Development of Cu-based hybrid catalysts for the electrocatalytic CO_2 reduction to added value products

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The simultaneous need to reduce greenhouse gas emissions and increase our energy supply makes the electrochemical reduction of CO_2 a very attractive alternative [1]. In this context, science seeks effective methods to transform CO_2 into chemicals of economic value. Among the possible products to obtain, we are especially interested in species with one or more carbon-carbon bonds, these types of compounds are favoured using copper as catalyst. Six catalysts were synthesized with different ratios of Cu, Zn Al and subsequently exposed to a thermal treatment to obtain the correspondent oxidized compounds. These kinds of catalyst are traditionally used in thermocatalysis for the efficient production of methanol at high temperature and pressure conditions [2]. Noting the good performance of this catalyst in thermocatalysis, it was chosen to carry out the experiment in the electrochemical reduction of CO_2 at ambient conditions. Electrochemical tests were carried out in the rotating disk electrode (RDE) in order to reduce the mass transfer limitations that may exist due to the low solubility of CO_2 in an aqueous medium. The chemical-physical properties of the catalyst were studied by several characterization techniques (e.g. XRD, XPS, BET, among others) to understand the role of the modification of the catalyst components during operation in the final selectivity and activity. Among the liquid products obtained are acetone, ethanol, isopropanol, formic acid and in some cases, methanol was also found. Moreover, gaseous products obtained were hydrogen, carbon monoxide and methane, being these last - gaseous products - those that present the highest faradaic efficiencies. These results were compared with the performance of the catalysts in a Gas Diffusion Electrode (GDE) cell, to obtain commercially-relevant current densities.

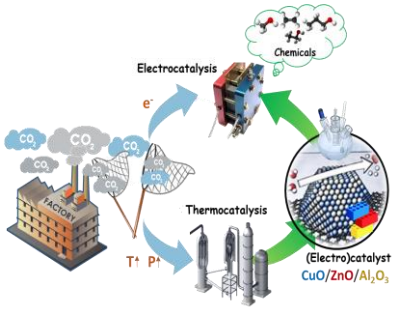

Figure 1: Synergies between thermo- and electro- catalysis for CO_2 conversion to added-value products

References

1. Hernandez, S., Farkhondehfal, M.A., Sastre, F., Makkee, M., Saracco, G., Russo, N. *Green Chemistry*. **2017**, 19, 2326 - 2346.
2. Ganesh, I. *Renewable and Sustainable Energy Reviews*. **2016**, 59, 1269-1297.