https://www.methasol.eu

METHASOL

CO_2 TO CH_3OH

INTERNATIONAL COOPERATION FOR SELECTIVE CONVERSION OF CO_2 INTO METHANOL UNDER SOLAR LIGHT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101022649 (METHASOL).
This output reflects only the author's view and the European Union cannot be held responsible

Deliverable Report

Start date of project:	01/07/2021
Duration of project:	42 months
Deliverable nº & name:	D7.1 Elucidation of Interregional Barriers
Version	1.0
Work Package n°	7
Due date of D:	M5, 30/11/2021
Actual date of D:	09/12/2021
Participant responsible:	École Polytechnique Fédérale de Lausanne
Main authors:	Dan Ren, Jing Gao
Website:	https://www.methasol.eu/

Nature of the Deliverable		
R	**Document, report (excluding the periodic and final reports)**	X
DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

Dissemination Level		
PU	**Public, fully open, e.g. web**	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Quality procedure			
Date	Version	Reviewers	Comments

PROJECT SUMMARY

This report is part of the deliverables from the project "METHASOL" which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101022649.

Methanol is an appealing energy vectors, with attractive volumetric and gravimetric energy values, storable in liquid phase at ambient conditions of pressure and temperature, and that can be used as fuel directly or converted into chemicals or gasoline. However, its production lacks a sustainable route. Thus, the METHASOL project aims to produce methanol through a sustainable and cost-effective process based on the selective visible light driven gas phase CO_2 reduction, with a solar to methanol energy conversion efficiency of 5%. During 42 months, METHASOL will gather 14 partners from EU/Associated MS, China and the USA, including some of the world's most recognized researchers on artificial photosynthesis, to achieve a ground-breaking combination of a CO_2 reduction reaction (CO_2RR) system based on Metal-Organic Framework (MOF) and a graphitic Carbon Nitride (g-CN) for photocatalytic oxygen evolution reaction (OER), through a Z-scheme heterojunction. Following the definition of the system specifications (WP1), a first set of materials for OER and CO_2RR will be synthesised and their photocatalytic activity and stability will be screened (WP2). The most promising materials will be further analysed thanks to experimental characterisation and modelling (WP3), leading to guidelines used for designing an enhanced CO_2RR and OER materials (WP4). The best systems will then be integrated through a Z-scheme heterojunction, either with or without a mediator, and tested in tailored reactors operating in the gas phase under different conditions (WP5). A complete sustainability analysis will be conducted (WP6) to ensure the clean production of methanol. The cooperation between European and Chinese research entities will be consolidated to last beyond the project lifetime through the creation of a common exploitation plan (WP7). Through its ambitious activities on photocatalyst developments for solar to methanol conversion, METHASOL will propose a new path for decarbonizing Europe.

More information on the project can be found at https://www.methasol.eu.

OBJECTIVE AND EXECUTIVE SUMMARY

The EU-China cooperation potential barriers has been investigated by EPFL and NKU. Attention has been paid to cultural, language, organisational structure, political and societal differences, legal aspect on the use of materials for photocatalysis, of methanol as a fuel, etc. Solutions to overcome these barriers has been proposed for METHASOL activities (including the use of communication networks adapted to European and Chinese partners). In particular, each WP and working groups will regularly exchange and hold joint seminars on the progress in each work package. EPFL has gathered the findings in this report shared for the partners for the optimisation of the collaboration during the lifetime of the project.

LIST OF PARTNERS

N°	Name	Short name	Country
1	UNIVERSITAT POLITECNICA DE VALENCIA	UPV	Spain
2	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	MPIKG	Germany
3	Wuhan University of Technology	WHUT	China
4	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	CNRS	France
5	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE	ICL	United Kingdom
6	DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES	DICP	China
7	ECOLE NORMALE SUPERIEURE	ENS	France
8	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	EPFL	Switzerland
9	FUZHOU UNIVERSITY	FZU	China
10	TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY	TECH	Israel
11	NANKAI UNIVERSITY	NKU	China
12	UNIVERSITEIT MAASTRICHT	UM	Netherlands
13	METHANOL INSTITUTE	MI	United States
14	EUROQUALITY SARL	EQY	France

TABLE OF CONTENTS

1. INTRODUCTION

METHASOL project aims at the international/interregional collaborations between scientists from EU and scientists from China on the development of efficient photocatalytic systems for converting CO_2 to methanol fuel using sunlight as the driving force. The past decade has witnessed the successful collaborations between two regions and the consortium plan to strengthen the collaborations. Both Europe and China have now devoted extensive efforts to research on mitigation of carbon emissions and increasing the share of sustainable energy, not only from scientists but also from governmental perspective. However, we shall admit that the barriers are still there for effective collaborations in addressing climate change, which shall be addressed from a global point of view. In this project, we aim to strengthen the cooperation between Europe and China by identifying these barriers as well as implementing strategies to overcome these barriers. In this report, we will elucidate the interregional barriers as well as propose strategies for breaking these barriers.

