

# Inorganic/Bioinorganic Chemistry

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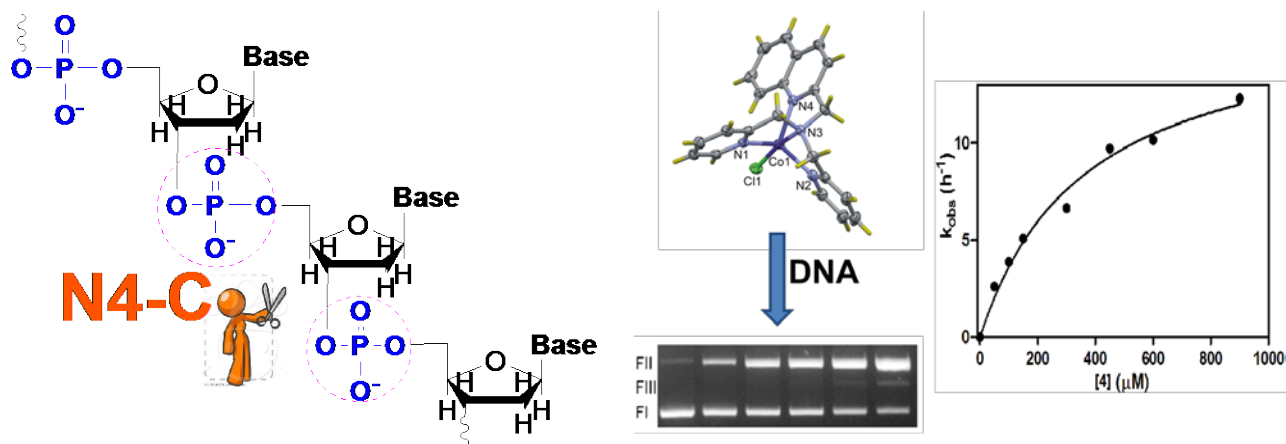
Research Fellow/Visiting Professor at Basel University, Boston University, University of Alberta, Ohio University-Athens and Houston University

Dr. Massoud's **research** focuses on coordination chemistry relevant to biological systems and material sciences. Our main activities involve the synthesis of novel inorganic compounds of some potential applications and biological interests. Currently, we are working on the following topics:

### 1) DNA Cleavage

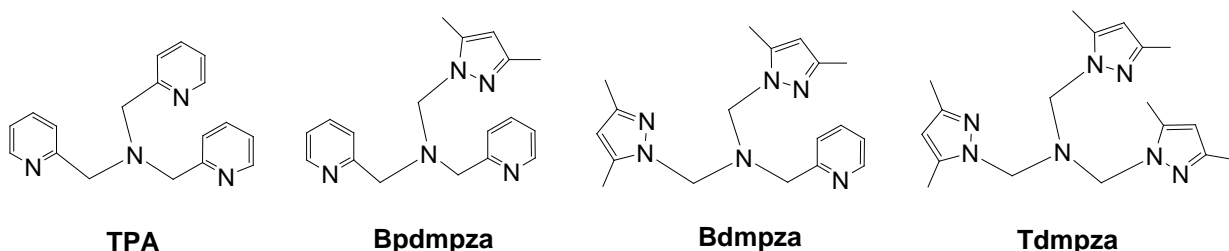
In the search for the development of "new reactive small molecule catalysts" that are inexpensive and efficiently hydrolyze the phosphodiester bonds of DNA, understanding the factors that might affect the DNA cleavage is considered to be the key step in synthesizing "efficient artificial nucleases" for DNA cleavage. Our group has focused on the synthesis and characterization of a number of mononuclear cobalt(II) and copper(II) complexes containing tripodal pyridyl ligands. These complexes were used to study the cleavage of DNA under the physiological conditions in order to evaluate the factors that affect this process such as 1) the nature of the chelate ring size, and the length of the pyridyl arms, 2) mononuclear vs. dinuclear, 3) the nature of the central metal ion, and 4) the steric environment around the central metal ion

For this reason a number of mono and dinuclear cobalt(II) and copper (II) complexes derived from tripod amines and phenolic binucleating ligands were synthesized and characterized, and their catalytic hydrolysis in promoting the DNA cleavage as well as phosphodiester hydrolysis are currently tested.



