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2008 - 2011
Refining of Novel Products by Biomass Gasification

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Novel catalytic approach in the production of biofuels

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Introduction

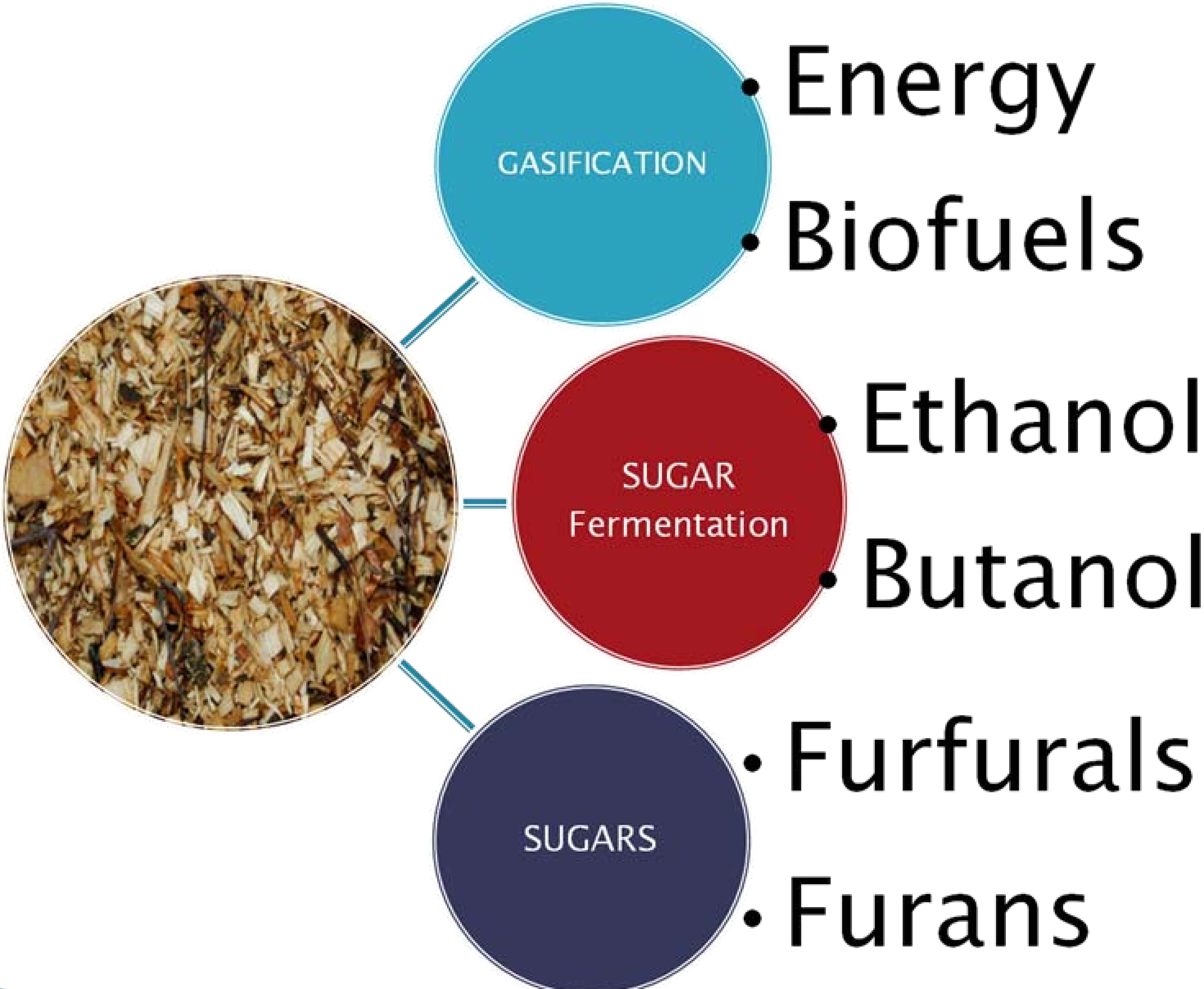
- Conversion of biomasses into biofuels
  - Biofuels
  - Pathways from biomass into biofuels
    - Utilization of biosyngas
    - Fermentation of alcohols
    - Catalytic conversion of biomasses
- Catalytic conversion of sugars into furfurals
    - DMF as a biofuel
- Conclusions

Biofuels

- Ethanol production by fermentation
- Biodiesels
  - DME
  - FT Diesel
- Butanol
- Furfurals and furans

Fuel	Energy density (MJ/l)	RON*
Gasoline	32	91–99
Diesel	35,5	–
Ethanol	19,6	130
Butanol	29,2	96
DMF	30	119

RON = Research octane number



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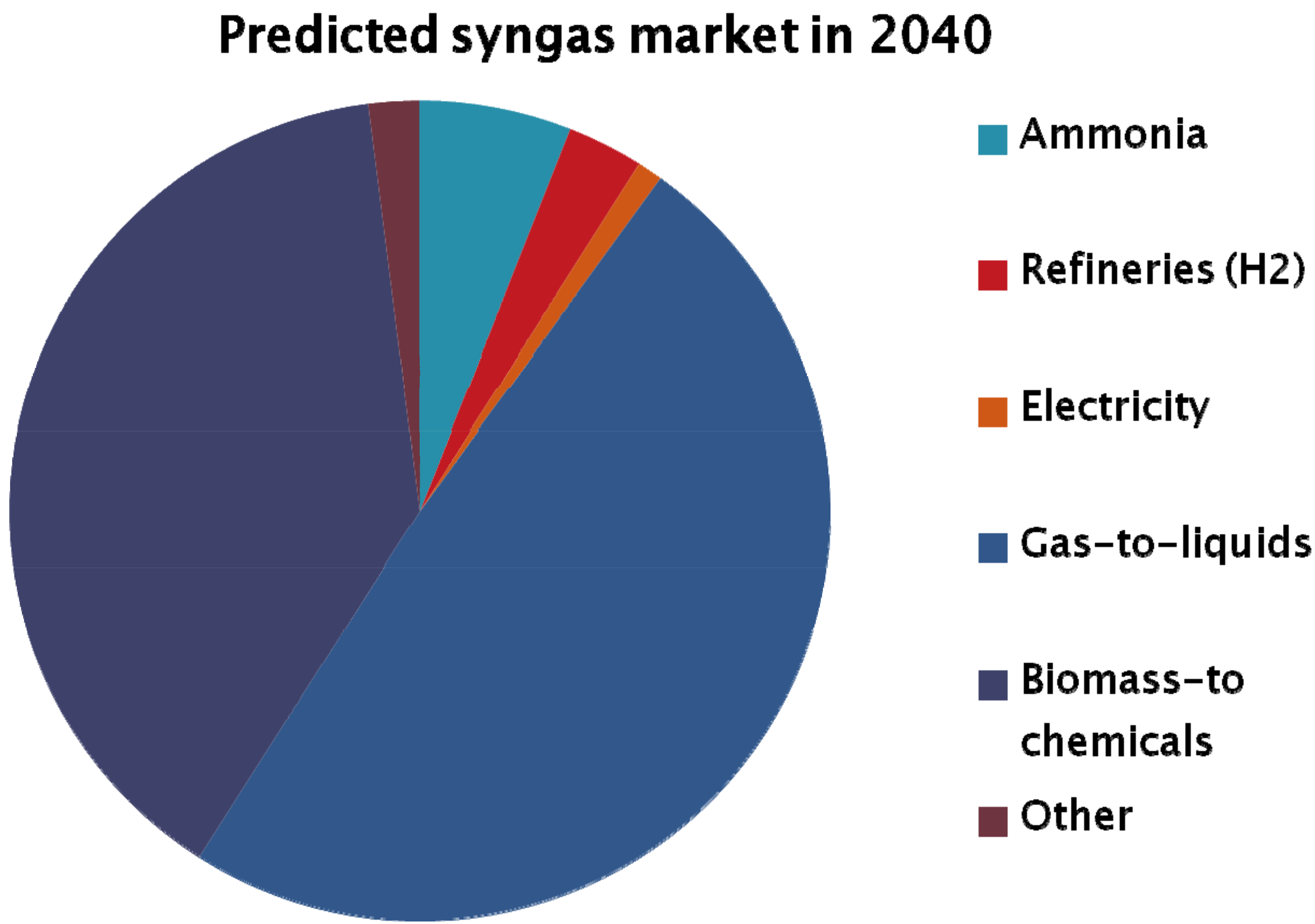


Knoef: Handbook of biomassgasification, 2005

Utilization of biosyngas

- Main application of product gas is direct or indirect combustion to generate power and heat
  - Energy content of syngas (H_2, CO) ~ 50 % of complex composition
    - Economical reasons
- Other applications are catalytic methods:
  - Ammonia synthesis
  - Gas-To-Liquids synthesis
    - Fischer-Tropch (FT)
    - Methanol
    - Mixed alcohol

FT synthesis

- Diesel
- Gasoline

- Active metals Fe, Co, Ru
- Support material alumina, Al_2O_3
- Ruthenium prevents an oxidation of iron and cobalt
- $Cu/Ru/Al_2O_3$, $Fe/Ru/Al_2O_3$

Methanol synthesis

- Methanol

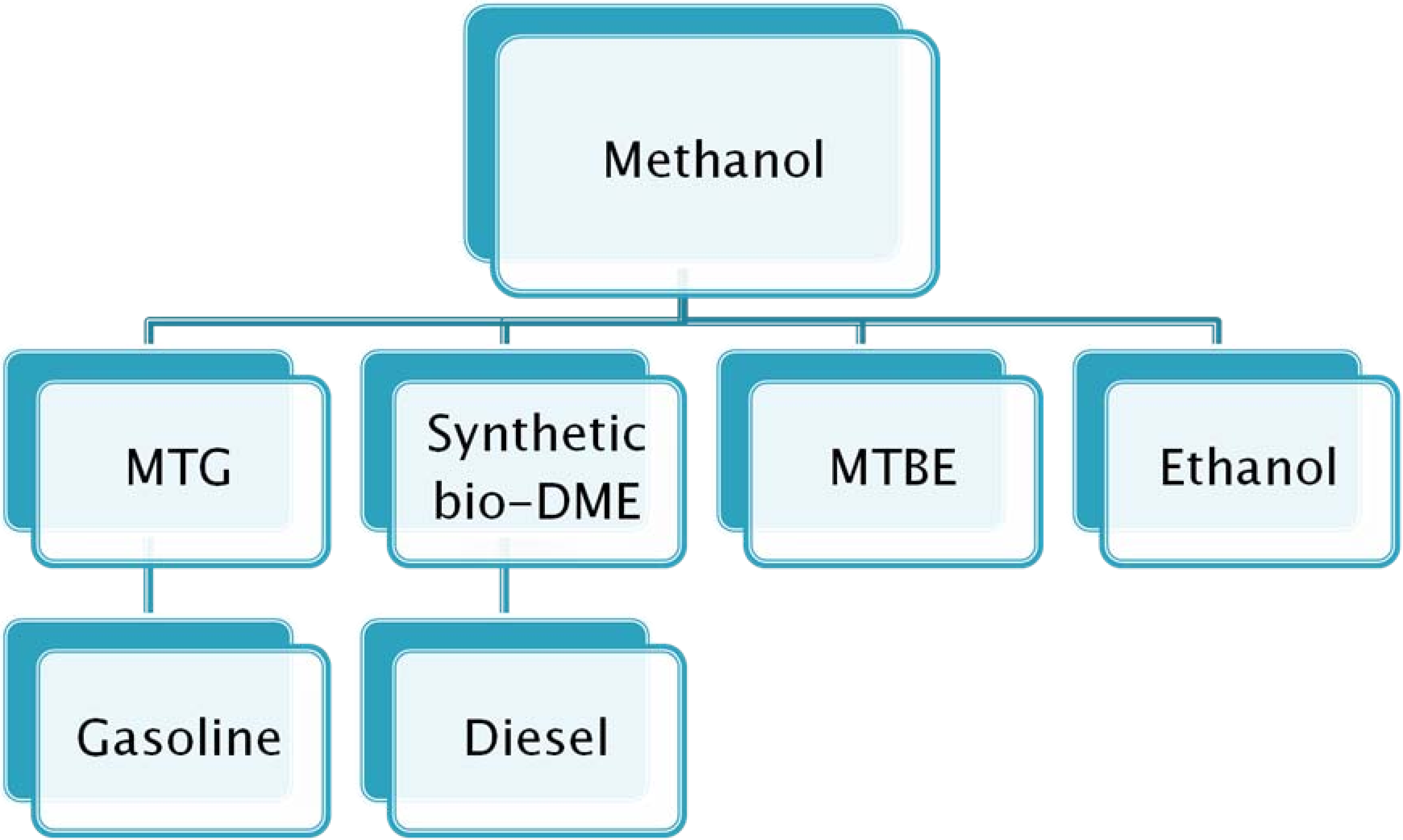
-> ethanol, gasoline, diesel, MTBE

- Most active metal Cu
- Support material alumina or zirkonia, ZnO
- Cu/ZnO, $Cu/ZnO/Al_2O_3$

Mixed alcohol synthesis

- Ethanol
- Butanol

- Alkalimetal catalysts
- Support material alumina, Chromium oxide, cobalt oxide and molybdenum sulphide
- Alkali/ZnO Al_2O_3, Alkali/MoS_2, Fe_2O_3 catalysts


Methanol
MTG
Synthetic bio-DME
MTBE
Ethanol
Gasoline
Diesel

Biofuels from biomasses

Sugars

- Fermentation

- Ethanol
- Butanol

Sugars

- Katalysis

- DMF

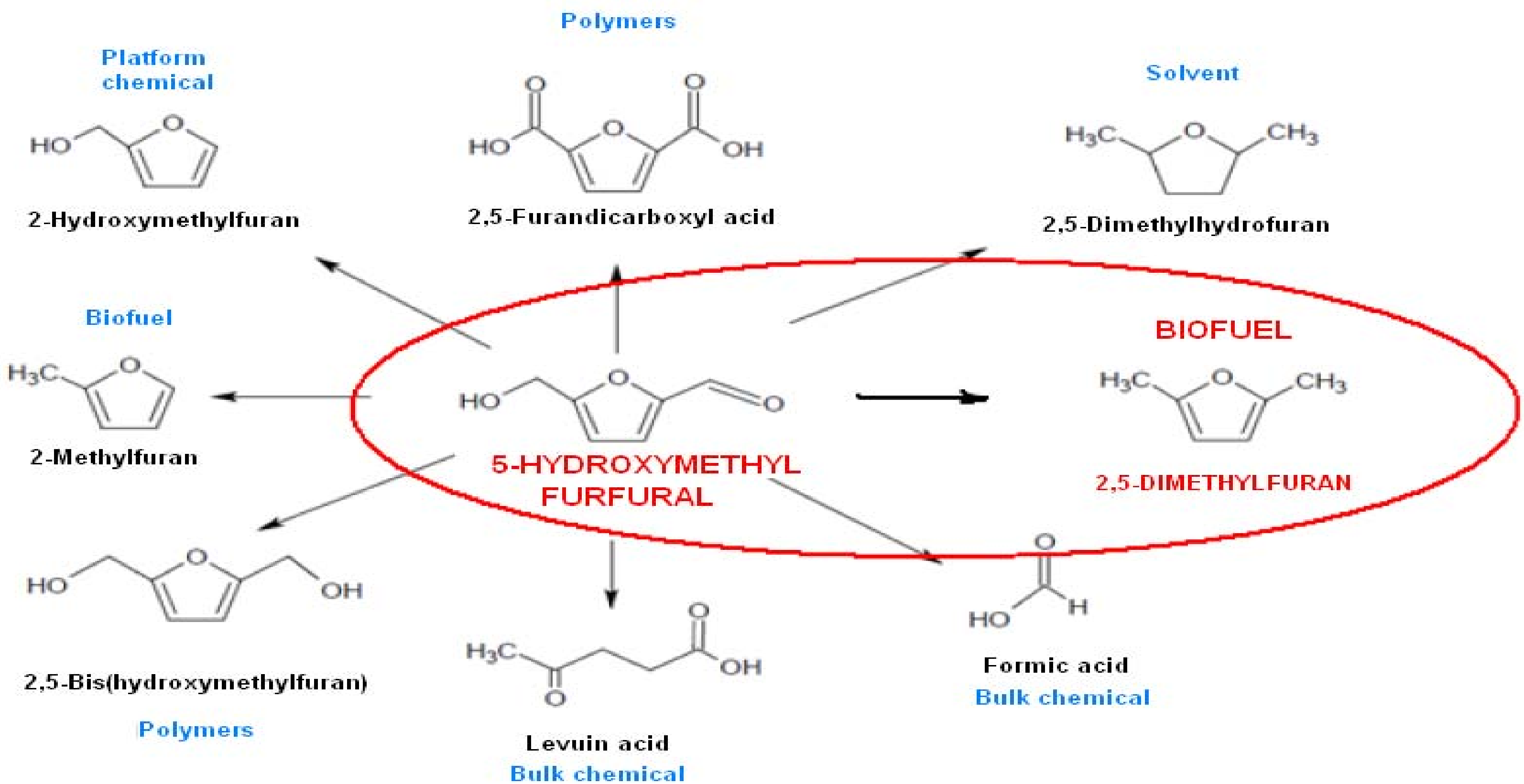
Alcohol fermentation

- Enzyme catalysis
- Ethanol fermentation most commonly used

- Butanol has great advantages over ethanol
  - Higher energy density
  - Lower solubility
    - Less corrosive!
  - Lower vapour density
  - Commercial processes in 5 to 10 years from now

  - Lower productivity
    - Butanol toxic to enzymes
    - Only C_6 sugars
    - Genetic manipulation of enzymes highly developing area!

Catalytic conversion of sugars: HMF



Boisen, A. et al. Chem. Eng. Res. Des, 2009, 87, 9, 1318

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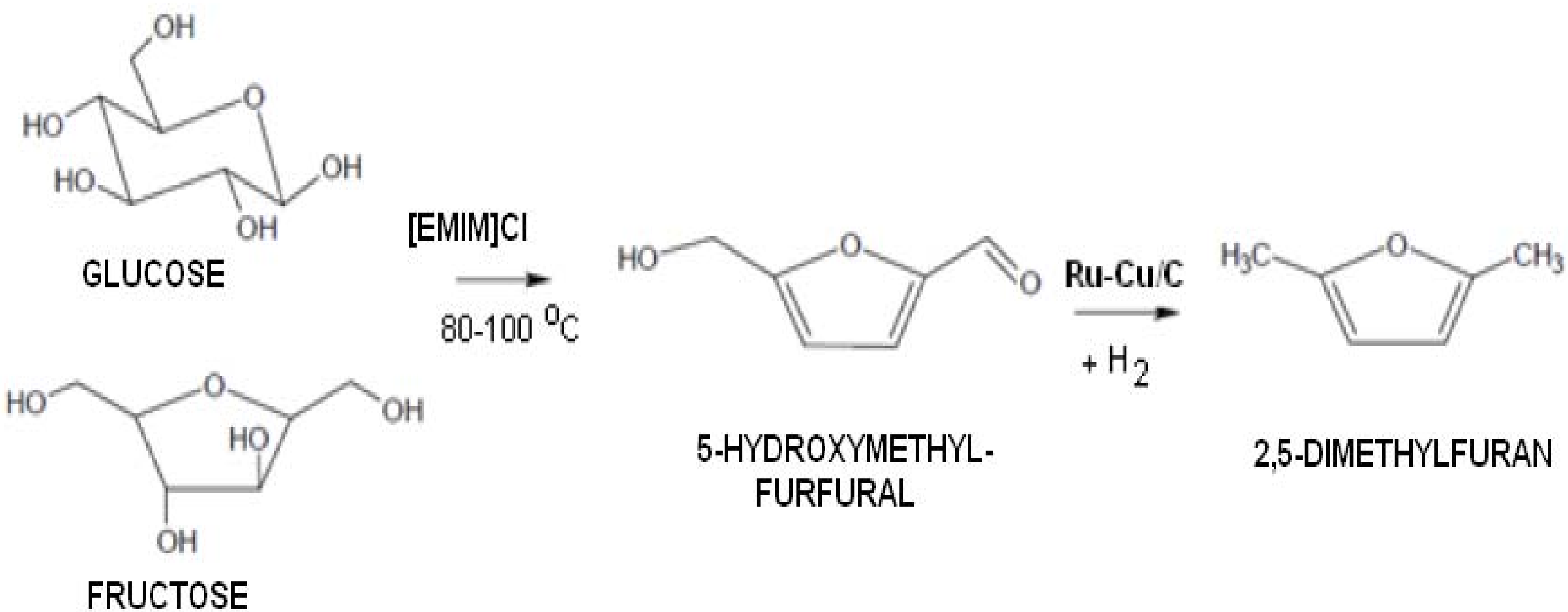
Catalytic conversion of sugars into HMF and DMF



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DMF as a fuel

- DMF has great advantages over ethanol
  - Higher energy density
  - Low solubility in water
    - Less corrosive!
  - Not examined in vehicles yet (corrosion, ...?)

- Processes not yet complete
- A lot of research, a lot of potential
- Commercial processes in 10 years from now?

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Conclusions

- Recent research focused to use waste materials, leftovers and byproducts
- Biorefineries can be converted to biofuels using enzymatic catalysis, heterogeneous catalysis and by combusting biomaterials from syngas to biofuels
- Commercial biofuels ethanol and biodiesel

- Competitive biofuels in 5-10 years
  - Higher alcohols
  - DMF
  - Other?

Thank you.
Questions?

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