Studying oximes and beyond

by

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NG-group

A lecture-seminar about my current research interests and publishing practices.

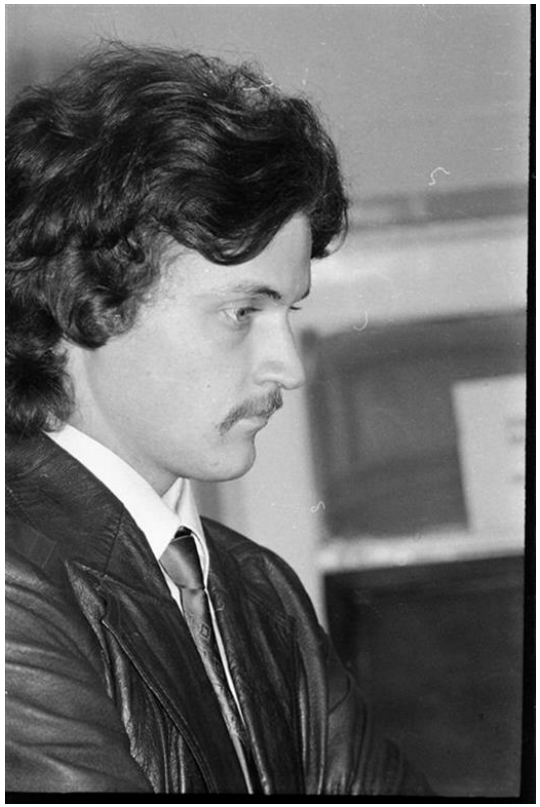
Last time I have done it in 2007…

Time to update!

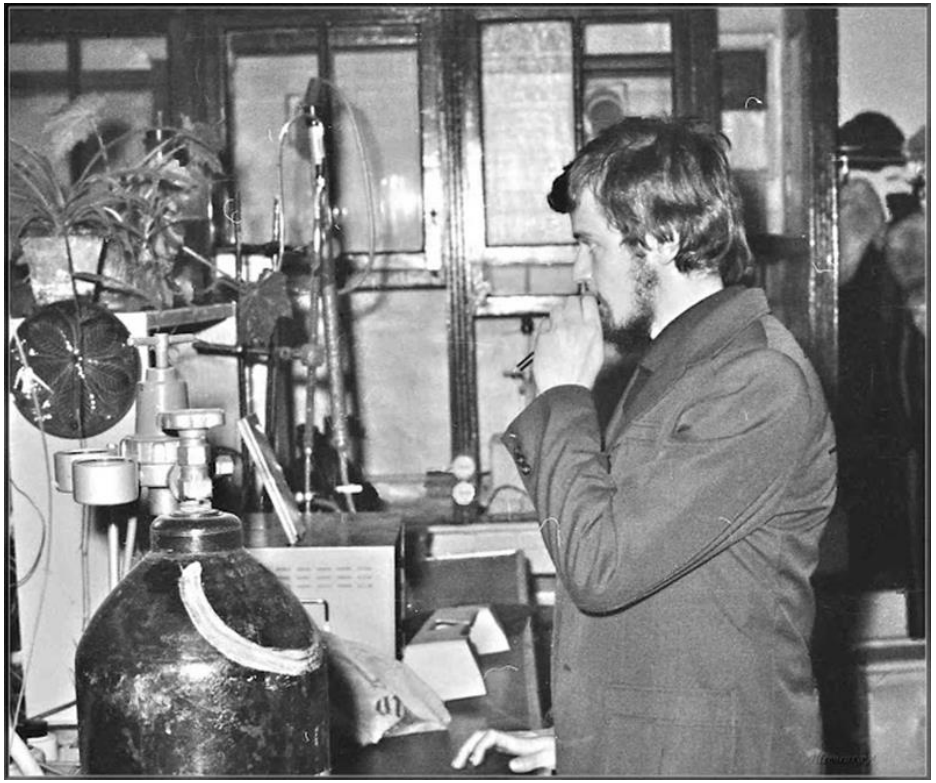
Left Ukraine on Christmas of **1992** with one way ticket to Chicago…

Was tenured Associate Professor at the Inorganic Chemistry Division of
Kiev State University with **16** tenure-track faculty; whole Chemistry Department
was 3 buildings complex in downtown Kiev with **83** teaching / research faculty.

…had **46** publications and 5 Soviet patents; graduated **2** Ph.D. students and **5** Masters.

