

相変化物質を用いた高速熱交換技術に関する研究
Study on high speed heat exchange technology using
phase change material

相変化班

M1 Mitsuhashi



Theme

Study on heat storage technology



Objective

Latent heat storage technology using
microcapsule PCM



Plan

Use for exothermic and endothermic reactions that
occur during organic hydride reactions

Why use for organic hydride?

Renewable energy surplus power
⇒ Electrolysis with a fuel cell to produce hydrogen

Change hydrogen to organic hydride and transfer to various hydrogen stations

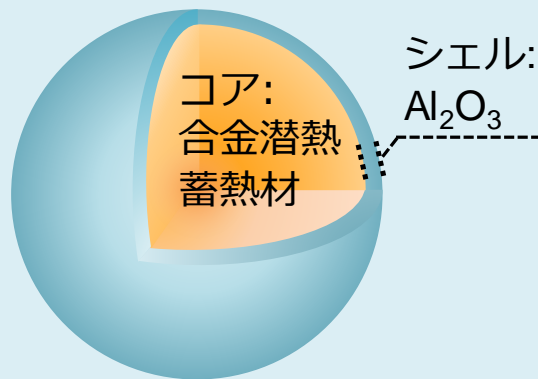
Use phase change materials to transfer reaction heat
⇒ Loss of heat input/exhaust heat can be eliminated



PCM = Phase Change Material

Technology developed by Hokkaido University

Core(alloy PCM)-shell(ceramics) type microcapsule PCM capable of high density heat storage in the temperature range from room temperature to over 800°C



