KTSoftSkills - Soft Skills for Knowledge Transfer - Project n. 2022-1-IT02-KA220-HED-000089663

Co-funded by the European Union

Invention Disclosure Form

1. Title of Invention

Novel method of converting methane to methanol using a Zeolite catalyst.

2. Inventors (namely the researchers whose intellectual contribution to the design or discovery can be described as inventive, being different from team members whose contributions applied skills but not inventive input. If more than 3 inventors please append additional sheets)[1]

Name (Contact person):	**Professor Jaroslav Heyrovský**		
Employer:	Institute of Physical Chemistry		
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% inventive contribution:	50%		

Name:	**Gerty Cori** (PhD Student)		
Employer:	Institute of Physical Chemistry		
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% inventive contribution:	50%		

3. Other Contributors

These are people with whom you may like to share any acknowledgement or returns in the event of successful valorisation of the invention. They are people whose work contributed to the success of the research but who were not responsible for the inventive spark or design of the research. They can include PhD students, technicians, postdocs or other colleagues whom you believe made a material, non-inventive contribution.

Name (Contact person):	**Mr. Peter Grünberg** (Laboratory technician)		
Employer:	Institute of Physical Chemistry		
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% contribution:			

4. Description of invention

Please try to answer the following questions.

4.1. What problem does the invention solve?

The invention uses a novel Zeolite catalyst to convert methane to methanol. This can be done at a significantly lower temperature than existing methods (below 250 C) with higher yield (> 50 times compared to existing methods). The conversion of methane to methanol is a significant area of research due to the potential to transform a readily available greenhouse gas into a valuable chemical feedstock. Methanol can be used as a fuel, a solvent, and a precursor for various other chemicals, making this conversion process industrially attractive.

4.2. Do you know of any similar inventions that exist and if so, how does your invention differ?

The established industrial process also uses catalysts, (see below) but they are different and the temperature needs to be much higher and the current conversion level from existing catalysts is lower.

4.3. Abstract or summary of the invention. Please explain the invention in general terms (max. = 100 words)

The process of catalytic conversion of methane to methanol is often described as a "holy grail of catalysis" due to its potential for efficient energy storage and transportation. These catalysts can be broadly categorized into those inspired by nature (biomimetic) and those synthesized based on specific chemical principles. Metal-organic frameworks (MOFs), metal-exchanged zeolites, and metal oxides have been shown to be among the most promising materials for this conversion.

Our novel Zeolite catalyst is the result of many years of research. It has been shown to significantly lower the temperature needed to carry out the methane conversion process and the conversion ratio is much higher.

4.4. Keywords (for an overview, see the Annex) maximum of five

Zeolite; catalyst; Methane; methanol; conversion.

4.5. Technology Information. Technical description including background, what is new with respect to the state of art, what is the stage of development and further needed improvements (max. = 150 words)

Our technology of direct oxidation of methane into methanol using a cheap oxidant like oxygen, represents the most progressive approach to natural gas utilization. Current alternatives have limited efficiency and typically require cycling of temperatures between 250 °C and 450 °C as well as the help of a water effluent to enable the release of methanol from the active material.

The technology developed is able to significantly improve the efficiency of the methane conversion at much lower temperatures, with methanol directly evolving into gas phase thus eliminating the necessity to use any effluent. The reached level of the methanol production is up to 80 times higher than any currently disclosed alternatives.

Benefits

- High activity in methane selective oxidation at low temperatures
- under isothermal regime
- Release of oxygenate product without need of added effluent
- Highly stable system under cycling procedures
- “Super” dry conditions not required

Stage of development
The novel catalyst has been produced in the lab at a small scale e.g. milligrams.
The technology is currently at TRL4: technology validated in lab.
The purity of the catalyst as produced by the current methods is around 65% and needs to reach 90% for industrial use.
Industrial scale use would require production of Kg.
It would be necessary to demonstrate that the methane conversion rate does not drop below 80% when the process is scaled up.

4.6. Additional Information, please attach all available information, for example a summary of the invention being disclosed (Include photographs, drawings, sketches, or any other descriptive material)

4.7. What products and/or processes do you think could be protected by a patent?

The process/ novel use of the catalyst.

