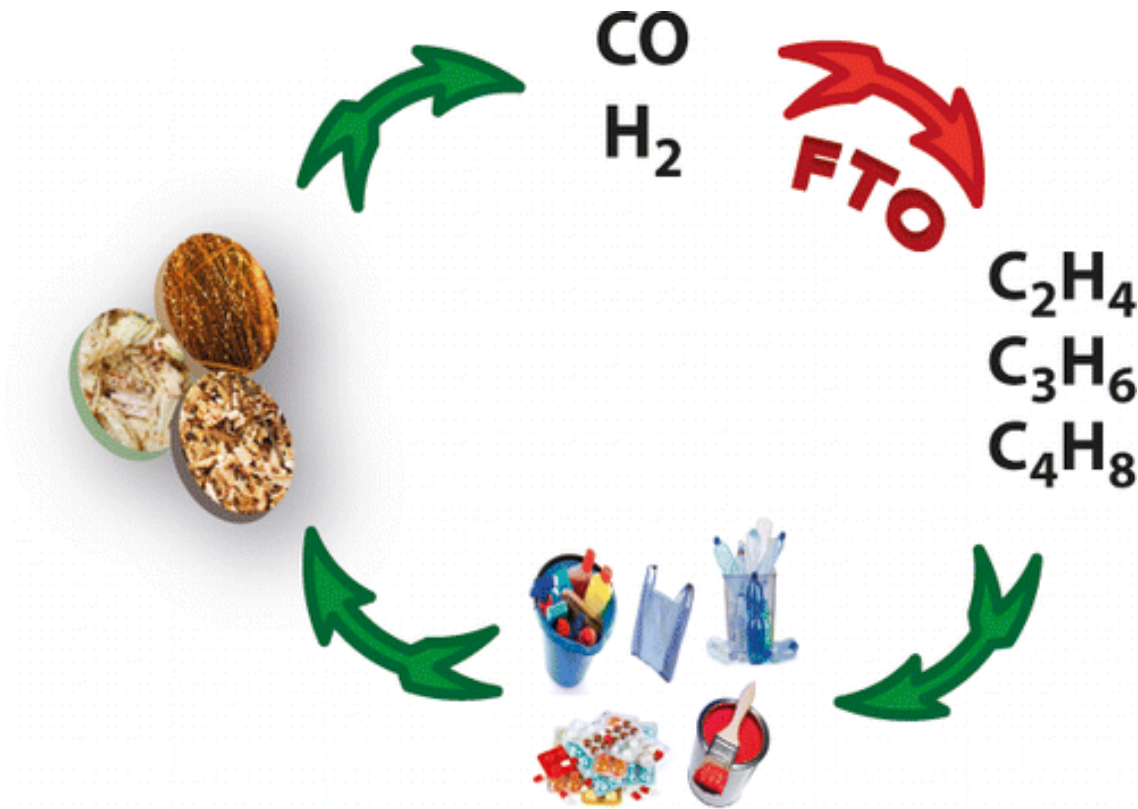


# Status and Plans for catalysis for sustainable energy

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# Renewed interests on olefin production by Fischer Tropsch



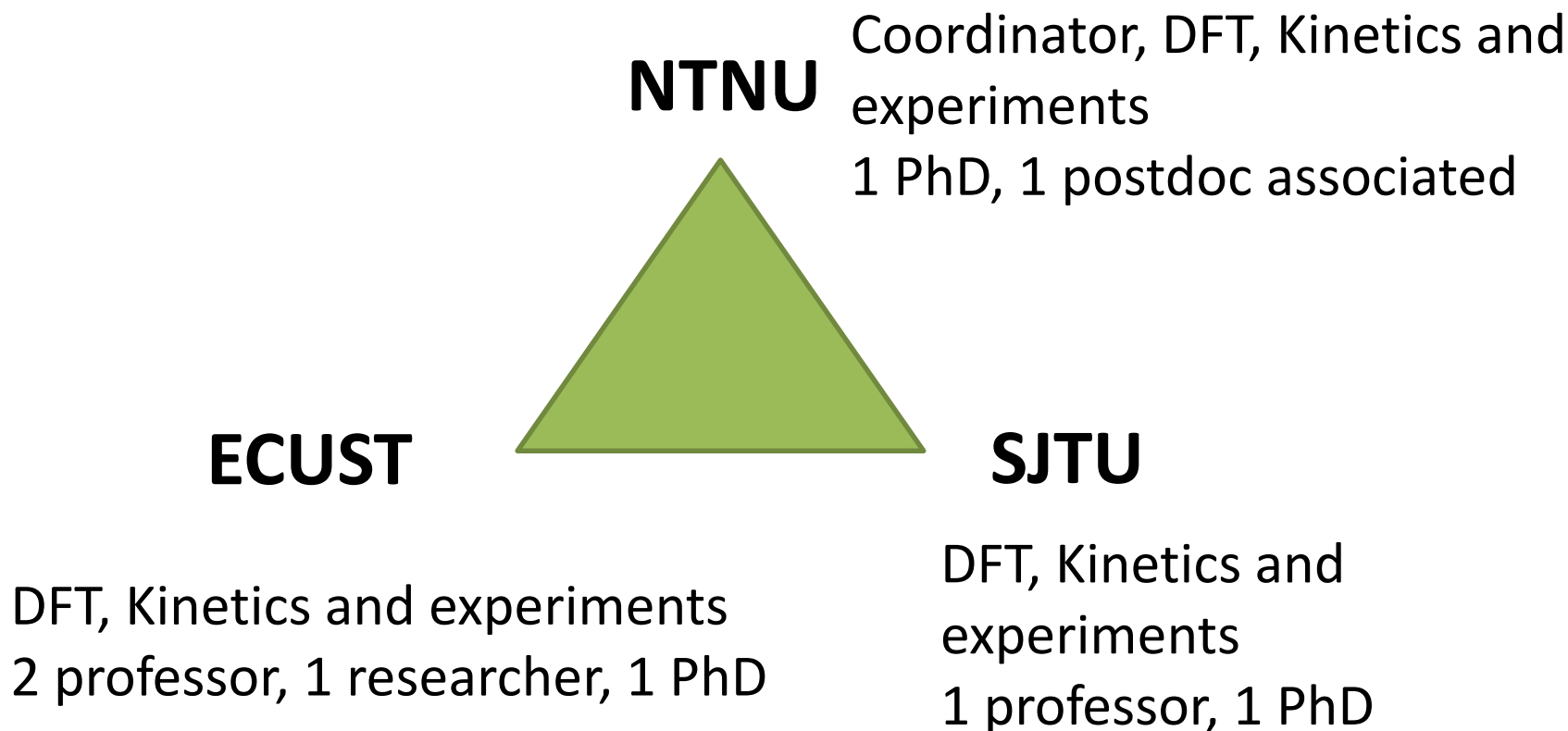
- Possible to produce olefin via synthesis gas from natural gas, coal and biomass

