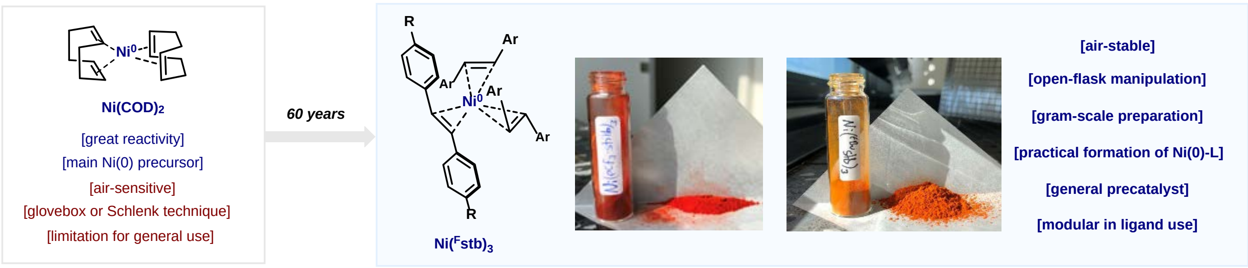
# Research Interests – Dr. Josep Cornellà

Our research programme is driven by our passion for organic synthesis, and the discovery of new transformations that will enable the fast, practical and efficient assembly of complex molecular structures in a more sustainable fashion. To this end, homogeneous catalysis provides the adequate platform to investigate new reactivity and will certainly play a key role in developing sustainable chemical processes in the near future, which have an enormous impact in our society. In addition to efficiency and practicality, we are highly interested in the fundamental reactivity of catalysts and the application of catalytic processes to construct new chemical bonds in organic synthesis.

One of our main research areas has focused on the study of nickel (Ni), a cheap and Earth-abundant metal with fascinating diverse catalytic activity in a variety of chemical transformations. Nickel has been for years involved in the preparation of pharmaceutical and agrochemical compounds as well as in the production of multi-ton industrial compounds (Shell Higher Olefin Process or oligomerisation of butadiene). However, since its discovery in 1960 by the late Günther Wilke (Max-Planck-Institut für Kohlenforschung), $Ni(COD)_2$ (Figure 1, left) has vastly dominated the area, thus reigning sovereign for more than 60 years as the main source of Ni(0). However, $Ni(COD)_2$ is highly air-sensitive and must be handled and stored under inert atmosphere at low temperatures to prevent decomposition. This leads to tedious manipulations and the use of expensive infrastructure associated with high energetic demands. With these drawbacks in mind, our laboratory has recently developed a couple of air- and bench-stable Ni(0) complexes: $Ni(^{4\text{-tBu}}stb)_3$ and $Ni(^{4\text{-CF3}}stb)_3$. These new nickel catalysts circumvent all the sensitivity issues and remain stable under air for long periods of time (Figure 1, right). The development of these complexes is a solution to years of tedious, expensive and energetically costly chemistry using gloveboxes or Schlenk techniques and provides access to facile and practical setups for Ni catalysis.

The facility of handling and storage, their facile preparation at multi-gram scale and the high reactivity associated, immediately caught the attention of the scientific community. The work, published earlier this year in *Nature Catalysis* 2020, *3*, 6–13, and subsequently in *Organometallics* 2020, *39*, 3295, was highlighted by several scientific journals such as *Nature Catalysis*, *Chemical & Engineering News*, *Organic Processes and Research Development* and *Nature Reviews Chemistry* and led to the filing of a patent. After the publication, the technology was rapidly licensed by a chemical company and (STREM chemicals) in order to commercialise the catalysts to industries and laboratories worldwide.




*Nature Catalysis*, **2020,** *3*, 6-13
*Organometallics* **2020**, *39*, 3295
*Patent:* EP19189236.3

**Figure 1**. Development of an air-stable Ni(0) catalyst.

In another endeavour driven by our passion for discovery, our group scrutinised the periodic table in search for a dormant element, whose properties were yet to be awakened. In this sense, we focused our attention on bismuth (Bi), the last stable element of the periodic table. This element is abundant and cheap and certain benign properties have been associated with it. For many years, this element was considered an outlier, something that would not be catalytically interesting for organic synthesis. But these misconceptions could not be farther from the truth, as bismuth hid an enormous potential which was yet to be exploited. Encouraged by this disregard, our group started to work on this element in order to understand the fundamental reactivity. By doing so, we could tame its properties and develop catalytic processes, which are of high interest for the chemical industry. For example, we have been able to use bismuth to forge carbon-fluorine (C-F) bonds, which are of capital importance in the design of medicines. This work, published in *Science* 2020, *367*, 313–317, represented a paradigm shift in catalysis, as it opened the door to the visualisation of bismuth as a good candidate to explore and discover new chemical pathways previously unknown. We are incredibly honoured to being one of the recipients of the Heinz Maier-Leibnitz Prize 2021, as it represents a high recognition to all the contributions of my co-workers, which have joined my research laboratory over these four past years. Receiving this honour certainly elevate our spirits and helps to consolidate our research approach in the field of homogeneous catalysis.