4.8. What are disadvantages to the invention or limitations that needs to be overcome?

It is not proven beyond lab scale. We do not know if there will be problems if it is taken to industrial scale e.g. if the conversion factor will remain the same at the lower temperature.

5. Information on the intellectual property

MATERIALS	Yes	No	Don't Know
• Have you supplied any material relating to the invention to anyone outside your research group? Please include names of researchers or others outside of your institution.		X	
• If yes, was the material transferred under a Material Transfer Agreement (MTA)? If appropriate, please supply a copy of the MTA or a contact person.			
• Did you use any materials supplied by other researchers or companies to make your invention?		X	
• If yes, were the materials supplied under an MTA? If appropriate, please supply a copy of the MTA or a contact person.			

When did the idea for the invention first arise? Please indicate who was/were the employer(s)[2] at the time of the invention

Date: June 2020 Place: Institute of Physical Chemistry

Employer(s): Institute of Physical Chemistry

6. Funding sources

Please list all sources of funding that have contributed to the invention

Time Period	**Source** First money stream (University), Second money stream (national funding agencies), Companies, Other sources including EU (please specify)	**What was the relation to the inventive step** (idea, people, materials, etc.)
20020-2021	National Science Foundation grant for fundamental science	First attempts by Professor Jaroslav Heyrovský to produce the catalyst.
2021-2024	National Science Foundation PhD Grant	Demonstration of the idea in the lab and refinement of the Zeolite formulation (Heyrovský and Cori).
2024-ongoing	EC ERA PoC Grant	PoC (TRL3-4) further validation of the idea and refinement of the operating conditions (Heyrovský and Cori).
2025-ongoing	Industrial support from Company A.	Scale up demonstration with support from Mr. Peter Grünberg. Further refinement of the parameters.

[2] Please indicate if the employer is different from the employer as indicated on page 1.

7. Public disclosures and confidentiality

	Yes	No
• Has the invention or any part of it been disclosed in a publication, an abstract or any other written materials? If yes, please attach a copy and write the date of the disclosure on the material. **Was presented as a technical flier and poster at the 2023 Conference on Synthesized Catalysts in Berlin.**	X	
• Will the invention or any part of it be disclosed in a publication, an abstract or any other written materials? If yes, what is the intended date of disclosure?(please be aware that any disclosure may jeopardize the ability to obtain a patent; we advise you to contact the KTO as soon as possible)		
• Is there a draft manuscript detailing the invention? If yes, please attach a copy.	X	
• Has this draft manuscript been submitted to a journal or publisher? Please provide details of the publishers, dates of submission and whether or not the publication has been accepted. Planned publication in the late December of this year Journal name: **Journal of Syn Cat Materials** Submission date: in the next 4 weeks Outcome/Status:	X	
• Has there been/ will there be a (poster) presentation or lecture during a public meeting? Executed/ planned disclosure date: See above: Was presented as a technical flier and poster at the 2023 Conference on Synthesized Catalysts in Berlin. See above.	X	
• Has a third person (outside the institution) been approached about the invention? If yes, who was this person and was the information shared in confidence? Company A approached us after the Berlin confidence and offered us a small collaborating to explore scale up. Confidentiality is mentioned in the funding agreement. We also approached 3 other companies after the conference because they had expressed some interest but they have not responded. We sent them the technical flier which does not contain any confidential information. See section 8 below.		

8. Commercial interest

	Yes	No
• Are you aware of any companies or other users that might be interested in this invention? Do you know of companies or other research groups that could possibly have developed inventions in the same area? If yes, please list names. As above: Company A approached us after the Berlin confidence and offered us a small collaborating grant to explore scale up. We also approached 3 other companies who either make catalysts (Companies B and C) or manufacture methane by an established method (Company D) after the conference because they had expressed some interest but they have not responded.	X	
• Is the invention related to previous sponsored research projects within your department? If yes, please provide details. Only with regard to the ongoing agreement with Company A to try and scale-up the project.	X	
• Do you know of any other past or ongoing collaborations and/or agreements with third parties that may be relevant to this invention? • If yes, please provide details. See above. All other research has taken place under research grants.		

Signature of inventors

_____	_____	_____
Print Name	Signature	Date
_____	_____	_____
Print Name	Signature	Date
_____	_____	_____
Print Name	Signature	Date