

## Synthesis and incipient impregnation of MCM-22 zeolite for the one pot conversion of furfural to $\gamma$ -valerolactone.

Y. L. Lima<sup>1\*</sup>, L. H. Vieira<sup>1</sup>, J. F. Gomes<sup>2</sup> J.M. Assaf<sup>2</sup>, E. M. Assaf<sup>1\*</sup>

<sup>1</sup>University of São Paulo, São Carlos, Brazil

<sup>2</sup>Federal University of São Carlos, São Carlos, Brazil

\*yurilima\_10@usp.br; eassaf@iqsc.usp.br

**Keywords:** biomass, furfural,  $\gamma$ -valerolactone, MCM-22 zeolite.

**Background and motivation.** Due to the environmental problems caused by fossil fuels, there is an increasing interest in green and renewable energy sources like biomass. Furfural (FAL), derived from biomass, is essential for making biofuels and other valuable products. Gamma-valerolactone (GVL), a versatile compound derived from furfural, holds promise as a sustainable fuel additive and chemical precursor. The conversion of FAL to GVL involves multiple reaction steps, requiring catalysts with an optimal balance of Brønsted and Lewis acid sites. This research focuses on creating bifunctional MCM-22 zeolite catalysts that have Brønsted acid sites and encapsulated transition metal clusters to produce GVL from FAL.

**Materials and methods.** The synthesis of the MCM-22 zeolite was carried out using a hydrothermal method adapted from the literature [1]. Zr and Cu metal clusters were added by incipient impregnation followed by calcination. The synthesized catalysts were Zr<sub>0.8</sub>/MCM-22; Cu<sub>0.6</sub>/MCM-22 and Zr<sub>0.8</sub>Cu<sub>0.6</sub>/MCM-22 (values in wt%). For catalytic tests, 0.1 g of catalyst was added to a reactor with 10 mL of 0.1 M FAL solution in isopropanol, stirred at 170 °C for 5 hours under 20 bar N<sub>2</sub> + autogenous pressure.

**Results and discussion.** Figure 1a depicts product selectivity for the studied catalysts. The low values for GVL selectivity can be attributed to the low amount of metal active sites in the catalysts. This coupled with the excess of FAL ( $g_{cat}/g_{FAL} = 1$ ) was responsible for the saturation of the active sites, hindering the complete conversion in the reaction pathway (figure 1b). Consequently, the Zr<sub>0.8</sub>Cu<sub>0.6</sub>/MCM-22 which has a higher number of metallic active sites achieved the best GVL selectivity. Further optimization of reaction conditions and modifications to the MCM-22 zeolite are the next steps to achieve higher GVL selectivities.

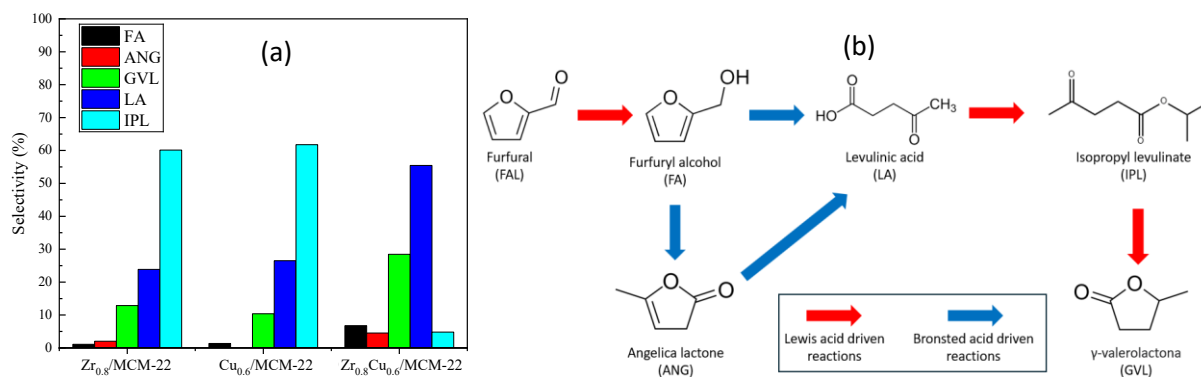


Figure 1 – (a) Product selectivities for the studied catalysts. (b) Reaction pathway for the conversion of FAL to GVL.

### Acknowledgments

The authors are grateful for the financial support of the São Paulo Research Foundation (FAPESP) (Project: 2024/01433-2)

### References

[1] Cheng, Yue, Xiao Yuan Su, and Mang Lu. *Advanced Materials Research* 197 **2011**, 1587-1590.