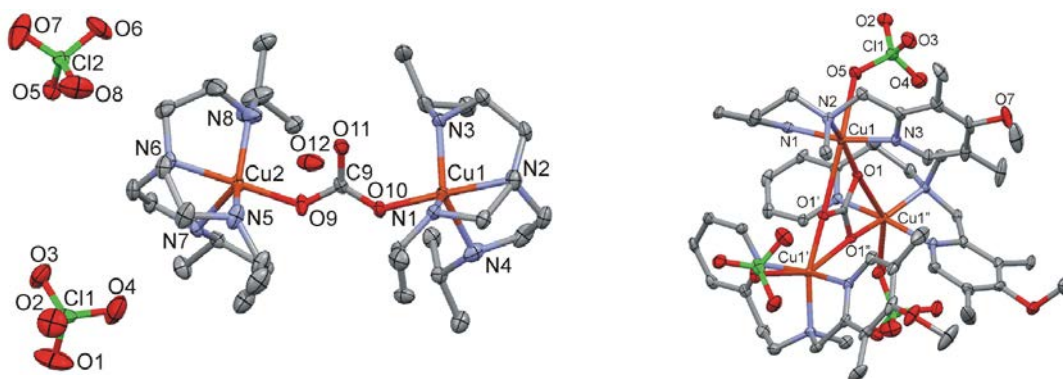
## 2) Antitumor Compounds

The search for an effective therapeutic anti-tumor compounds requires lowering the therapeutical dosage of the drug and also reducing its toxicity. To achieve this target we testing a new series Co(II) and Cu(II) based on different tripod amines that derived from heterocyclic bases such as pyrazolyl groups and their antitumor and toxicity activities are now tested. Some of these ligands are illustrated below:



## 3) Carbon Dioxide Fixation

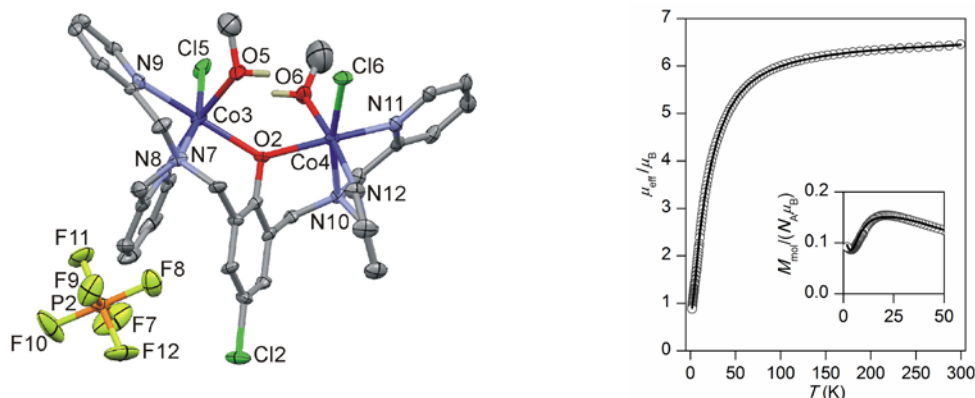
Recently, we have been involved in synthesize a series of polynuclear metal(II) complexes that efficiently can fix the atmospheric CO<sub>2</sub> from the air and convert it into carbonate that bridges several metal ions. Hopefully, that these compounds can serve as green chlorophyll and reduce global warming by eliminating CO<sub>2</sub> from the air. Some examples of dinuclear and trinuclear Cu(II) bridged-carbonato species are shown below:



