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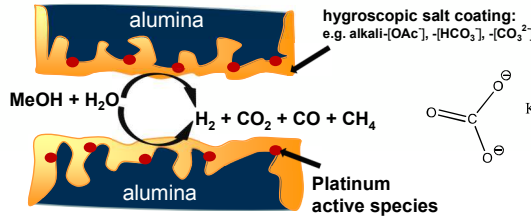
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Renewable energy sources are intermittent, therefore an effective storage technology is required. One possible compound for chemical energy storage is methanol (12.5 wt% H<sub>2</sub>-storage capacity, 6.3 kWh kg<sup>-1</sup> energy density [1]). The stored hydrogen can be released by methanol reforming, typically heterogeneously catalyzed. For this type of reaction a commercially available catalyst (5 wt% platinum on alumina) is modified by primarily alkali-acetate salts according to the SCILL-approach [2].

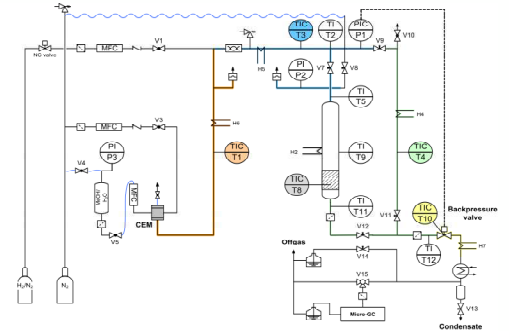
## Experimental

Pt-alumina catalyst
4.86 wt% Pt on γ-alumina (Alfa Aesar)
A <sub>BET</sub> = 143 m <sup>2</sup> g <sup>-1</sup>
V <sub>pore,BJH</sub> = 0.9 cm <sup>3</sup> g <sup>-1</sup>



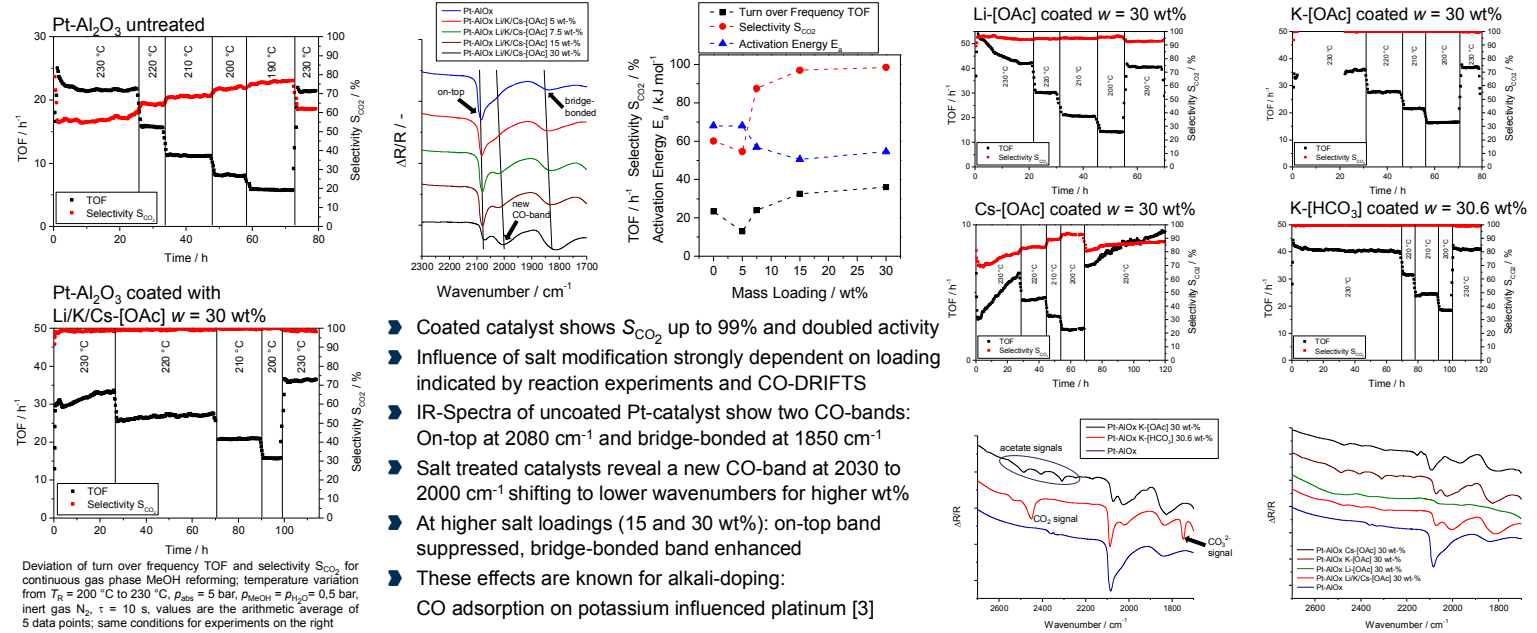
$$X_{MeOH} = \frac{\dot{n}_{CO_2} + \dot{n}_{CO} + \dot{n}_{CH_4}}{\dot{n}_{MeOH,in}} \quad S_{CO_2} = \frac{x_{CO_2}}{x_{CO_2} + x_{CO} + x_{CH_4}}$$

