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Depolymerization of Waste Plastics and Wood Lignins to Valuable Chemicals Using a Hydrosilylation Strategy

Plastics are ubiquitous in our modern society. Mainly due to their lightness, their ease to be molded and their low costs, these polymers have forced their use in various applications such as electronics, packaging, medicine, etc. It is estimated that 4-6 % of the annual production of fossil resources are used to supply the 335 million tons of plastics required worldwide.(1) Main recycling processes of these materials do not meet sustainable criteria since they are based on incineration and landfilling and the latter causes irreversible contamination of the oceans, the soils and the fauna leading to an increasing concern in the population.

To circumvent these ecological issues, the most promising approaches consist in decoupling plastics from fossil feedstocks by producing biosourced monomers and to improve recycling at the same time as to reduce losses of organic matter.(2) In this context, we recently developed an efficient hydrosilylation strategy for the depolymerization of oxygenated polymers such as some plastics and lignin to afford pure compounds.(3) This method involves the reduction of oxygenated polymers under homogeneous catalytic conditions with tris(pentafluorophenyl)borane $B(C_6F_5)_3$. Based on this approach, we search for novel metal catalysts able to hydrosilylate strong C–O bonds and that would be more stable and selective than $B(C_6F_5)_3$

We found that Brookhart's iridium(III) complex supported by pincer ligands $[(tBuPOCOP)IrH(THF)][B(C_6F_5)_4]$ ($tBuPOCOP = 1,3\{tBu_2PO\}_2(C_6H_3)$) (4) is very efficient catalyst for the reduction in homogeneous conditions of model compounds and natural or manufactured polymers. This complex enables the convergent depolymerization of lignin samples from various plant species(5) as well as polycarbonates or polyesters,(6) under mild conditions (<80 °C, 0.3-3 %mol). The reactivity and the stability of this new catalytic system and its role in the reduction of C-O bonds will be presented.

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