



Villeneuve-d'Ascq, le 13 novembre 2020

Luc-Sy TRAN

Chargé de Recherche CNRS

PC2A

CNRS-Univ. Lille

« **Combustion of liquid biofuels** »

Cette présentation est préparée en se basant principalement sur des travaux de recherche collaborative avec:

KK Foo (PC2A)

N Lamoureux (PC2A)

S Gosselin (PC2A)

L Gasnot (PC2A)

A El Bakali (PC2A)

P Desgroux (PC2A)

H-H Carstensen (ARAID, Saragosse, Espagne)

Energy demand of the transport sector

~ 25%-50%

increase in energy demand by transport sector by 2040

[ExxonMobile 2019]

~ 90%

of today's liquid fuels are made from **petroleum**

[ExxonMobile 2019]

- Problem of pollutant emissions
- Greenhouse gas emissions
- Depletion of reserves
- Increase of costs

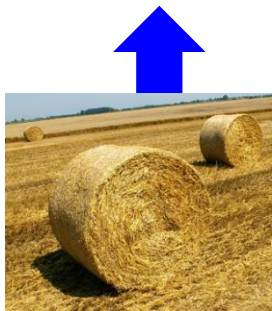


Interest of biofuels

Advanced biofuels

(second and third generations)

- Renewable energy source
- Decrease of dependance on petroleum
- Energy security
- Already mature production methods
- Many applications already developed



Cellulosic biomass

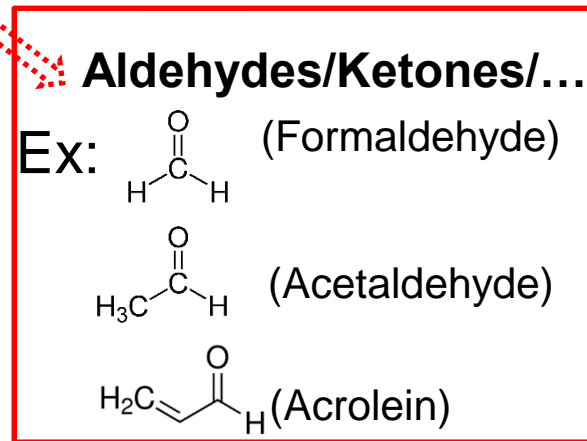
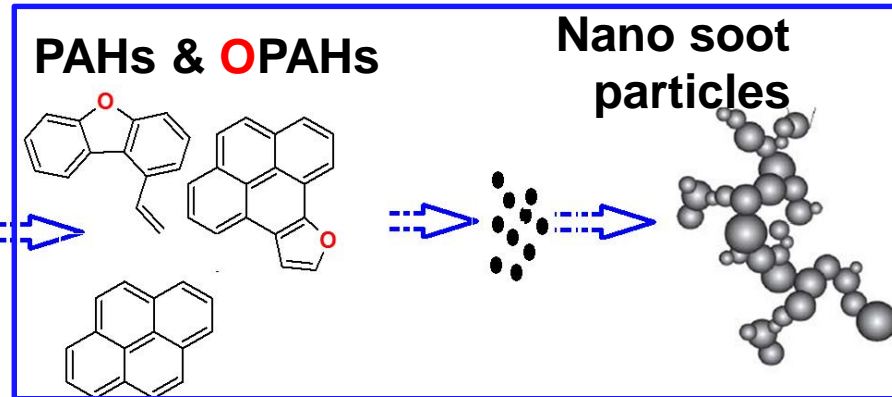
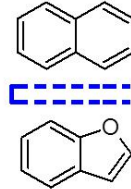
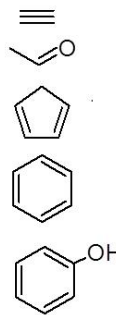


Micro-algae

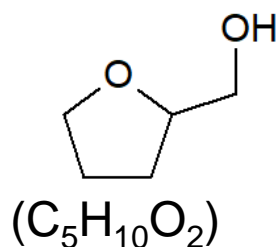
Combustion chemistry of biofuels

- ❑ Very complex process
- ❑ Very important for understanding and controlling fuel reactions and pollutant emissions (NO_x, CO, soot, PAHs, VOCs)