2. CULTURE

EU countries generally pay attention to the protection of cultural heritage. In addition to the policies of the "cultural powers" such as Italy, Spain, France, and Germany at the national level, EU advocated cultural-heritage protection at all levels – from the series of resolutions passed by the European Parliament in 1974 to the signing of the Treaty on the European Union in 1993.[1]. In December 2013, in line with the latest national strategy of “new urbanization development” in China, the central conference on urbanization put special emphasis on cultural inheritance as one of the Four Fundamental Principles of “new urbanization.” It was stressed that the country should "improve the level of historical relics protection, develop beautiful towns of historical value, protect and carry forward our excellent traditional culture, extend the urban historical context, pay attention to retaining the original style of villages, allow residents to be able to see mountains and rivers and remember symbols of their hometowns” in the process of urban construction. Guided by principles of "giving priority to protection”, “rescue first”, “reasonable use”, and “strengthening the management", archaeologists were tasked with the dual responsibility of development in protection and protection in development to ensure the special nature, integrity, the authenticity of ancient cities was preserved and the approach to relic protection was people-oriented. [2]

While both EU and China have their policies on the protection of cultural heritage, we foresee little impact of cultural barriers between two regions for scientific collaborations. Over the past decade, the scientific collaborations between EU and China become more intense, thanks to the launch of €500M investment under Horizon 2020 funding scheme for projects with scientists in China. Moreover, the launch of China’s policy on ‘giving priority to protection’ could be a booster for strengthening the collaboration project on ‘environmental protection’.[3] In the case of METHASOL project, the ultimate goal is in coherent with such a policy since we plan to address the climate change and energy usage by sourcing renewable energy like solar radiation and producing chemical fuels in a more sustainable way.

3. LANGUAGE

Though European countries speak different languages, the scientists within Europe have established successful collaborations with little barrier in terms of communications since almost all the scientists speak English. European commission has different funding schemes for EU countries and associated countries in Europe, which has been a great success over the past decades.

For China, the partners mainly speak Mandarin as the working language. However, the Chinese scientists mainly publish their research in journals using English as the language. Moreover, the government is now taking dramatic steps to improve the quality and international reputation of its home-grown science journals, which are published in English (or bilingual versions). Publishers of hundreds of Chinese titles will receive generous government funding as part of a major five-year plan to elevate the country's publications to raise/be among the world's best[4]. The new policy and support from the government will improve the English communication skills of the scientists in China.

The Chinese partners in METHASOL consortium include DICP, WHUT, FZU, NKU. The key personnel involved in this project almost all have the overseas experience, which provided the training for those scientists in terms of communications in English. For example, Prof. Xincheng Wang from FZU, has 8 years' experience overseas including Germany and Hong Kong, where the working language is English. Prof. Jingshan Luo has gained his PhD degree in Singapore (working language English) and spent four years at EPFL, Switzerland (working language English). All key PIs from four institutes/universities have established many successful collaborations with overseas. For example, Prof. Xiuli Wang' group (DICP) and Prof. James Durrant's group (ICL); Prof. Xincheng Wang's group with Prof. Markus Antonietti 's group (MPIKG); Prof. Jingshan Luo's group (NKU) with Prof. Michael Graetzel's group (EPFL), Prof. Jiaguo Yu's group (WHUT) with Prof. James Durrant's group (ICL). All these successful collaborations are good indicators of low barriers between European partners and China partners within our consortium in terms of communication in English.

4. ORGANISATION STRUCTURE

Due to the cultural difference, European universities and Chinese universities have different organizing structures. Even within Europe, universities from different countries may differ in terms of organization structure. According to a recent case study, we are able to identify these similarities and differences as summarized below[5].

In overall, the governance principles in the European cases are more democratic than for the Chinese universities. For the European universities, leaders at all levels, university or faculty, are often elected internally, and staffs and students may also get involved in the governance process. Integrated external participation in boards and councils, both at central university and at faculty level, are possible. External members may have key responsibilities but do not necessarily have decisive power in practice, and they are often absent in the senate type bodies.

For the Chinese universities, the Shuji (representative of CPC) and the president are mostly appointed by the Ministry of Education. Internal democracy is in line with the election of leaders and participants in the university governance structure at lower levels in the university. External members can only participate in the university governance process by joining the university board, alumni associations, or by donations, etc. The level of external participation in Chinese universities is relatively low. Political power, administrative power, and academic power are present in parallel. The university is led by the party committee and can closely integrate the needs of society and the socialist republic with Chinese features in terms of university operation and development.

Due to the above difference, decision-making authority is more centralized in Chinese universities than in European universities. In China, university governance is divided into two parallel pillars: a political and an administrative one. This is similar to the PRC's governing bodies, namely the party and state institutions. Among European universities, the Board-type characteristics of university governance also guarantee the presence of societal actors through external representatives.

