Development of CO_2 Reduction Catalysts to Mitigate Global Warming and Energy Crisis

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Abstract

The increasing anthropogenic emission of CO_2 has caused many global environmental issues i.e. global warming, ocean acidification and species extinction.

Conversion of CO_2 to useful chemicals including fuels utilizing clean and sustainable solar light becomes a promising approach that can not only tackle CO_2 emission caused global issues but also provide a clean and sustainable energy source simultaneously.

In this project, a series of novel multinuclear metal complexes consists of earth abundance metals and bridging polypyridyl ligands will be designed and synthesized as potential CO_2 reduction photocatalysts.

The catalytic performance of the new metal complexes will also be studied using (i) Gas Chromatograpy with Thermal Conductivity Detector (GC-TCD) for CO and H_2 generation, (ii) ion chromatography for formate ion.

Introduction

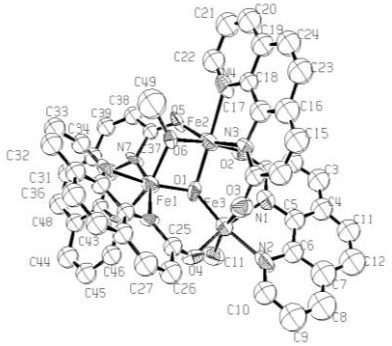
The acceleration of artificial photosynthesis research in recent years have revealed the really crucial and challenging issues in photoconversion of CO_2 into valuable chemicals and fuels. Some primary challenging issues include the extremely complicated photocatalytic reaction mechanisms and pathways, low efficiency and selectivity of different products, complex activation and adsorption of CO_2 molecules and richness of excited state dynamics and the semiconductor surface chemistry.

Objective

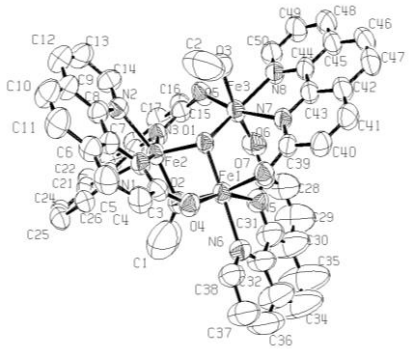
- To design, synthesize and characterized a series of earth abundant metal complexes with polypyridyl ligands
- To study the CO_2 reduction catalytic properties of the novel complexes.
- To deign, develop and study the photocatalytic systems systemically and rationally.

Results

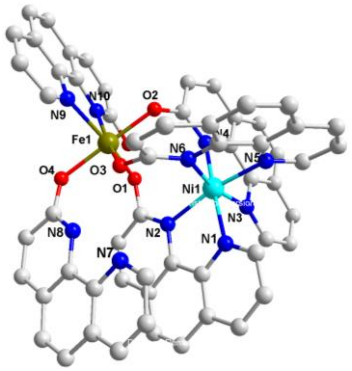
Many new multinuclear polypyridyl transitional metal complexes have been successfully synthesized and characterized by IR spectroscopy, mass spectrometry and x-ray crystallography. The ORTEP diagrams are shown below.



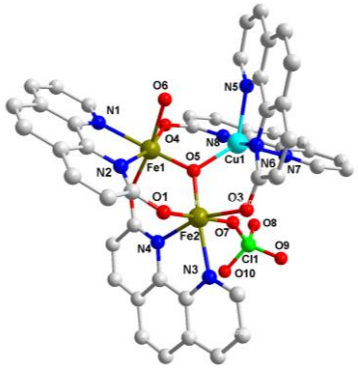
$[(\mu_3\text{-O})(\mu\text{-OMe})Fe_3(\mu\text{-Phen-O})_4(OMe)]^+$



$[(\mu_3\text{-O})(\mu\text{-OMe})Fe_3(\mu\text{-Phen-O})_4Cl]^+$



$[FeNi(PhenO)_3(PhenOH)_2]^{2+}$



$[CuFe_2O(PhenO)_4(ClO_4)(H_2O)]^+$

Acknowledgements

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