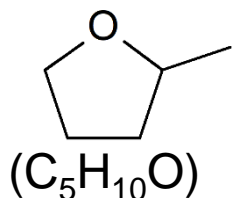
Advanced
biofuels



Examples of our recently-studied liquid biofuels



THFA*



MTHF*

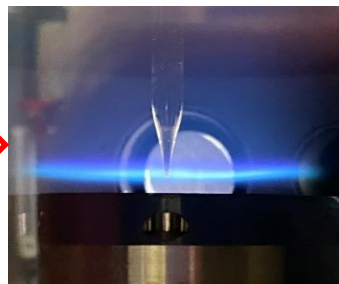


*THFA: Tetrahydrofurfuryl Alcohol
MTHF: 2-Methyl Tetrahydrofuran

Suitable for gasoline engines

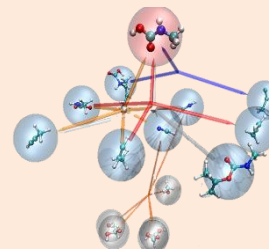
Fuel system

Laminar
premixed flame
P=40 Torr
Φ=1



GC**
(methanizer/FID**,
TCD**, MS**)

Newly-
developed
kinetic
model



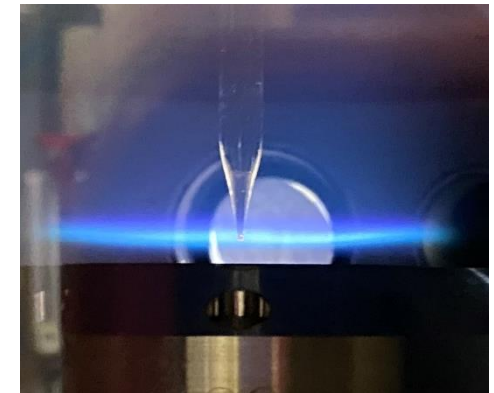
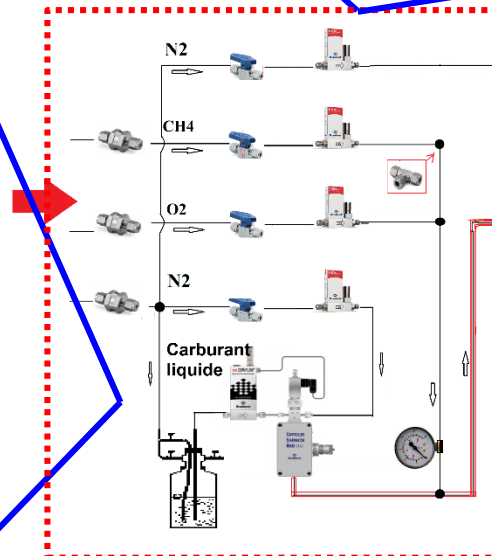
Understanding

- combustion chemistry of studied biofuels
- formation of aldehydes, VOCs, and other products

** GC: gas chromatography
FID: flame ionization detector
TCD: thermal conductivity detector
MS: mass spectrometry

Examples of our recently-studied liquid biofuels

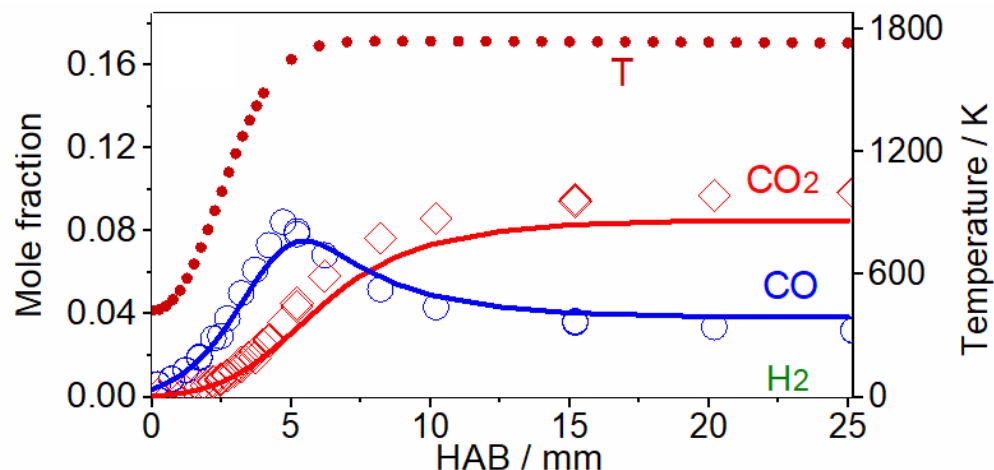
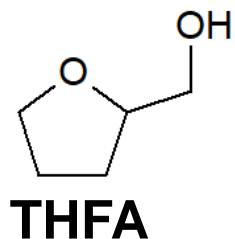
Funding (4000 euros) from IRePSE via AAP 2018 for improving the supply system of liquid biofuels