# Objectives of the project

- The ultimate goal of the project is to identify the principles for rational design of the catalysts to maximize the C<sub>2</sub>-C<sub>4</sub> olefin formation and minimize the methane formation from synthesis gas with different hydrogen to CO ratios, by combining competences from NTNU and SJTU
- 1) Preparation of Fe and Co and their alloys with well controlled sizes and surface compositions.
- 2) Correlate chain growth or termination probability to the catalyst properties.
- 3) Apply the gained scientific insights to optimize the catalysts to maximize C<sub>2</sub>-C<sub>4</sub> olefin yield.
- 4) Enhance the cooperation between NTNU and SJTU by joint the projects and personal exchanges
- **More than 10 joint publications**

# Status of the project

- Three partner-network has been established for cooperation in the project
- Competences in both groups have been mapped



# Status of the project

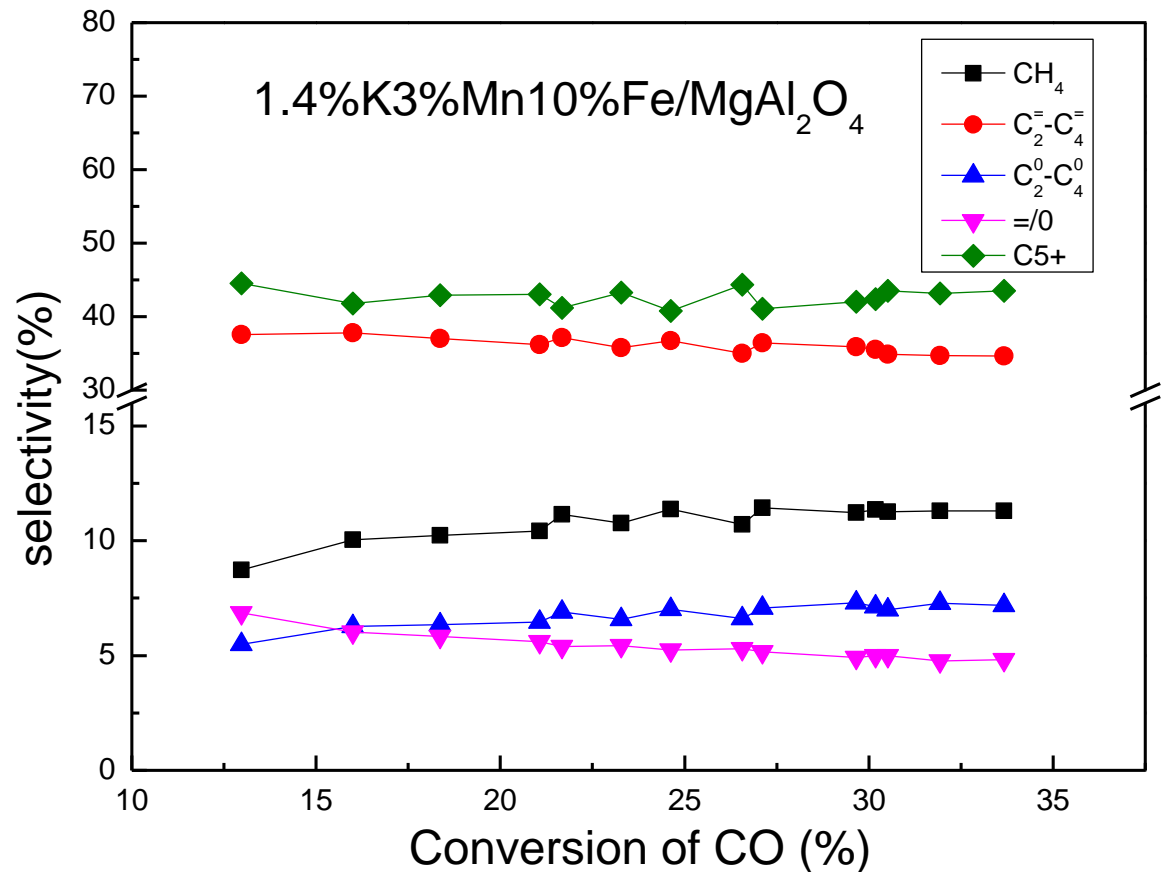
- One student has been placed in each group.
  - 2015 January at SJTU (Yu Wang)
  - 2015 September at NTNU (Yalan Wang)
  - 2014 at ECUST (Di Wang, currently visiting NTNU for one year)
- Student exchange
  - The PhD student (Di Wang) from ECUST supported by Chinese scholar council (09.2015-08.2016), 3 months for professor, research stay at NTNU
- The joint project makes it possible to establish a relatively large research groups to combine different competences to carry on cutting-edge research

