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Chemical bonds, which are crucial for converting raw chemicals into useful products for society in a sustainable fashion [1]. Homogeneous catalysts, which generally consist of metal centres surrounded by a variety of ligands, are highly versatile, act under mild conditions and can give very high selectivities. By tuning the metal centre and the surrounding ligands, regio-, chemo-, regio-, and stereo-selectivities can be controlled so that a very wide range of different products can be made available. As nature has served as a dominant source of inspiration in the area of catalytic chemistry, it is no surprise that enzymes have served as natural prototypes for the design of catalysts. By far the oldest homogeneous catalysts are metallocenes, although one might wonder whether a metal complex built in to higher molecular weight proteins, encapsulated in a compartment of a cell is truly homogeneous. If the answer is positive it means the homogeneous catalysts are millions of years old. Some famous examples complexes are the following: iron porphyrin complexes active for oxidation, cobalt corrin (vitamin B₁₂) complex for carbon–carbon bond formation, copper imidazole (from histidine) complex in hemocyanin, etc. [2].

To carry out a reaction with the help of homogeneous catalyst, not only choice of metal centre is important, also the selection of ligand is equally important. Different transition metals are employed to carry out a variety of reactions. Table 1 summarizes the most important homogeneous catalytic reactions and the corresponding metal combinations that give stable complexes and

selective reactions. Table 2 lists the most commonly used ligands in industry [3]. Ligands play a key role in tuning the reactivity of metal complexes. One metal can give a variety of products for a single substrate simply by changing the ligands around the metal center. For example, variety of products can be obtained from butadiene with various nickel catalysts. Polymers are obtained when allylnickel(II) complexes are used as catalysts and cyclic dimers and the cyclic *trans* trimers are the products when NiCl₂ is the catalyst precursor. Linear dimerisation requires the presence of protic species [4].

The stability and the selectivity of a homogeneous catalyst are strongly related to its molecular structure as well as size, bonding and secondary interactions of ligands with metal. These properties of ligands can be explained in terms of steric and electronic properties. Modeling methods can be used to judge the steric properties of a ligand. However, electronic properties of a series of ligands are typically achieved using spectroscopic probe, such as the IR vibrational frequency of a metal–CO complex, structural determination of M–L bond lengths (e.g., *trans*-influence and reactivity studies). A comparison of electron donating strength of different ligands can be made by the IR ν(C–O) stretching frequency in a complex of Ni(CO)₂(L)₂. Lower the frequency higher would be the electron donation by the ligand (L). However, structural determination of the M–L bond lengths from X-ray data on palladium complexes containing a *trans*-PdCl₂ motif. Catalysts are classified into homogeneous and heterogeneous catalysts. Homogeneous catalysts are those that give stable complexes and