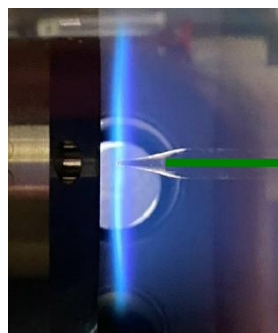
Fuel system

Examples of our recently-studied liquid biofuels

Results on **THFA flame**: final products, temperature



Symbols: experiment
Lines: present model

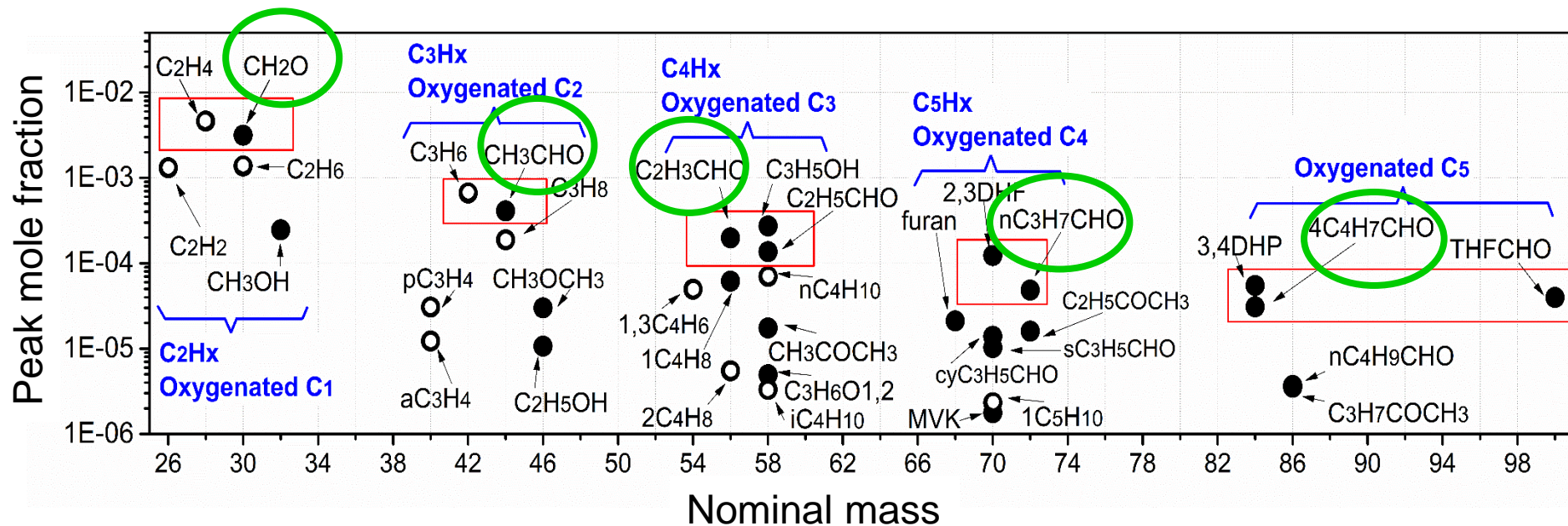


HAB: Height Above the Burner

Examples of our recently-studied liquid biofuels

Results on **THFA flame**: 35 detected intermediate species

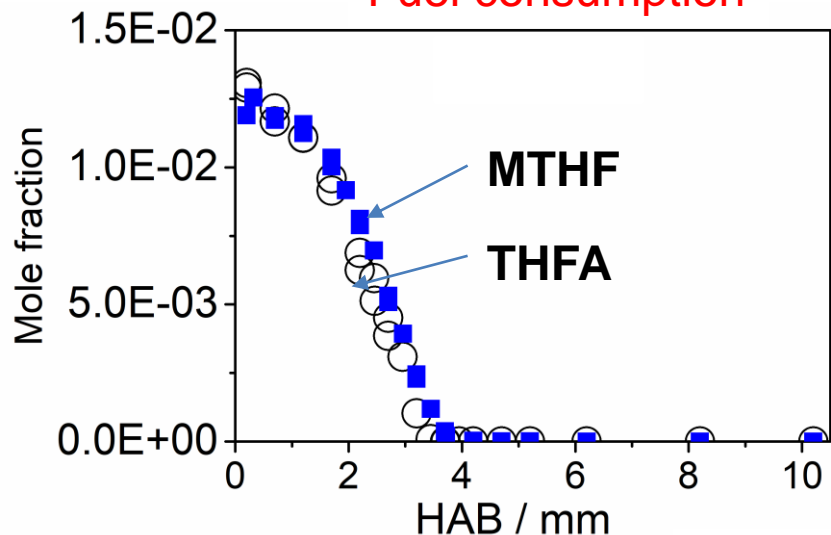
- Important in analyzing reaction mechanism of fuel, validating the kinetic model
- Knowing the nature of pollutants (VOCs): useful information for studies in the atmospheric environment field



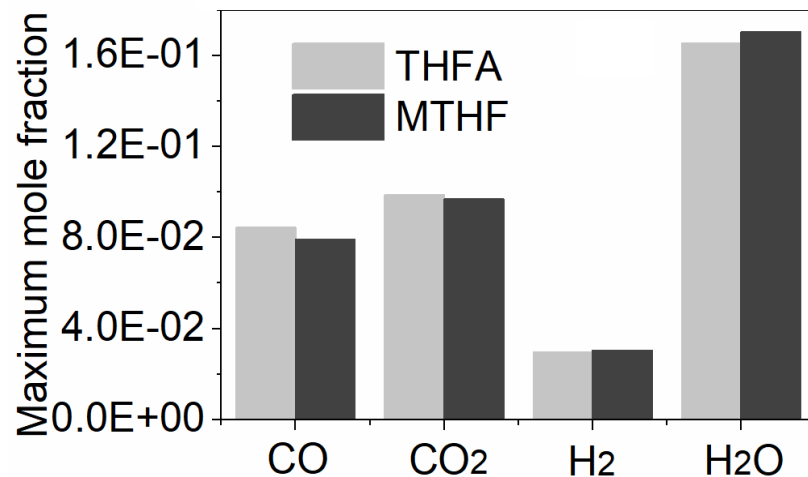
Examples of our recently-studied liquid biofuels