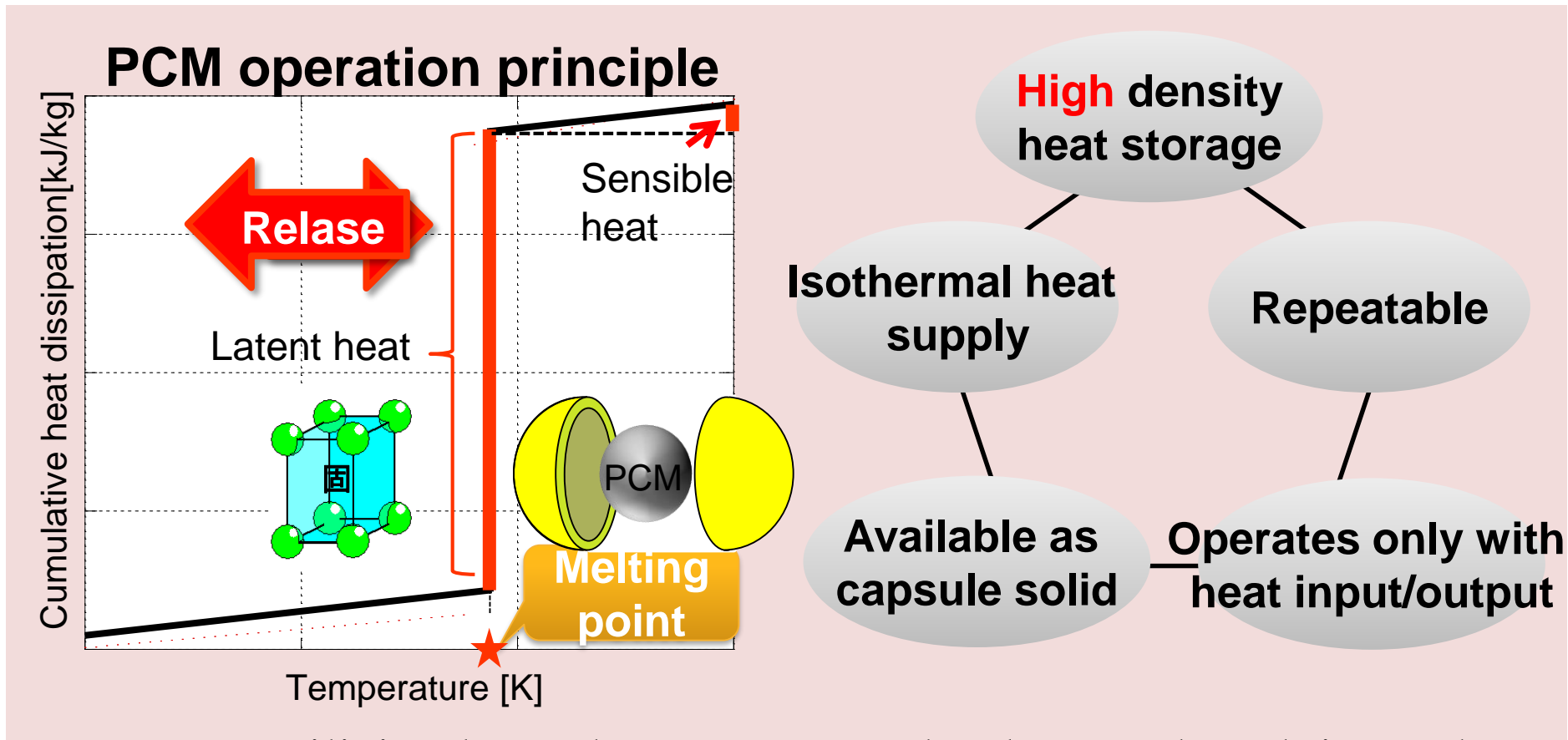
Microcapsule PCM

Features of this technology

- Operating temperature : Can be made separately from room temperature to over 800°C
- High heat storage density (≒ 300 J g⁻¹ 5 times conventional)
- Micro capsule (30μm)
- Bottom-up design of heat storage structure is possible because it can be handled as ceramic particles



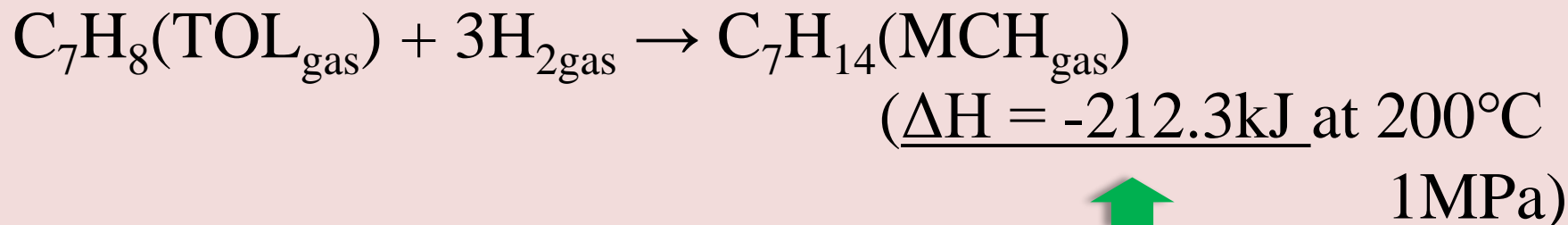
- Latent heat storage : Utilizes phase change latent heat of material (mainly solid soot and liquid)



Target ⇒ Utilizing latent heat storage technology and applying to heat transport

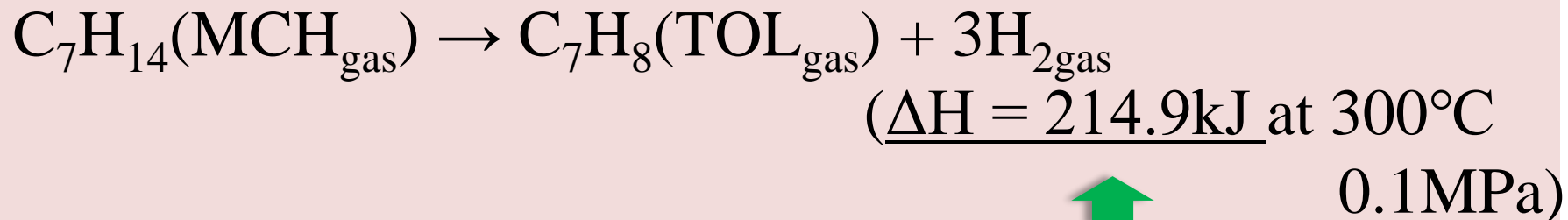
- Utilize latent heat storage technology using phase change material for organic chemical hydride

