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Nanofiber-supported nanocatalysts for the hydrogenation of CO_2 to ethanol

Aim

Preparing and testing nanofiber-supported nanocatalysts for the hydrogenation of CO_2 to ethanol.

Justification

In combating rising CO_2 concentrations in the atmosphere, CO_2 utilization has gained increasing attention. An example of such a reaction is the selective hydrogenation of CO_2 to ethanol, which can then be used as raw material or as fuel additive. However, the yield of this reaction is largely limited by its thermodynamic equilibrium. In order to effectively exploit this application, the main challenge is to synthesize new materials which can account for these limitations.

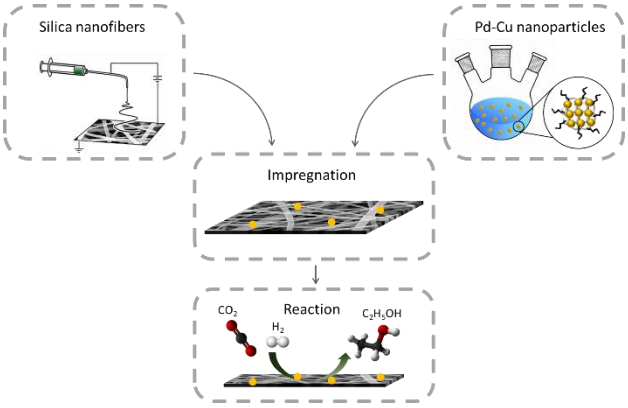

Figure 1. Schematic representation of the combined use of silica nanofibers and Pd-Cu nanoparticles for the hydrogenation of CO_2 to ethanol.

In that regard, nanofiber-supported nanocatalysts are an interesting option. Nanofibers have a large surface-to-volume ratio and are therefore an ideal support for catalytic particles. Furthermore, they offer a means of separating the products from the reactants, thereby shifting the equilibrium. Nanoparticles created by colloidal synthesis routes are an interesting choice for the active phases, as these generally exhibit high activities and selectivities. Moreover, this synthesis route allows for considerable flexibility in tuning the catalyst properties (e.g. size, composition).

Due to their high thermal and chemical resistance and ease of production, silica nanofibers have a lot of potential as a support for this application [1]. In addition, Pd-Cu catalysts have already proven their high activity and selectivity towards ethanol synthesis by CO_2 hydrogenation [2]. Therefore, in this master thesis, the goal is to combine the advantages of both materials by impregnating nanofibers with Pd-Cu nanocatalysts to maximize the ethanol yield in this reaction (see Figure 1).

Program

- Literature study on CO_2 hydrogenation, silica nanofiber production and colloidal synthesis of (Pd-Cu) nanoparticles
- Synthesis of nanofiber support (CTSE) and Pd-Cu nanoparticles (LCT)
- Impregnation of nanofibers with the colloids
- Characterization of the materials (ATR-FTIR, BET, SEM, XRD, DLS …)
- Testing the reaction in designated setups (LCT)

References

[1] J. Geltmeyer, J. De Roo, F. Van den Broeck, J. C. Martins, K. De Buysser, and K. De Clerck, *Journal of Sol-Gel Science and Technology,* vol. 77, no. 2, pp. 453-462, 2016.

[2] S. Bai, Q. Shao, P. Wang, Q. Dai, X. Wang, and X. Huang, *Journal of the American Chemical Society,* vol. 139, no. 20, pp. 6827-6830, 2017.

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