Production of oxygen on the Moon

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Description:

In-Situ Resource Utilisation (ISRU) is seen as an essential requisite for a sustainable return to the Moon [1]. European Space Agency (ESA) plans for missions in the next 10 years to demonstrate and then scale up ISRU. Most important is the production of oxygen for use in life support and propellent. The FFC process (named after the inventors Fray, Farthing, and Chen) extracts metals by electrolysis of metal oxides in a molten calcium chloride bath [2]. This has been further developed by Metalysis Ltd. as an industrial process to produce exotic alloys and metal powders for 3D printing, but because the electrodes are graphite the oxygen is extracted as carbon monoxide and is a waste product. A proof of principle study has shown that pure oxygen can be extracted by using inert electrodes [3]. As a consequence, ESA has initiated a project to build FFC reactor cells to investigate the production of oxygen from lunar simulants. As part of this initiative, The OU in collaboration with AVS Ltd will build a gas processing system MOPS (Metalysis Oxygen Processing System).

The objectives of MOPS are to:

- quantify the yield of oxygen by mass spectrometry
- quantify the composition and concentration of impurities by FTIR spectroscopy
- remove impurities from the reactor gas
- convert the oxygen in the carrier gas to water by either combustion with hydrogen or using a fuel cell developed by AVS Ltd.
- separate the water from the carrier gas

The MOPS will be designed, assembled, and tested at the OU, before integration with the reactor cells at LIST.

The candidate will:

- evaluate the capabilities of various components of MOPS: suitability of analytical techniques, cleaning, and water collection.
- integrate the MOPS with the FFC reactor cells
- carry out experiments to determine the operating parameters of the FFC cells to gain optimum yield of oxygen – a trade off between oxygen yield, energy, and generation of impurities.

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References:

1. Martinez, Roland, Kandyce E. Goodliff, and Ryan J. Whitley. "ISECG global exploration roadmap: A stepwise approach to deep space exploration." In *AIAA SPACE 2013 Conference and Exposition*, p. 5504. 2013.
2. Schwandt, C., Hamilton, J.A., Fray, D.J. and Crawford, I.A., 2012. The production of oxygen and metal from lunar regolith. *Planetary and Space Science*, *74*(1), pp.49-56.
3. Lomax, B.A., Conti, M., Khan, N., Bennett, N.S., Ganin, A.Y. and Symes, M.D., 2020. Proving the viability of an electrochemical process for the simultaneous extraction of oxygen and production of metal alloys from lunar regolith. *Planetary and Space Science*, *180*, p.104748.

Qualifications required: BSc Physics / Chemistry/ Engineering