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Au/TiO_2 Catalyst for Conversion of CO_2 in Ethanol

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Global warming is one of the most serious problems humanity is facing, changing fauna and flora over the years and putting at risk the existence of life as we know it. There is an urgent need to reduce the emission of greenhouse gases, because the emission of these types of gases may one day be no longer optional. Aligning environmental concerns with the need for the formation of the valuable C-C bonds from a non-fossil resource, widely available and renewable, the valorization of CO_2, as well as its use as a source of carbon in fine chemicals synthesis, receives great relevance today.[1,2] However, because it is a thermodynamically stable and kinetically inert molecule, employing CO_2 as a building block in fine chemical synthesis is very challenging. Among the various types of CO_2 utilization reactions, its direct application to olefin carbonylation has attracted great interest. The classical process of hydroformylation, carbonylation of olefins with synthesis gas (CO and H_2), which employs Rh and Co catalysts, is considered a leader in the industrial production of aldehydes. The direct use of CO_2, possibly with the formation of CO in situ, requires new catalysts or CO_2 activators.

In the present work gold nanoparticles supported in TiO_2 (anatase), has been successfully synthetized by deposition–precipitation with urea (DPU), where $HAuCl_4$ is vigorously stirred at 80ºC for 20h with a little excess of urea in deionized water. Afterward the solid is washed with acetone and water and dried under reduced pressure. The catalyst has been characterized by transmission electron microscopy, **Figure 1**, showing the formation of 1 nm averaged gold nanoparticles well distributed in the TiO_2 (anatase) surface. Atomic absorption spectrometry analysis demonstrated that 91% of the $HAuCl_4$ gold was impregnated in the TiO_2 (anatase) surface, resulting in 0.97 wt.% Au.

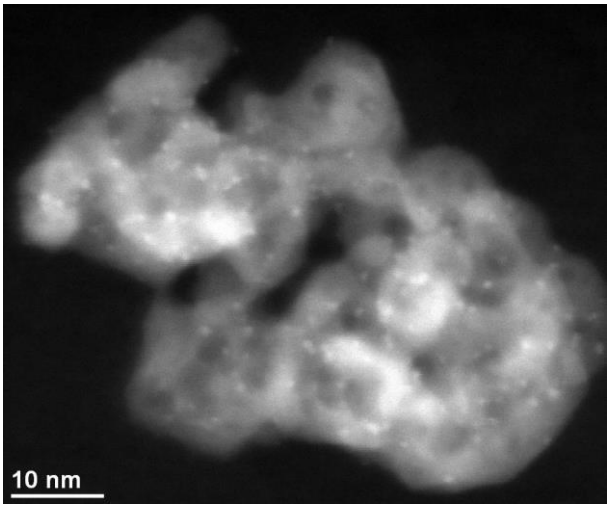

Figure 1. Au/TiO_2 catalyst

The catalyst successfully converts CO_2 and H_2 giving ethanol as the only product. The reaction was performed at 40 bars of CO_2/H_2 3:1 (at room temperature) and heated to 200ºC with DMF or Acetonitrile as solvent for 10 hours. Currently the work is focusing on studying the effect of solvent, additives and catalyst doping in the yield/selectivity of the reaction. The obtained results exhibit the potential of the Au/TiO_2 system to activate small molecules like CO_2 and H_2, as already demonstrated by our group,[3] having the potential to catalyze other types of CO_2 conversion, like olefin carbonylation.

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References

[1] Čuček, L.; Klemeš, J. J.; Varbanov, P. S.; Kravanja, Z., Clean Technol Environ Policy., 2015, 17, 2125–4211.
[2] Budzianowski W. M.; Postawa K., Renew Sustain Energy Rev., 2017, 68, 852–868.
[3] Fiorio J. L.; Lopez, N.; Rossi, L. M., ACS Catalysis, 2017.