3. Surface chemistry and catalysis

Supported catalysis by shape-controlled nanoparticles

The possibility to grow anisotropic objects on metal surfaces inspired us to develop new supported catalysts based on nano-objects prepared by colloidal chemistry. This approach enables a control of the morphology of the catalytically active phase, but at the same time implies the presence of surface stabilizers on the catalyst. Macroporous supports such as metal foams have the advantages of facilitating heat exchange, of limiting the effects of interactions between the support and the active part of the catalyst and of allowing better accessibility to the active phase. In collaboration with the LCC and IFP-EN, we have used macro-structured copper foams as supports for growing in solution cobalt nanowires of hcp structure, considered to be the most active phase for the Fischer- Tropsch (FTS). The foan support functions as a seed for the growth of Co nanowires (Figure 1). Studies of the catalytic performance in fixed bed FTS of a Co@Cu_{foam} catalyst have shown much higher activity and selectivity towards long-chain carbon products than reference catalyst of the IFP-EN (Co-Al_2O_3-SiO_2) of the same Co content. Excellent stability in FTS tests lasting up to at least 80 hours has also been demonstrated. It should be noted that after reaction, the catalyst does not show any signs of morphology change. The remarkable performances presented by this catalyst can be explained by the purely hcp structure (more active than the fcc), but also by the good management of the exothermicity which prevents sintering, while promoting the propagation of the chain and by limiting CH_4 production (Angew Chem 2018).

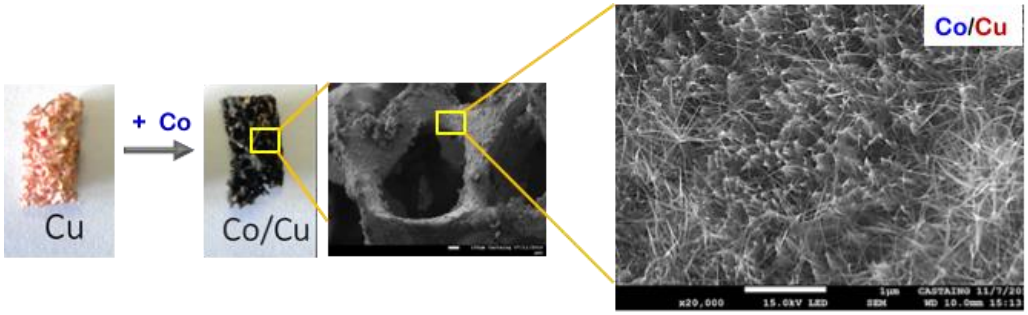

Fig. 1 : Monolithic catalyst of Co nanowires on Cu foam

We have also developed "multipode" cobalt nanoobjects by liquid phase overgrowth of Co nanowires on Co particles already existing on the IFP-EN reference catalyst (Figure 2). The morphology is not stable after 500 hours of reaction, however, the hcp structure and the metal character are preserved and very interesting results in terms of stability with respect to the IFP-EN reference catalyst have been obtained in slurry reactor. The ligands present on the catalyst are responsible for this stability, but also of a lower activity compared to the reference catalyst (ChemCatChem, 2018).

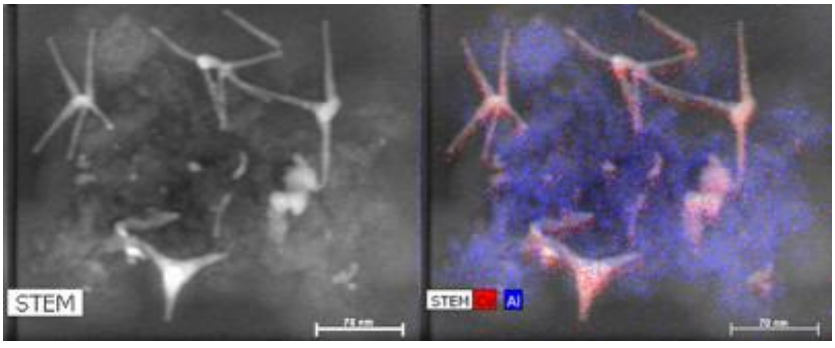

Fig. 2 : Co nanowires developed by Co overgrowth in solution on Co-NPs belonging to a conventional catalyst.