UNIVERSITY OF FLORIDA

Solar Fuels from Thermochemical Cycles at Low Pressures

PI: Jörg Petrasch

Students: Midori Takagi, Ben Erickson

Description: The project focuses on the production of solar fuels from solar thermochemical cycles employing metal/metal oxide redox pairs. These thermochemical cycles consist of a high temperature endothermic solar driven reduction step and a low temperature, slightly exothermic water or CO_2 splitting step. The high temperature step typically proceeds at temperatures above 2000 K. Hence, it poses a range of material and design challenges. According to Le Chatelier's principle, the temperature for the solar dissociation reaction decreases as the pressure inside the reactor is reduced. The central hypothesis of the project is that operating the high temperature step of metal/metal oxide solar thermochemical cycles at reduced pressures will lead to significantly relaxed temperature requirements, while the work necessary to produce the pressure difference will not significantly reduce the overall efficiency of the process.
The main goal of the project is to demonstrate the feasibility of carrying out high temperature thermal reduction of metal oxides in rarefied conditions using high intensity solar radiation from UF's solar simulator.

Budget: $100,000.00
Universities: UF
External Collaborators: Wojciech Lipinski, University of Minnesota

Progress Summary

Since October 2010, we have made significant progress in *two areas*. Firstly, the construction and commissioning *UF's high flux solar simulator* has been successfully completed. UF's solar simulator is a 56 kWe high flux solar simulator providing peak flux levels in excess of 5000 kW. It provides a unique platform for concentrating solar thermal research. Secondly the design of the solar thermogravimeter is nearing completion. The solar thermogravimeter (STG) consists of a high precision analytical balance with a sample holder that can be heated using high flux radiation emanating from the solar simulator. The STG can be evacuated to test chemical reactions under rarified conditions.

UF Solar simulator

UF's high flux solar simulator (Fig. 1a) is a 56 kWe experimental facility capable of delivering highly concentrated radiation at flux levels in excess of 5000 kW/m^2 (see Fig. 1b), equivalent to blackbody stagnation temperatures of approximately 3000 K.

Figure 1a. UF's High Flux Solar Simulator.

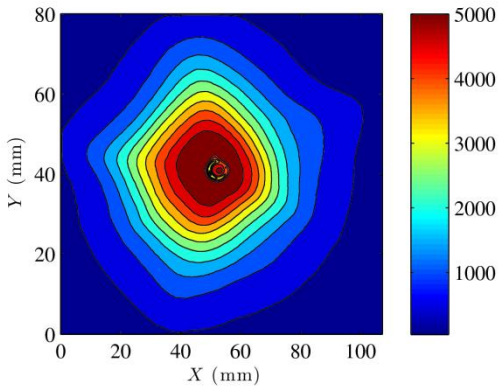

Figure 1b Measured flux distribution in the focal plane in kW/m^2.

The simulator provides the highly controllable radiation source necessary for fundamental investigations of solar thermochemical reactions, for testing and improving solar reactor prototypes. It will furthermore serve as an experimental platform for the development of control systems capable of dealing with rapid fluctuations in solar energy supply.

Solar thermogravimeter

The design of a solar thermogravimeter is ongoing. Figure 2a shows the conceptual layout. Figure 2b shows an exploded view of the current design revision. Construction of the STC is scheduled for summer 2011.

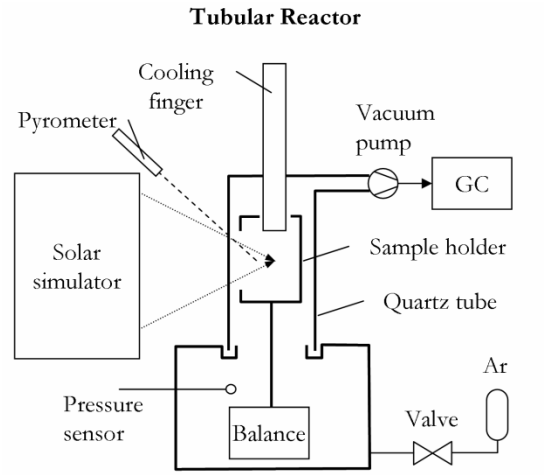

Figure 2a Solar thermogravimeter concept

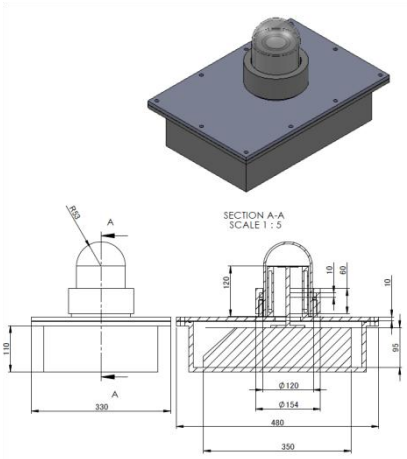

Figure 2b Solar thermogravimeter design.