still function as its supposed to
  • Stability – need to make sure this cell is safe enough for ordinary operation
How it’s done

• Two most important aspects:
  • Battery assembly
  • Figuring out the perfect electro catalyst

• Battery assembly requires high purity levels, requires work to be done in glove box setting

• Finding electro-catalyst is time consuming and lengthy
How is the electro-catalyst made?

MCA-g-C$_3$N$_4$ and TiN make superb catalysts.
Breaching the theoretical energy density

Think of the electro-catalyst as the Holy Grail of Li-Air batteries
How do we proceed from here?

- There’s various components of battery design that we can “fool around” with
  - CaLi2 alloy anode design
  - Replacing electrolyte salt
  - Trying different combinations of electro-catalyst concentration
  - Experimenting with Li-S batteries

Our work is far from done but results seem very promising
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