## 4) Material Sciences

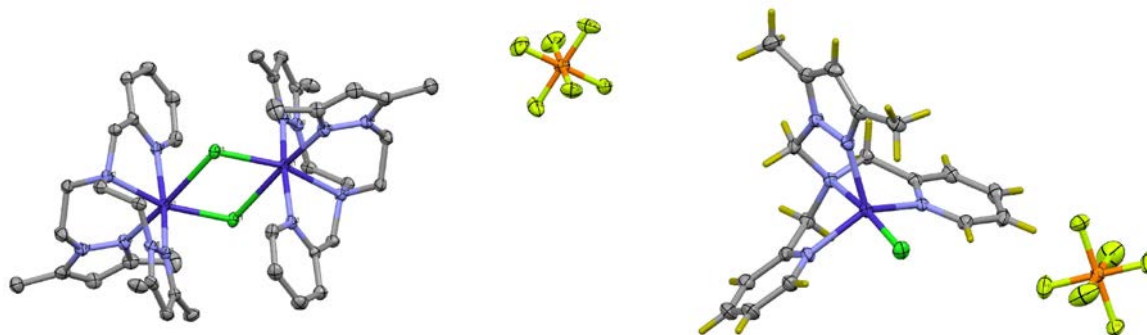
We are also interested in the design and characterization of polynuclear inorganic molecules with novel magnetic properties. The strategy for synthesizing these compounds depends on the assembly of paramagnetic centers (Cu<sup>2+</sup>, Ni<sup>2+</sup>, Co<sup>2+</sup>) via *bridging ligands* such as pseudohalides (N<sub>3</sub><sup>-</sup>, SCN<sup>-</sup> and NCNCN<sup>-</sup>), polycarboxylic acids, squarate dianion (C<sub>4</sub>O<sub>4</sub><sup>2-</sup>), croconate and dianion (C<sub>5</sub>O<sub>5</sub><sup>2-</sup>), as well as carbonates. We are hoping to correlate the structural parameters of the bridging compounds (geometrical factor, the M<sup>2+</sup>-X-M<sup>2+</sup> torsion angle, the axial M-ligand bond lengths, the intradimer M...M distances) to their magnetic properties. Recently, we became interested in the bicompartmental ligands which incorporating

a phenolate group which bridges two paramagnetic metal(II) ions. A typical example is illustrated in the following figure for a bridged-phenolate dicobalt(II) complex.



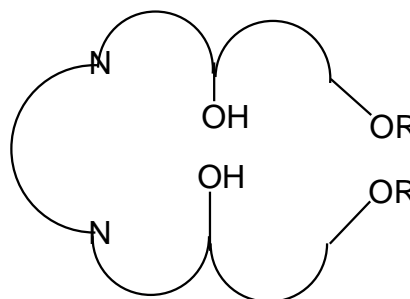
**Fig. 1.** Dinuclear Co(II) complex based phenolate compartmental ligand which bridging the two Co(II) centers and its corresponding magnetic susceptibility at different temperatures.

A novel series of Co(II) complexes based pyrazolyl ligand such as  $[\text{Co}_2(\text{bedmpzmpy})_2(\mu\text{-Cl})_2](\text{PF}_6)_2$  and  $[\text{Co}(\text{BPdmpza})\text{Cl}]\text{PF}_6$  complexes (Fig. 2) were shown to exhibit **Field-Induced Single-Ion Magnets (SIMs)**.



**Fig. 2.**  $[\text{Co}_2(\text{bedmpzmpy})_2(\mu\text{-Cl})_2](\text{PF}_6)_2$  (left) and  $[\text{Co}(\text{BPdmpza})\text{Cl}]\text{PF}_6$  (right) complexes

Other compartmental ligands have been designed to accommodate two metal ions or more that can act as bridging ligands. These ligands are used to synthesize polynuclear  $3d\text{-}3d$  and  $3d\text{-}4f$  (d-block transition metal(II) ion,  $4f$  = lanthanide metal(III) ion). These molecules may utilize useful applications in material sciences and in the field **Single Molecular Magnets (SMM)** or as **Field-Induced Single-Ion Magnets (SIMs)**.



## ***RESEARCH COLLABORATION (beyond UL Lafayette)***

- 2014-present: Prof. Zdenek Travnicek (Palacky University, Olomouc, Czech Republic)
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- 2003-present: Prof. R. Vicente (University of Barcelona, Barcelona –Spain)
- 2008-present: Prof. M. Mikuriya (Kwansei Gakuin University, 2-1 Gakuen, Sanda-Japan)
- 2013-present: Prof. Makoto Handa (Shimane University, Matsue-Japan)
- 2013-present: Prof. H. Akashi (Okayama University of Sciences)
- 1990-present: Prof. I. Bernal (University of Houston, Houston, TX USA)
- 2007-2013: Dr. J. Grebowicz (University of Houston-Downtown, Houston, USA)
- 2008-2013: Prof. F. Meyer (Georg-August-Universität Göttingen, Göttingen-Germany)
- 2006-2013: Prof. R. Lalancette (Rutgers University, York, NJ USA)
- 2008-2012: Prof. G. Yee (Virginia Tech., Blacksburg, VA USA)