# Status of the project : NTNU

- Microkinetic analysis: predictive modeling
- Catalyst design by microkinetic analysis
- Scaling relationship for adsorption heat and activation energy on different metals

# Status of the project (Yu Wang, SJTU)

- Catalyst development of Fe catalysts on Mg-Al spinel support for FTO
- Kinetic study



# Status of the project (ECUST)

- Design and Engineering of Iron-based Composite Catalysts for the Fischer-Tropsch Synthesis of Lower Olefins
- Mechanistic study of F-T synthesis by SSITKA

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Catalysts	FeK-OX	FeK-OX+1K	FeK-OX+2K	FeK-OX+5K
CO conversion (%)	28.8	37.6	46.1	60.4
CH selectivity (%C)	70.4	72.2	77	79.5
CH distribution (%C)				
CH <sub>4</sub>	19.5	17	16.3	12.9
C <sub>2</sub> <sup>=</sup> -C <sub>4</sub> <sup>=</sup>	42.2	43	40.1	35.8
C <sub>2</sub> <sup>0</sup> -C <sub>4</sub> <sup>0</sup>	11.4	12.1	10.9	10.2
C <sub>5</sub> <sup>+</sup>	26.9	27.9	32.7	41.1
Olefin/Paraffin	3.7	3.6	3.7	3.5

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# Joint publications

1. D. Wang, X. Zhou, J. Ji, X. Duan, G. Qian, X. Zhou, D. Chen, W. Yuan, *Modified carbon nanotubes by KMnO<sub>4</sub> supported iron Fischer-Tropsch catalyst for the direct conversion of syngas to lower olefins*, Journal of Materials Chemistry A 3 (2015) 4560-4567.
2. D. Wang,, J. Ji, X. Duan, G. Qian, X. Zhou, X. Zhou, D. Chen, *NanoFe catalysts on CNTs for the direct conversion of syngas to lower olefins*, Journal of Energy Chemistry, invited, submitted.
3. Yu Wang, Jiachi Chen, Wende Xiao, De Chen, *A catalyst for Fischer–Tropsch olefin reaction with MgO modified Al<sub>2</sub>O<sub>3</sub> support*. Submitted to The 11<sup>th</sup> Natural gas conversion symposium, Tomosø, Norway
4. Xianzhi Tang, Yu Wang, Wende Xiao, De Chen, *Macroporous  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> support preparation and application in the CO oxidative coupling carbonylation for dimethyl oxalate synthesis*, Submitted to The 11th Natural gas conversion symposium, Tomosø, Norway
5. Y. Wang, Y. Zhu, Wende Xiao, D. Chen, *Mechanism research of of light olefin formation in Fischer-Tropsch synthesis by combination of DFT calculations and microkinetic analysis*, Submitted to The 11th Natural gas conversion symposium, Tomosø, Norway
6. Xun Huang, Hu Li, De Chen, Wen-De Xiao, *Kinetic modeling of the side reactions in methanol-to-olefin process over HZSM-5: an extended study of the previous model*, Chem. Eng. J. accepted.

# Education

Two departments have agreed to cooperate on the joint education of master students on chemical engineering

- Master students to international master program at NTNU, exchange master students to SJTU
- Master (NTNU) +PhD (SJTU)
- Double degree of master student
- Plan to sign the agreement at kick-off meeting at Beijing

# Founding

- Chinese-Norwegian scholarship

Application through Chinese side, and paid by Norwegian Research Council

- Chinese Scholar Council

- Supporting different scholars: Bachelor, master and PhD students, postdoc, researchers and professors (0.5-3 years)