Project Summary

Techniques were developed in the SBIR Phase II to successfully demonstrate Molten Oxide Electrolysis (MOE) of lunar regolith simulant. During MOE, the regolith simulant was reduced to metal and oxygen was generated. A summary of key findings are:

- High temperature, hermetic electrolyzer for molten oxide electrolysis was designed, manufactured and installed at Plasma Processes;
- Ceramic retort and crucibles demonstrated the tendency to crack because of high temperature gradients and interaction with iron oxide. Therefore makes ceramic crucibles are impractical for long duration molten oxide electrolysis;
- An iridium container for the aggressive oxide melt was designed, manufactured and tested as a cathode in high temperature molten oxide electrolytic cell;
- It was shown that transparent material can be obtained from molten regolith simulant as a result of electrolysis;
- Oxygen extraction from molten regolith simulant was demonstrated;
- Interaction of iridium with molten iron-silicon formed on the cathode leads to formation low melting point alloy and iridium container failure;
- To eliminate the problems of interaction of containers with highly aggressive melt and products of electrolysis, a container-less concept was suggested and investigated;
- Self-heating iridium anodes were designed, manufactured and tested. The SBIR developed anode allows melting of the regolith simulant and sustained electrolysis up to 1650ºC. The oxidation resistance of the iridium anode in the gas phase needs to be improved by protective oxide coating;
- Silicon carbide was tested as a cathode material. This material also interacted with molten products of electrolysis and underwent severe erosion;
- The electrolysis of lunar regolith simulant JSC-1A using the container-less technique with self-heating iridium anodes was demonstrated. An iron-silicon alloy was obtained as cathodic product of electrolysis.
- Recycling of used iridium components, contaminated with products of electrolysis was developed.