The consortium well recognizes these differences, which could be potential barriers between the effective collaborations between China and EU. The centralized power within Chinese institute may lead to a decision, which may not be the expected one and in turn might impair our project. The effective communication between the decision-makers in EU and China may create barriers on reaching an agreement on some aspects of our project.

5. COMMUNICATION

The years since 2018 when Covid-19 breaks out have witnessed drastic changes of our daily life, most of which are negative. This also affects the face-to-face personal communications. As an alternative, virtual meetings and conferences have replaced the regular communications in the recent months. Though we have hopes for things to get back to normal, it is likely that virtual meetings will still last for a while, currently expected to be at least to the end of 2022.

For the METHASOL project, we expect to continue the virtual meetings through online platforms till the global pandemic condition gets released. The access to certain platforms such as google call are expectedly not feasible for the Chinese partners, but there are alternatives which are both allowed by European Commission and China. The platform which was used up to now is Microsoft Teams. Moreover, this platform could also be used as a deposit for sharing necessary documents among partners. Thus, we do not foresee any barriers in terms of communication platforms.

6. DATA SHARING

The effort to establish new rules for science collaboration with China has been progressing over the last five years thanks to the discussions between Brussels and Beijing.[6] Two sides reached an agreement on promoting open access to research data. EU and China agreed to make open access a condition of joint research, meaning published articles and data must be available without charge. In METHASOL project, the consortium partners aim at open-access publications at top-tier journals. This means the data associated with the publications will be open access worldwide.

7. LEGAL ASPECTS ON THE USE OF MATERIALS

The major concern on the usage of materials is related to the applications of nanomaterials for research purposed. European commission and the universities in Europe have strict regulations on the usage of nano materials. For every EU-funded project, the certificates from the university/institute who are concerned for the study of nanomaterials shall be requested. Thus, our European partners within METHASOL who plan to apply nanomaterials for research on this project shall prove their eligibility of such activities. The same rule applies for China universities/institutes as well.

The transportation of nanomaterials between EU and China is currently operative as long as the componence is not biological or customs forbidden. While all the synthesized composites proposed in METHASOL project are based on organic or inorganic chemicals, thus it is foreseen to be feasible to share the prepared photocatalysts between partners within the frame of METHASOL.

8. LEGAL ASPECTS ON THE USE OF METHANOL AS A FUEL

The ultimate goal of METHASOL project is to produce methanol as the transportation fuel, in a sustainable way by using sunlight and carbon dioxide as the raw materials. Methanol could be blended with gasoline for the purposes of transportation without modification of the current infrastructure.

China currently leads the world in methanol fuel blending[7]. According to a recent report by the Methanol Institute (MI) in 2019, the total consumption of methanol fuel in China reached nearly 6 million metric tons accounting for 7% of total methanol consumption in China, the world's largest methanol market. In mobility the acceptance and approval of neat methanol (M100) vehicles is growing due to the multiple provincial and municipal methanol fuel vehicles pilots. Thus, there was a significant growth of the number of M100 vehicles on Chinese roads in many provinces like Guizhou, Shanxi, Shanxi, and Gansu. Today, there are more than 25,000 M100 vehicles running in China, mostly taxies operated 24/7, and served by a network of nearly 100 pumping stations for methanol.

In Europe, from 1980s to 1990s, most gasoline in Western Europe only contained a small fraction of methanol, usually 2-3%, along with a co-solvent alcohol. Currently, gasolines used in European Union countries are allowed to have 3% methanol[8].

Both China and Europe accepted the usage of methanol as a blended fuel for gasoline. Though EU has more restrictions on the percentage of methanol, the large gasoline markets in EU as well as in China make the usage of methanol as a fuel very promising.

9. REFERENCES

Cui Qiao et al. 2015. *A joint mapping study prepared for the Ministry of Culture (MoC) of the People's Republic of China and DG Education and Culture (EAC) of the European Commission.* Brussels: European Commission.

David Cyranoski. 2019. "China splashes millions on hundreds of home-grown journals." *Nature* 346-347.

Kai Zhao. 2021. *MI Launches 'Methanol Fuel in China' Report.* 10 5. https://www.einnews.com/pr_news/540415037/mi-launches-methanol-fuel-in-china-report.

Nicholas Wallace. 2020. *Access to information an obstacle in EU-China joint research.* 6 4. Accessed 2021. https://sciencebusiness.net/international-news/access-information-obstacle-eu-china-joint-research.

Richard L. Bechtold et al. 2007. *Use of Methanol as a Transportation Fuel.* http://www.mefco2.eu/references/use-methanol-transportation-fuel.php.

Xiaojie, Li. 2013. "Press conference held by the State Council." Wuxi.

Xie, Zhenhua. 2020. "China's historical evolution of environmental protection along with the forty years' reform and opening-up." (Environmental Science and Ecotechnology) 1.

Yujie Xue et al. 2021. "EU-China university governance structures—case studies." *Asia Europe Journal.*