The Metalysis-FFC process for the efficient extraction of oxygen on the lunar surface

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Figure 1: schematic showing the FFC-Cambridge process operating at ~900 °C

- Regolith is a widely available source of oxygen
- All major elements in lunar regolith can be reduced - removes constraints on location
- Simultaneous production of metals highly beneficial

Figure 1: schematic showing the FFC-Cambridge process operating at ~900 °C
Results: Oxygen extraction

97 % of the total oxygen removed

Figure 3: oxygen recovery (% of total oxygen) from JSC-2A simulant vs. time (CaCl₂, 950 °C, 4A, inert anode)

- Oxygen detected in gas stream lower due to reactor corrosion (terrestrial cells designed for CO/CO₂)
- Oxygen remaining in product a more accurate indication of process success

Table 1: comparison to other oxygen extraction processes

<table>
<thead>
<tr>
<th>Hydrogen reduction</th>
<th>Carbothermal reduction</th>
<th>Molten regolith electrolysis</th>
<th>Metalysis-FFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp.</td>
<td>~900 °C</td>
<td>&gt;1600 °C</td>
<td>~900 °C</td>
</tr>
<tr>
<td>Oxygen yield*</td>
<td>1-2%¹</td>
<td>10-20%¹</td>
<td>20-30%¹</td>
</tr>
</tbody>
</table>


*Yield (%) = kg oxygen/kg regolith
Results: Metal/alloy production

- Mixed alloy from bulk lunar regolith – potentially useful?
- Possibility of metal/alloy separation based on electrolysis parameters
- Terrestrial technology is focused on pure metal and alloy production from various oxides
- Off-Earth technology development for lunar oxygen can feed into Mars metal production capabilities
Future directions

• Optimise process parameters
• Identify the sweet spot between oxygen yield vs. processing time/energy input
• Understand the reduction behaviour of individual minerals, how this relates to different regolith deposits and regions, and how this could potentially lead to metal/alloy separation

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Figure x: elements produced and scaled up by Metalysis as of 2018