

## סמינר - SEMINAR

הנדך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ב' 01.11.2021 (כ"ו בחשוון תשפ"ב), בשעה 14:30 סמינר יתקיים באודיטוריום 1, בנין ד. דן ובטי קאהן.

מרצה:

### Alon Lidor, Ph.D.

Postdoctoral Associate / Marie-Curie Fellow  
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על הנושא:

### High-Temperature Solar Thermochemical Processes for Sustainable Fuel Production

The seminar will be delivered in English

להלן תקציר ההרצאה:

The production of drop-in solar fuels can eliminate greenhouse gas emissions and provide the path to sustainable aviation. One such promising pathway to solar fuels is via a thermochemical redox cycle for splitting  $H_2O$  and  $CO_2$ , driven by concentrated sunlight. The product is a specific mixture of  $H_2$  and  $CO$  which can be further processed downstream by established Fischer-Tropsch synthesis to liquid hydrocarbons. The entire solar fuel process chain has been successfully demonstrated in a solar tower and a solar dish configurations, but with a limited solar-to-fuel energy efficiency of less than 6%. This value can be significantly increased by mainly recovering the heat lost during the temperature-swing redox cycle, accounting for up to 43% of the total solar energy input.

We have developed a novel method for heat recovery, utilizing the thermocline concept. The solar reactor is coupled with a thermal energy storage (TES) unit, and a heat transfer fluid (HTF) is used to extract high-temperature heat from the redox material and charge the TES unit. The high-temperature heat can then be delivered back to the solar reactor prior to reduction, or utilized in another process.

Numerical analysis of the system has been performed, solving the complex physical problem coupling heat transfer via radiation, convection, and conduction and fluid mechanics in a porous medium. The results show that recovering half of the sensible heat can in principle boost the solar-to-fuel energy efficiency to values exceeding 20%. An experimental setup was designed and constructed, consisting of a lab-scale solar reactor and several thermocline-based TES units, made of a packed-bed of alumina spheres or ceramic honeycombs. Testing in the ETH high-flux solar simulator demonstrated the concept feasibility. The measured heat recovery effectiveness was over 80%, with extracted HTF temperatures over  $1250^\circ C$ . The experimental campaign included the study of several key parameters on the performance: the HTF flow rate, oxidation start and end temperatures, HTF inlet temperature during the heat recovery step, and stability during consecutive redox cycles. These results show the potential of high-temperature heat recovery in solar reactors, outline the challenges, and provide important insights for high-temperature heat transfer processes.

#### Bio:

Dr. Lidor is a Postdoctoral Associate at the Professorship of Renewable Energy Carriers at ETH Zürich

since 2019. He received his B.Sc. (2011) from the Department of Mechanical Engineering at Ben-Gurion University,

and his M.Sc. (2013) and Ph.D. (2017) from the Faculty of Aerospace Engineering at the Technion – Israel

Institute of Technology. He was a DLR-DAAD Postdoctoral Fellow at the German Aerospace Center (DLR) in 2018-2019, before winning a Marie-Curie Individual Fellowship and starting his current position at ETH. His research interests include solar thermochemical processes, high-temperature heat recovery, thermal energy storage, small-scale propulsion units, and fundamental topics in thermodynamics, and his work combines theoretical, numerical and experimental approaches.

**מארח :** פרופ' אולג גנדלמן

בברכה,

פרופ' נח אתי סאס

מרכז הסמינרים