Formic acid and CO as key 'power molecules' in the catalytic conversion of CO_2 to chemicals

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The chemical industry is heavily dependent on oil-based resources, the latter being required for the synthesis of 87% of chemicals in 2016.[1] To reduce this need and engage into a circular economy pathway, which would ultimately lead to its carbon-neutrality, it would be attractive to synthesize chemicals directly from CO_2. Nevertheless, the direct use of CO_2 for the production of functionalized chemicals remains limited in industry: its use as a C_1 building block for the production of chemicals has been well developed for the production of urea (81 Mt in 2016), salicylic acid (70 kt/y), and more recently for the production of cyclic and polymeric carbonates (130 k/y).[2] These transformations implicate the functionalization of CO_2, but only chemicals containing a carbon at the +IV oxidation state have been industrially synthesized so far. Accessing other chemicals directly from CO_2 would require synchronizing reduction and functionalization, which is an active field of research but is difficult to control. An interesting intermediate would be carbon monoxide (CO) that can provide access to functionalized chemicals at a more reduced oxidation state, +II, closer to the average oxidation state of most industrial chemicals.

In this lecture, I will discuss our recent progresses in CO chemistry aiming at developing novel carbonylation reactions with ideal atom economy and coupling CO production from CO_2 with its downstream use in catalysis.[3-5] Key transformations highlighting the potential of formic acid as a sustainable source of carbon and hydrogen will be presented.[6-7]

References

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