



Title: Concentrating Solar Pyrolysis of Lunar Regolith for Oxygen Extraction

Acronym: ROAST: Regolith Only and Sunlight

Keywords: concentrated solar energy, pyrolysis, regolith, oxygen extraction, moon exploration.

Localization: PROMES-CNRS laboratory (Odeillo Solar Furnace)-FRANCE

Objective: The objective of the project is to explore an innovative avenue for the production of oxygen on the Moon by the concentrated solar pyrolysis of the regolith. This process consists in heating the rocks from the lunar soil (regolith) at very high temperature to extract different materials, including the oxygen necessary for any lunar base project. This process has the advantage of not requiring any resources from the Earth. Preliminary studies have been carried out by CNES/ESA and the proof of concept requires the use of efficient solar concentrators available at the PROMES laboratory in Odeillo. The work will consist in continuing theoretical studies, designing, building and testing a solar pyrolysis device to extract oxygen from rock composed of a mixture of oxides. Other products (i.e. metals or other strategic elements) may also be separated and must be analyzed for recovery. This work should bring out new perspectives for the establishment of a lunar base by in-situ use of the resources present for a further away exploration of space.

Details of the PhD Proposal:

The work will start by a state-of-the-art study for in-situ resources utilization on the moon. A thermodynamic study will also be performed to evaluate the influence of temperature and pressure on lunar regolith pyrolysis reaction. Then, preliminary tests will be carried out on an existing batch solar reactor at CNRS. The adaption of an existing prototype at ESA will be studied in parallel for an experimental campaign at the CNRS solar facilities. Finally, process intensification and design for lunar operation is envisioned.

The objective is to publish at least 3 papers in international journals and to participate to 2 international conferences (Solar Power and Chemical Energy Systems Conference, International Conference on Moon Exploration and Utilisation...).

Work context:

The position will be based at the PROMES Odeillo laboratory (CNRS 1MW solar furnace) located in the Pyrénées Orientales at an altitude of 1600 m, 100 km from Perpignan, 20 km from Spain and 40 km from Andorra. In order to reach the objectives, this thesis will benefit from the CNRS-PROMES solar infrastructures (solar furnaces, solar reactors, gas analysis devices, ...) along with the long experience of the laboratory in materials and solar thermochemistry. It will also benefit from close collaboration with CNES (Centre National d'Etudes Spatiales) and ESA (European Space Agency). The PhD will integrate the Solar Fuels team of CNRS-PROMES in Odeillo, and will be supervised by 2 CNRS researchers. The PhD is co-funded between "region Occitanie" and CNES.

Skills

The candidate (Master2 or Engineer) must have a strong background in materials, processes and energy engineering (materials science and characterization, chemical reactors, thermochemistry, kinetics, mass/energy balances). An interest in both experimental and modeling work is required, as well as a good command of scientific English (writing reports and articles in English).

Application online : <https://emploi.cnrs.fr/Offres/Doctorant/UPR8521-SYLROD-001/Default.aspx?lang=EN>

Bibliography:

[1] Schlüter, L., & Cowley, A. (2020). Review of techniques for In-Situ oxygen extraction on the moon. *Planetary and Space Science*, 181, 104753.