Hydrogenation reaction to toluene

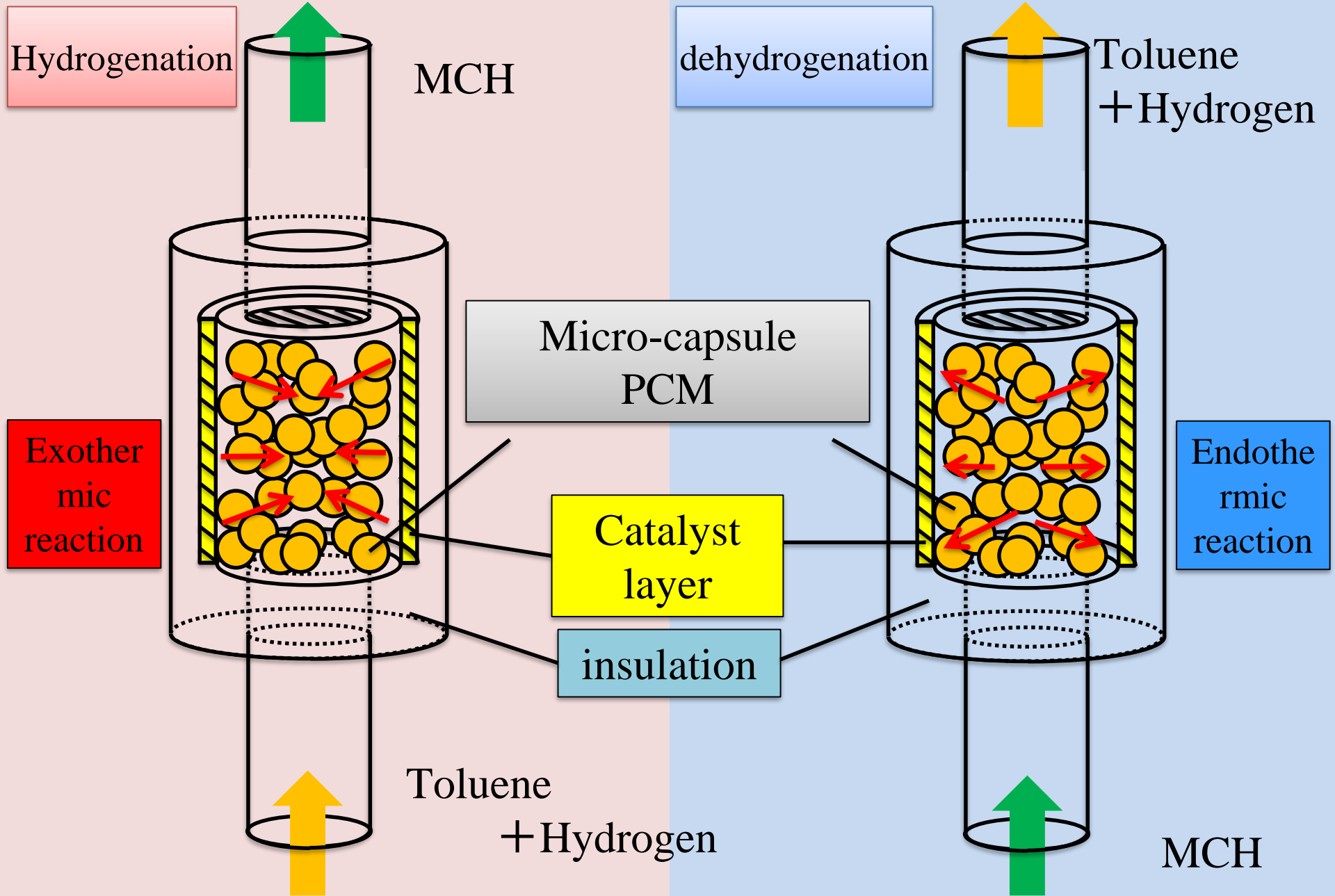


Accumulate heat generated during reaction! Can be carried around!

Dehydrogenation of methylcyclohexane



Release the stored heat when you need it!





Problems

- Difficult to use as fluidized bed due to strength problem of microcapsule PCM
 - ⇒PCM leaks due to particle collision
- The size and strength can be increased by mixing with glass, but the heat storage density is reduced
 - ⇒Search for applications according to material characteristics
- Not suitable for latent heat storage of organic hydride heat generation at a melting point of 577-580 °C
- ⇒Insufficient heat to change phase (however, heat input for dehydrogenation has applications)



- Creation of new academics, discovery of phenomena
- The foundation for mass introduction of renewable energy
- Thermal management for next-generation vehicles
- Industrial waste heat recovery
- Biomass gasification
- Heat dissipation sheet for smartphones and laptop
- Reactive heat circulation PSA etc. using MEPCM...



Future plans

- As a second plan, is it possible to store industrial waste heat (especially waste heat from waste incinerators) as latent heat?
- It can be used as the heat input required for organic hydride dehydrogenation.
- Can it serve as a decentralized energy source?
- Need to devise specifically how to use microcapsule PCM