Comparison: **THFA** OCC1OCCO1 vs. **MTHF** CC1OCCO1

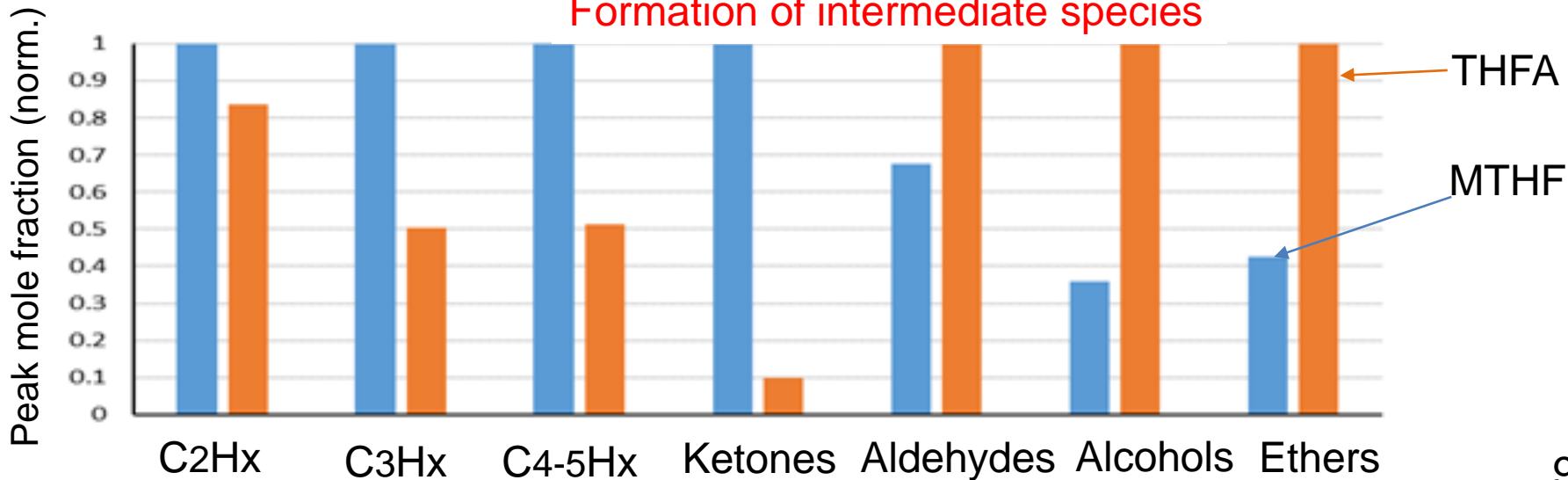
Fuel consumption



Formation of major products

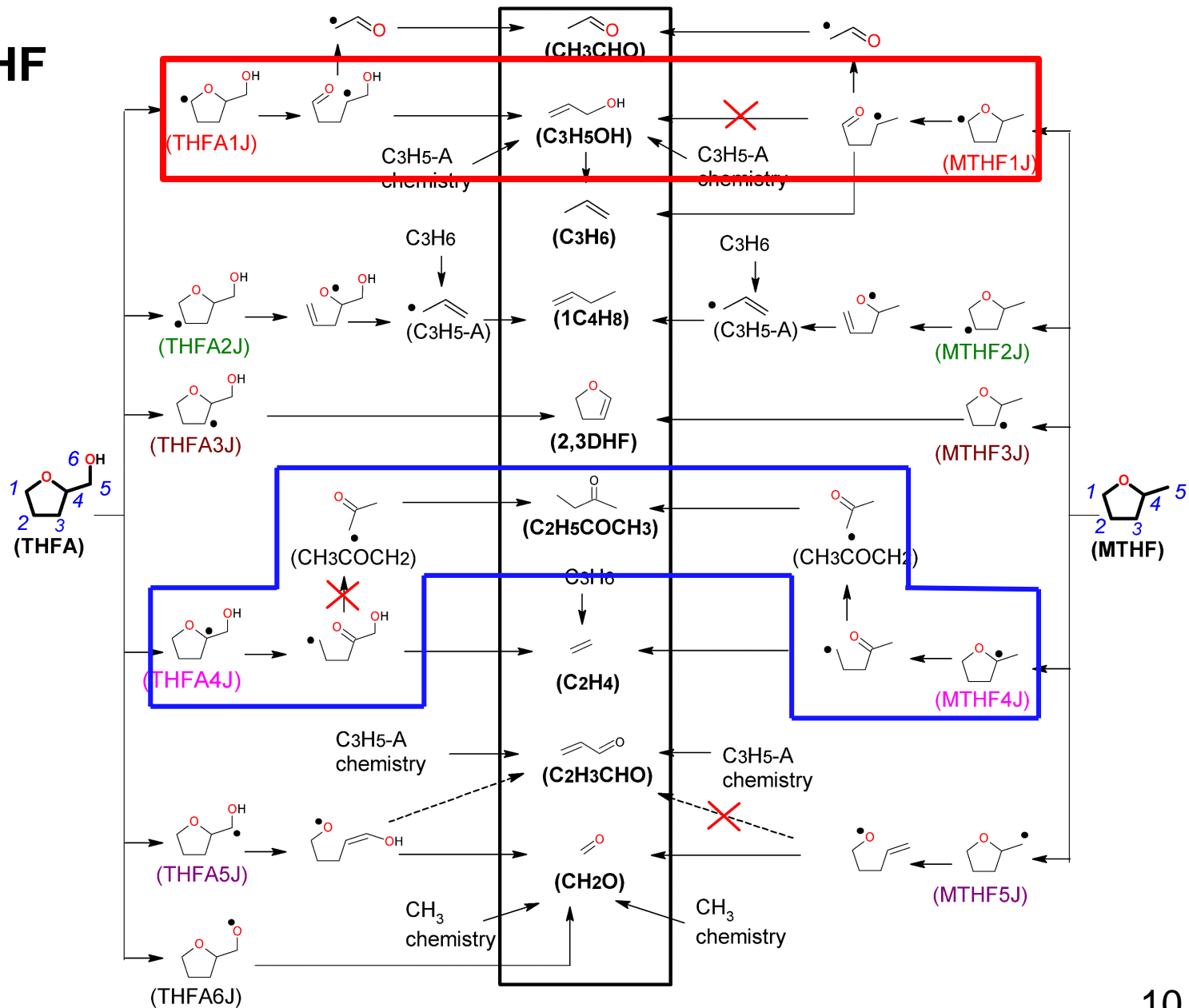


Formation of intermediate species



Examples of our recently-studied liquid biofuels

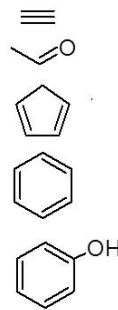
THFA vs. MTHF



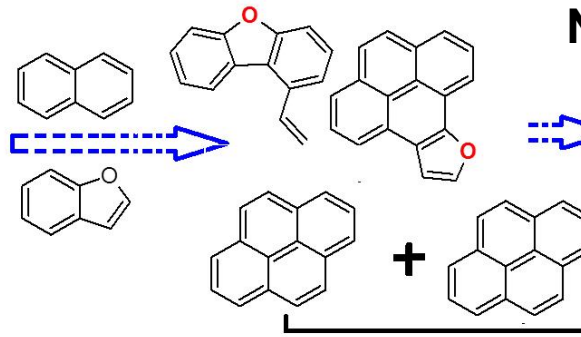
Perspectives: go to **fuel-rich** conditions

- ❑ Necessary to study the influence of biofuel combustion on PAHs/OPAHs/Soot formation, especially **O**PAHs:
