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Coach	**Supervisor(s)**	**Funding**
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Acid-modified structured carbon catalysts for methane pyrolysis– an experimental and optimization study

Aim

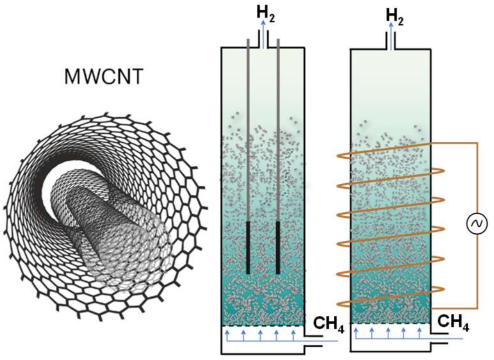
Surface engineering of structured carbon materials for enhanced catalytic performance during methane pyrolysis.

Justification

CO_2-free hydrogen (H_2) will play an important role in transforming the world into a climate-neutral community, as hydrogen is a sustainable energy carrier and feedstock enabling a net-zero economy. In the coming decade, hydrogen production is expected to increase by 40% to a total production of 130 Mt/year in 2030 (International Energy Agency, IEA), of which 25% will be renewable to reach existing climate pledges. Therefore, alternative and more efficient hydrogen production technologies with no or negative greenhouse gas emissions (GHG's) are needed. Recently, methane pyrolysis has been shown to be a promising sustainable technology to produce “turquoise” hydrogen by splitting methane directly into hydrogen and the potentially valuable by-product solid carbon.

Methane pyrolysis is generally performed in the presence of a metal- or carbon-based catalyst. For example, BASF's electrically heated moving bed reactor technology use a Ni catalyst and carbon granules. In the case of carbon catalysts, flaws, edges, and other surface defects are regarded as the active sites for methane decomposition. The main challenge to industrializing this process is the rapid deactivation of the catalyst due to solid carbon deposition (cokes) in low surface area carbon materials. On the other hand, structured carbon materials with high surface area and high pore volume allow high carbon deposition and thus improved stability, but often display a low intrinsic activity. This is basically due to the well-defined surface structure and low concentration of defects in structured carbons. Artificial surface modifications of structured carbon with acid treatments can overcome the low activity problem. It can also adjust the catalyst's electrical conductivity for applications in the electrothermal fluidized bed reactor (ETFB) and inductive heating reactor.

This study will focus on identifying the active sites of structured carbon-based catalysts for methane pyrolysis and how the catalyst surface can be modified and optimized by acid treatments. Structured carbon materials that show high surface area and pore volume but poor intrinsic activity, will be engineered for improved catalytic performance.



Program

- Literature study: Identification of the active sites of carbon catalysts for methane pyrolysis and activation of carbon by acid treatments.
- Structured carbon modification.
- Characterization of the synthesized materials (N_2-physisorption, XRD, XPS, STEM).
- Methane pyrolysis in multiple reactors.

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