$$W = \frac{m_{salt}}{m_{catalyst}} \quad TOF = \frac{\dot{n}_{CO_2} + \dot{n}_{CO} + \dot{n}_{CH_4}}{n_{Metal}}$$



- Preparation according to the SCILL-approach [2]
- Use of Li/K/Cs-acetate (0.2/0.275/0.525) to lower the melting point ( $T_m = 120$  °C)
- Coating of catalyst with salt layer by wet impregnation, vacuum drying
- Catalyst test experiments in continuous gas phase fixed bed reactor
- Temperature variation:  $T_R = 200$ - $230$  °C,  $p_{abs} = 5$  bar,  $p_{MeOH} = p_{H_2O} = 0.5$  bar
- Substrate dosage via MFC with inert gas nitrogen, product analytics via GC
- Characterization of CO-adsorption with DRIFTS (Diffuse Reflectance Infrared Fourier Transform Spec.)

## Results



## Conclusion / Outlook

- Low melting salt mixture Li/K/Cs-[OAc] not necessary for an efficient reaction
- Stable operation and pronounced enhancement of activity and selectivity for K-[OAc] ( $T_m = 292$  °C) coated catalyst even at  $T_R = 200$  °C in an humid atmosphere
- DRIFT spectra of K-[OAc] and Li/K/Cs-[OAc] coated catalyst nearly identical
- DRIFT spectra of K-[OAc] and K-[HCO<sub>3</sub>] treated catalyst show similar CO-bands
- Potassium reveals the most significant influence on the active platinum species
- Salt modified catalysts show enhanced bridge-bonded adsorption of probe molecule CO → one fact that might explain the high CO<sub>2</sub>-selectivities
- Analyse the catalysts with MeOH-DRIFTS
- Determine the influence of adsorbed H<sub>2</sub>O
- Inspect the influence of the hygroscopic nature of the salt coating
- Extend the concept towards other salts
- Apply the approach to other reactions

[1] G.A. Olah, Beyond Oil and Gas: The Methanol Economy, Wiley-VCH, 2009. [2] U. Kernchen et al., Solid Catalyst with Ionic Liquid Layer (SCILL) – A New Concept to Improve Selectivity Illustrated by Hydrogenation of Cyclooctadiene, Chem. Eng. Technol. 30(8), 2007, 985-994. [3] H.P. Bonzel, Alkali-Metal-Affected Adsorption of Molecules on Metal Surfaces, Surface Science Reports 8, 1987, 43-125