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Synthesis, characterization of copper based metal organic frameworks and their application in heterogeneous catalysis

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Metal organic frameworks (MOFs) are crystalline porous materials that consist of metal ions/clusters (which act as connectors), coordinated to organic ligands (linkers) to form 2-D or 3-D framework like structures. Basically the choice of metal and the linker dictates the structure of the MOF and hence the properties. The properties exhibited by MOFs are; high surface area, high porosity, size selectivity, fine-tunability and stability. Due to these physiognomies, MOFs can be applied in many industrial applications. Heterogeneous catalysis is one of the important applications of MOF materials. Not only MOFs exhibit higher catalytic activity but also when they are used as catalysts they allow for easier separation and recyclability. In this project the catalytic behavior of two known Metal Organic Frameworks; STAM-1 (St. Andrew's MOF-1) and Cu[TPA] (Copper Teriphthalate) is studied with compared to HKUST-1 (Hong Kong University of Science and Technology) and MIL-100 (Materials of Institute Lavoisier–100).

STAM-1, Cu[TPA], HKUST-1 and MIL-100 were prepared using solvothermal method and they were analyzed using FTIR and PXRD. Then the synthesized MOFs were used as catalysts for previously studied MOF catalyzed organic reactions. The studied organic reactions are Claisen-Schmidt condensation between benzaldehyde and acetophenone and reduction of para- nitrophenol (PNP). The yielded products from the reactions were analyzed using FTIR, GC-FID, GC-MS and UV-Visible Spectrometer.

In literature, it has observed that 2% of Chalcone was given without a MOF, 6% with HKUST-1 and 98% with MIL-100 when the Claisen-Schmidt Condensation was carried out in Toluene. In this project, the percentage yields of the product chalcone with respect to benzaldehyde were; 4% without MOF, 57% with MIL-100, 10% with HKUST-1, 8% with STAM-1 and 13% with Cu[tpa].DMF.

When the reduction of PNP was carried out with HKUST-1 in literature, the complete reduction of PNP was observed in 3 minutes. In this project, PNP was completely converted in 3 minutes with HKUST-1, in 1.5 minutes with STAM-1 and in 6 minutes with Cu[TPA]. However, without getting a clear solution, a black color solution was obtained after the reaction. When analyzing this incident it was found that Cu based MOFs in the presence of $NaBH_4$, either get reduced or decomposed and the reaction proceeds with the reduced form of MOF or with CuO, respectively.

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References:

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