Preparation of microporous adsorbents from biomass and waste streams for effective H2 storage

Summary

This topic aims to contribute to the development of innovative hydrogen storage materials to contribute to the development of CO2 utilization and to help achieve climate neutrality in both the energy and transport sectors. The project studies the applicability of renewable natural resources (biomass) and waste streams (plastics) as raw materials for preparation of sorbent materials for hydrogen storage.

Research field:	Chemical, materials and energy technology
Supervisors:	Prof. Dr. Alar Konist Dr. Oliver Järvik
Availability:	This position is available.
Offered by:	School of Engineering Department of Energy Technology
Application deadline:	Applications are accepted between June 01, 2022 00:00 and June 30, 2022 23:59 (Europe/Zurich)

Description

H_2 is used widely in chemical industries and is a key component in CO_2 utilization by transforming CO_2 to chemicals. Although many interesting technologies for reduction of CO_2 to chemicals are still under development, number of technologies are already available. All these technologies depend on the availability of green H_2. While technologies for green H_2 production are well known, the storage of H_2 is one of the biggest obstacles hindering its widespread use.

Promising attempts have been made to solve the problem of storing H_2 in carbon materials due to their high volumetric and gravimetric capacity, and good H_2 storage performance.

The PhD study project will extend the knowledge gained from the PSG project “Effects of activation conditions on the preparation of porous carbon from oil shale” (PSG266) by developing a method for preparing H_2 storage material (adsorbent) using available methods.

In principle, the project will study the production of carbonaceous materials from biomass and waste streams by utilizing pyrolysis followed by carbonization of obtained tars. The properties of tars and subsequent carbonization conditions determine the yield, porosity and pore size distribution of the obtained carbonaceous materials.

For the analytical research equipment available in the laboratories of the Department of Energy Technology will be used. I.e.:

- Quantachrome Autosorb Anygas analyser for determination of surface area and pore size. Physisorb ports for micro- and mesopores and one chemisorb port;
- Agilent 7890A GC-MS
- FTIR Iterspec 301-X

- NETZSCH Simultaneous Thermal Analyzer STA 449 F3 Jupiter® (TGA/DSC) coupled with Quadrupole MS. Water vapor and high-speed furnace (1000 K/min) and other apparatus (https://taltech.ee/en/department-energy-technology/equipment).
- Pyrolysis reactors

Responsibilities and (foreseen) tasks

- Prepare a research plan with the help of the supervisor and carry out research according to the plan.
- Conduct necessary laboratory experiments, perform measurements using analytical apparatus, analyse results.
- The PhD student will work closely with collaborators from TalTech and abroad (e.g. USA) and will be expected to participate in relevant national and international conferences, and develop journal papers within the research field.

Applicants should fulfil the following requirements:

- A master’s degree in thermal, chemical or mechanical engineering
- good speaking and writing English.
- a clear interest in the topic of the position
- practical experience with thermal analysis and thermal treatment of materials
- knowledge about the pyrolysis process.
- experience with Aspen and Python programming language.
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to provide assistance in organizational tasks relevant to the project

The following experience is beneficial:

- Knowing SimaPro
- Practical experience with TGA analysis
- Previous participation in research projects

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