MISSION INNOVATION

accelerating the clean energy revolution

SHORT REPORT ON THE WORKSHOP ON THERMAL ENERGY STORAGE MATERIALS ACCELERATION PLATFORM, TESMAP

Monday 11 and Tuesday 12 November, 2019
Venue: Helmholtz-Institute Erlangen-Nuremberg/ZAE Bayern
Immerwahrstr. 2, 91058 Erlangen
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Innovation Challenge 7: Affordable Heating & Cooling of Buildings
&
Innovation Challenge 6: Clean Energy Materials

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ABSTRACT

Thermal energy storage is a key enabling technology for reaching the fully renewable energy supply of the future. In order to accelerate the development of compact thermal energy storage materials, an initiative within the framework of Mission Innovation was set up to draft a roadmap towards the so-called TESMAP: Thermal Energy Storage Materials Acceleration Platform. To define the first steps towards such a Platform, 29 materials and system experts gathered and discussed in Erlangen two main elements of building this automated, artificial intelligence supported materials development: the materials characterisation techniques needed for a fast and effective materials analysis and the ways to synthesise composite storage materials. A number of suitable characterisation techniques was shortlisted and four different synthesis procedures drawn, plus a list of general boundary conditions for the further development of the TESMAP. The workshop results will be described in a more detailed report and a draft proposal for the roadmap towards a TESMAP will be produced and used in the discussion for further realisation of a TESMAP with MI IC6 and IC7 representatives.

OBJECTIVES

The goals of the workshop are to have a first sketch of the roadmap towards a TESMAP facility, and to have an inventory of the characterisation techniques that could be used for thermal energy storage materials.

WORKSHOP PROCESS

In order to arrive at the goals, 29 international experts in the field of thermochemical and phase change materials and applications gave input at the workshop. The process followed is described next.

In three presentations the background and the work was introduced. First, Mission Innovation (MI) in general and the MI Challenge 7 on Affordable Heating and Cooling of Buildings in particular was presented. The second presentation was on the work on compact thermal energy storage materials in the IEA SHC/ECES Task58/Annex33. In the third presentation, the work on materials acceleration in MI Challenge 6 was introduced. The group then visited the facilities of the Helmholtz Institute in Erlangen, showing a materials acceleration platform (MAP) in development. It concerns a MAP that works with novel mixtures of organic photovoltaic materials. The MAP automatically prepares mixtures and pre-processes them for subsequent characterisation in two different measurement set-ups. Next step in the development of the MAP is to couple the measurement outcomes to models of the materials and let artificial intelligence determine what the composition of the next sample should be, depending on the target functionality or characteristic of the material.

The group then started with a brainstorm on all possible characterisation techniques with which properties of thermochemical materials can be determined. The longlist then was discussed and annotated and grouped into clusters: material structure, chemical composition, mass and enthalpy change and physical and thermophysical properties. Each cluster of characterisation techniques then was further discussed in sub-groups. A shortlist of characterisation techniques then was made for the

original list, with estimates of the suitability of the method for a MAP and of the required capital investment and the nature of the sample needed for characterisation.

A second block of discussion was the synthesis of the materials. The group of composite materials was addressed. These are porous carrier materials, like zeolites or aluminophosphates, that are impregnated with a salt hydrate. The steps to prepare and mix the salts (for 2- or 3-component systems) and subsequently dispense this on the carrier material and dry the composite were discussed. Four different handling techniques were described, dependent on the number of salts in the composite and on the required mass of the sample.

There was also a general discussion on the points to be considered in the further development of a TESMAP: the multi-disciplinary work that requires a new way of thinking for scientists and students, the necessity of also including the engineering and design approach as the TES materials will only function in a component, in a system. Further aspects are the inclusion of other work in the MI IC7 on the Comfort Climate Box, the thermal comfort and the Global Cooling Prize, the possible application of compact thermal storage for power-to-heat applications (flexible sector coupling), the importance of establishing an IT backbone for control of the MAP over a standard internet protocol and the incorporation of safety measures in the TESMAP in order to handle unstable or toxic materials generating situations in a controlled way. Also, existing literature was discussed with the conclusion that it may be just as efficient to create an experimental plan and redevelop some of the known work through the TESMAP to increase confidence in its repeatability and reproducibility.

NEXT STEPS

From the workshop a detailed report will be written, containing all the steps performed, the discussions done and the conclusions for the characterisation techniques and the preparation or synthesis procedures.

Also, a draft proposal of the TESMAP roadmap will be produced, indicating the main steps and decisions to be taken towards the realisation of a TESMAP. Attention will be paid to the expertise needed, the multidisciplinary approach and the estimated budget.

The documents then will be shared with the IC6 and IC7 representatives in order to plan next steps in the process.

The organisers would like to thank all the experts for their very productive input and the EC for supporting the workshop.

[i] "The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein."