

# SYNTHESIS AND CHARACTERIZATION OF SULFONATED ACTIVATED CARBON AS A CATALYST FOR BIO-JET FUEL PRODUCTION FROM BIOMASS AND PLASTICS

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## ABSTRACT

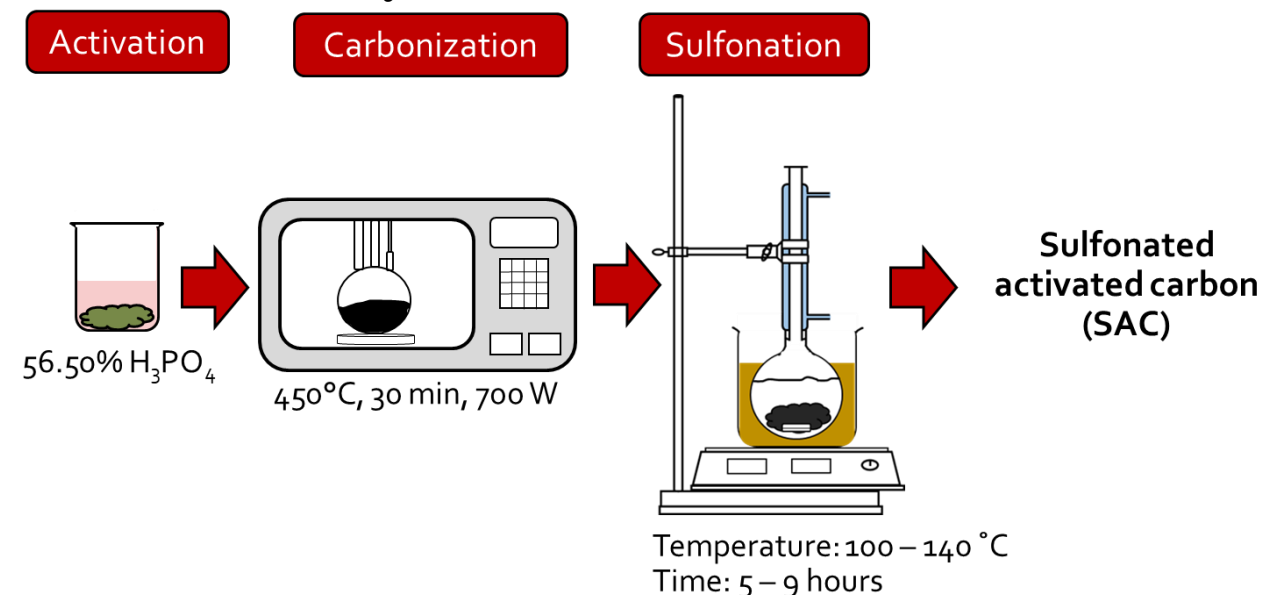
The study aimed to investigate the effects of sulfonation temperature and time on yield and SO<sub>3</sub>H density of sulfonated activated carbon (SAC). SAC-based catalysts were prepared by microwaved-assisted carbonization of phosphoric acid activated corncob followed by sulfonation using concentrated sulfuric acid. Sulfonation temperature showed a significant effect on the introduction of SO<sub>3</sub>H on the AC precursor while time had a minor role. The highest bio-jet fuel range hydrocarbons (aromatics and C8-16 alkanes) obtained was 97.51% using the SAC sulfonated at 100°C for 5h. Results showed that SAC has great potential as a catalyst in the co-pyrolysis of biomass and plastics for the production of jet-fuel range hydrocarbons.

## OBJECTIVES

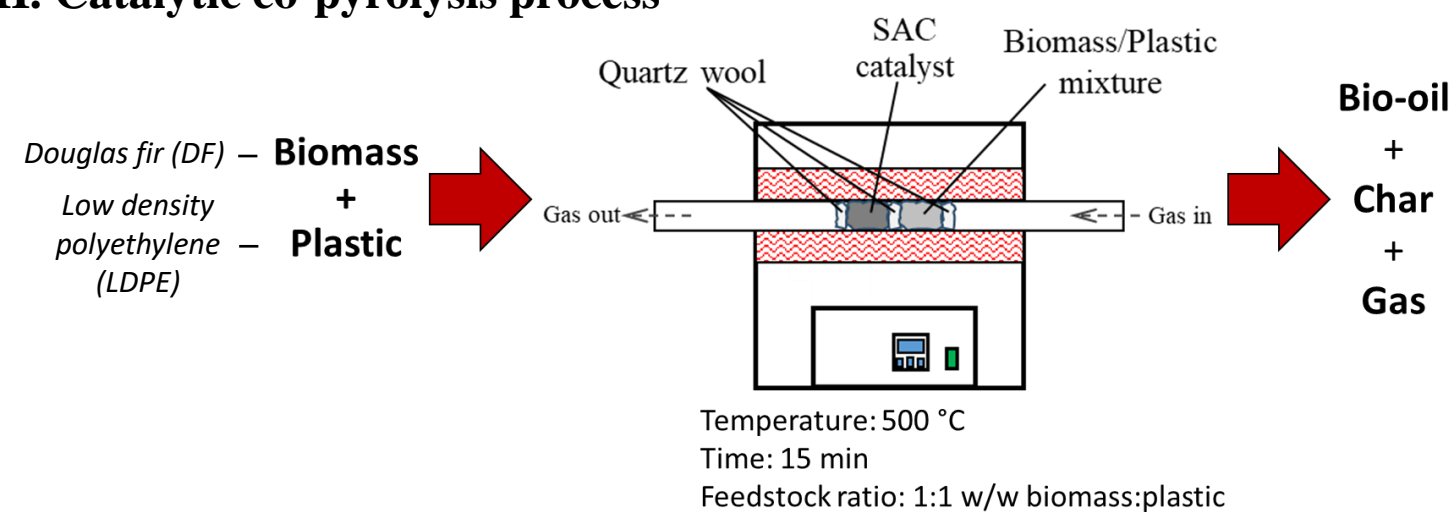
- To investigate the effects of sulfonation temperature and time on yield and SO<sub>3</sub>H density.
- To evaluate the catalytic performance of SAC on the catalytic co-pyrolysis of biomass and waste plastics.

## METHODOLOGY

### I. Preparation of SAC catalyst



### II. Catalytic co-pyrolysis process



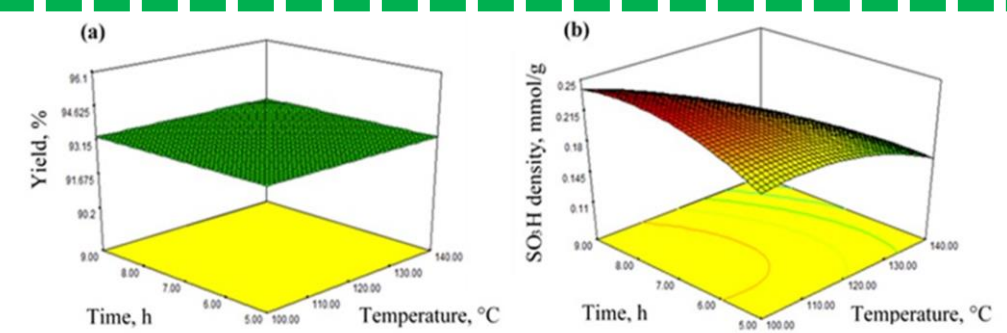
## CONCLUSIONS

Sulfonation temperature had a major impact on the SO<sub>3</sub>H density on carbon precursors while time had a minor role. Although SO<sub>3</sub>H density did not show a significant impact on the product distribution of catalytic co-pyrolysis of DF and LDPE, results showed that SAC facilitated the interactions between the pyrolysis products of DF and LDPE during the co-pyrolysis process. The SAC has a great potential as an efficient catalyst on the production of bio-jet fuel range alkane and aromatic hydrocarbons via co-pyrolysis of biomass and plastics.

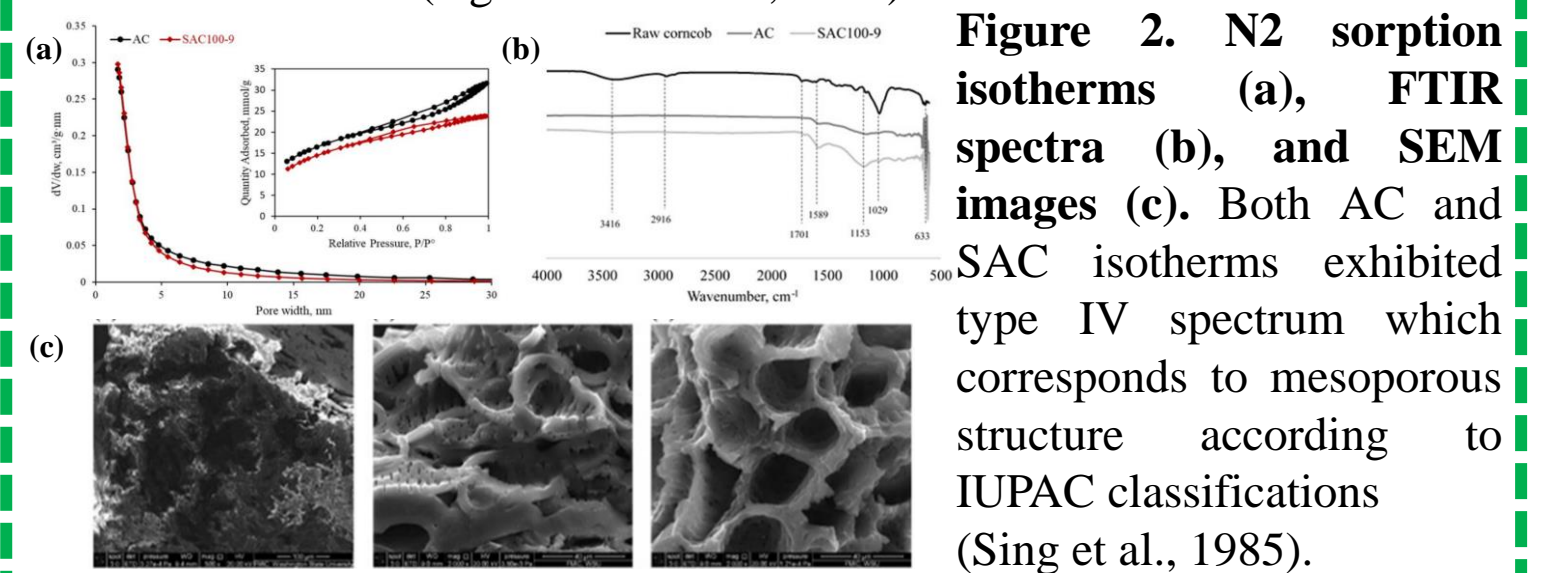
## INTRODUCTION

Pyrolysis is recognized as one of the promising technology for the production of solid, liquid, and gaseous products that can be used as alternative sources of energy (Balat et al., 2009). The high liquid production of up to 70wt% of dry feedstock in the biomass fast pyrolysis has caught the interest of many researchers because of the great potential of the liquid product as a substitute for fossil-based fuels and chemicals. The complex composition of bio-oil poses several problems including high acidity, high viscosity, instability, as well as high water and oxygen content resulting in low heating value. Thus, upgrading of bio-oil to improve its quality similar to hydrocarbon fuels is necessary to overcome these challenges in bio-oil's further utilization and applications (Bridgwater, 2012). Catalytic co-pyrolysis of biomass and plastic is an emerging and promising technology towards clean and environment-friendly valorization of waste plastics to high-value products including fuels and chemicals. The use of SAC as a catalyst for catalytic co-pyrolysis of biomass and plastics for bio-jet fuel range hydrocarbon production has not yet been investigated.

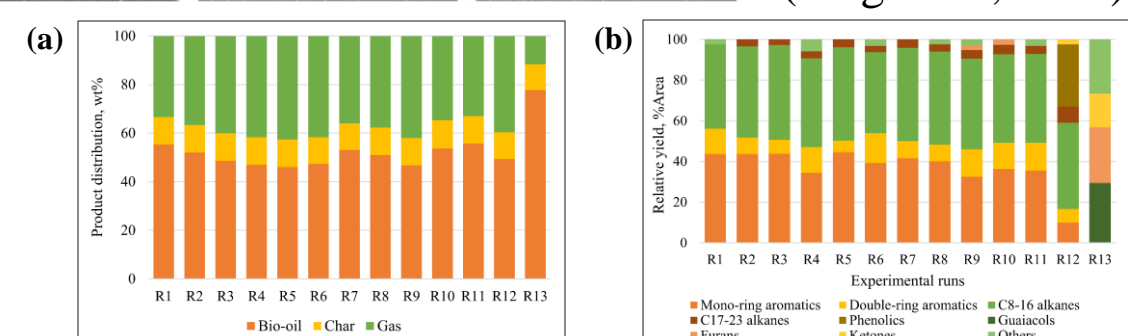
## RESULTS AND DISCUSSIONS



**Figure 1. Response surface and contour line of yield (a) and SO<sub>3</sub>H density (b).** The S content of the SAC was used as the appropriate parameter to estimate the SO<sub>3</sub>H density assuming all S atoms were present on the carbon surface as SO<sub>3</sub>H groups (Liu et al., 2010; Malins et al., 2015). The reduction of SO<sub>3</sub>H group density as the sulfonating temperature increase may be due to the oxidation/dehydrogenation reaction taking place besides sulfonation. (Ngaosuwan et al., 2016)



**Figure 2. N<sub>2</sub> sorption isotherms (a), FTIR spectra (b), and SEM images (c).** Both AC and SAC isotherms exhibited type IV spectrum which corresponds to mesoporous structure according to IUPAC classifications (Sing et al., 1985).



**Figure 3. Product distribution (a) and chemical composition of the bio-oil (b).** The major compounds found in the bio-oil from the co-pyrolysis were aromatics, alkanes, and other oxygenated compounds. Results showed that the introduction of SO<sub>3</sub>H to the SAC catalysts had significantly improved the quality of bio-oil compared to using AC catalyst. Results implied that the increase in acidity contributed by the introduction of SO<sub>3</sub>H groups into the AC materials promoted catalytic cracking, hydrogenation and aromatization reactions.