- ❑ OPAHs: enhanced by O-atoms of biofuels, more toxic than parent PAHs, involved in the formation of nano soot particles =>increasing the toxicity of soot

Advanced biofuels

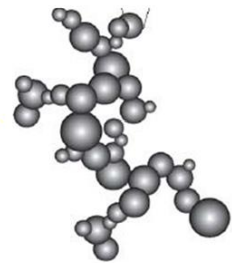


PAHs & **O**PAHs

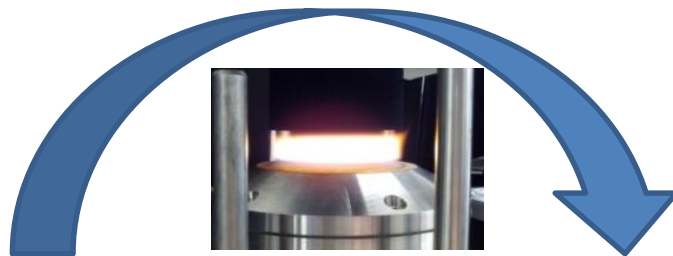
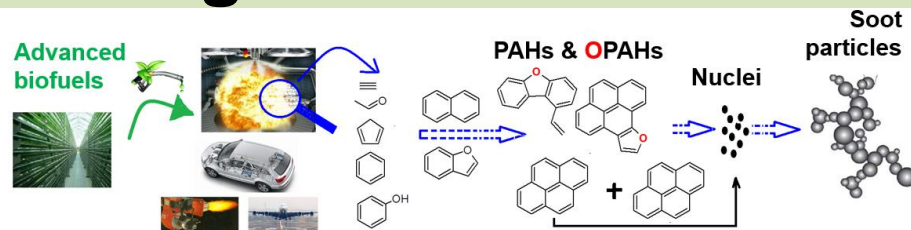


Nuclei

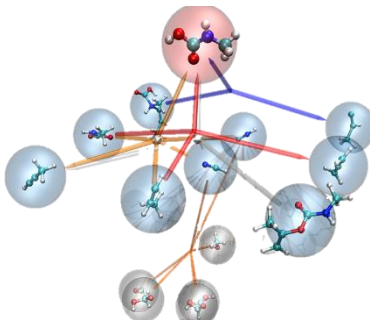
Soot particles



Perspectives: go to **fuel-rich** conditions



Understanding the formation chemistry of OPAHs and nano soot particles (<10 nm).



PhD thesis

Kanika SOOD,
starting from 10/2020
(supervisor:
L Gasnot and LS Tran)



Agence de l'Environnement
et de la Maîtrise de l'Énergie

Project “Biofuel-Soot”, Consortium:

starting from 01/2021

- Juan Lizardo (post-doc)
- Kanika Sood (PhD student)
- L.S. Tran (PC2A)
- L. Gasnot (PC2A)
- A. El Bakali (PC2A)
- P. Desgroux (PC2A)
- V. Vallet (PhLAM)
- C. Toubin (PhLAM)

OVERSEE



107 536 euros

Merci pour votre attention