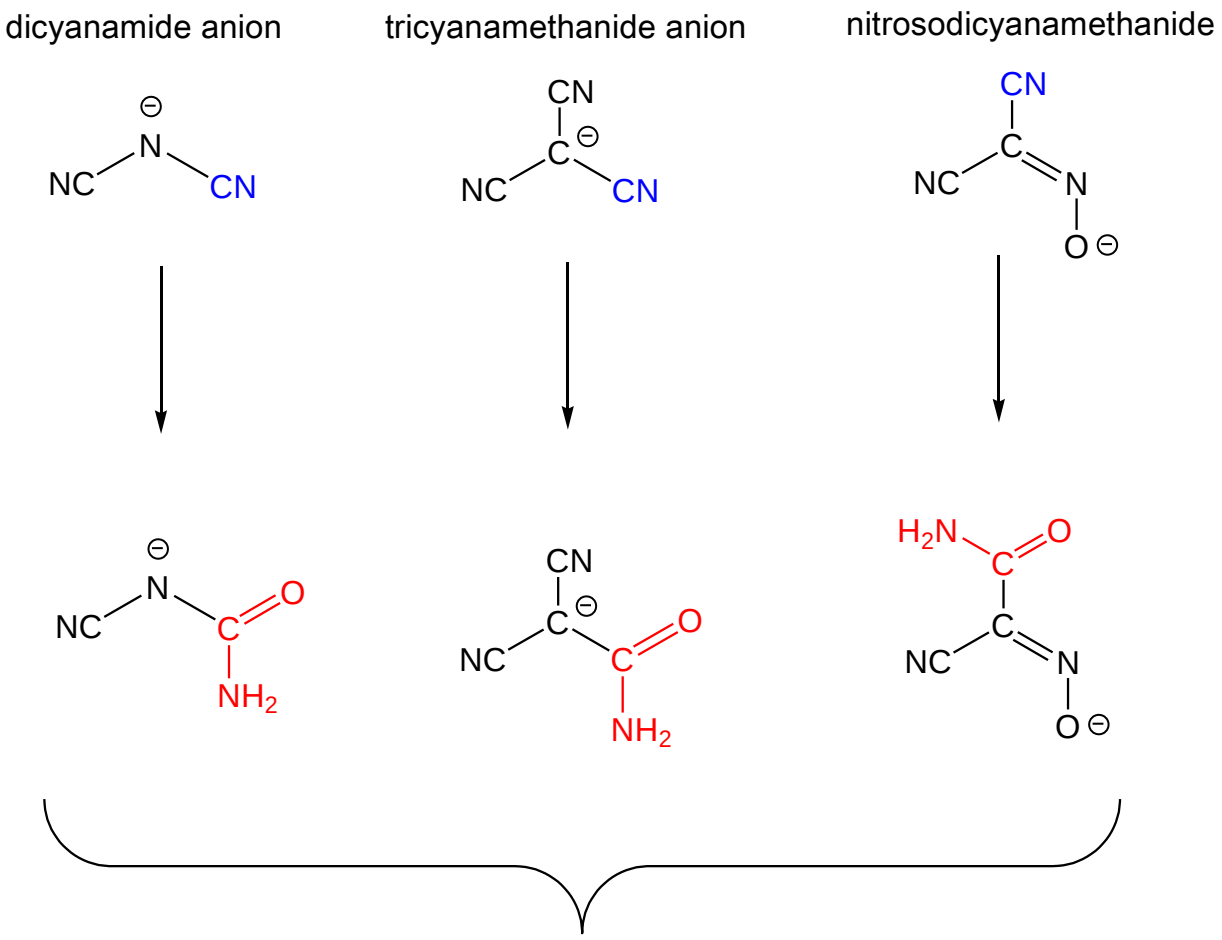


Undergraduate student, 1980



Graduate student, 1985

1981 – 1985 graduate studies and 1st Ph.D. (Candidate of Science) in inorganic chemistry:



With my two (and only) former Ph.D. students:
Prof. **Vira Ponomareva** and Head of the Laboratory Dr. **Konstantin Domasevitch**

2018

Timeline:

1993 – 1996: graduate studies and 2nd Ph.D. in bioinorganic chemistry
work with di-Mn complexes including expanded porphyrins
as catalase and SOD mimics

1 publication

1997 – 1998: 1st post-doc at North Dakota State University
synthesis of tetraaza-porphyrins and their Mg and Zn complexes

1 publication

1998 – 1999: 2nd post-doc at pharmaceutical company in Sunnyvale (CA)

1999 – 2001: research chemist II at Pharmacyclics
work on synthesis, spectroscopic and electrochemical,
magnetochemical characterization and enzymology of
metallo-texaphyrins (Fe, Mn and lantahnides)

8 publications (including book chapter)
and 1 patent

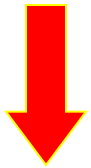
2001 August: move to Springfield, SMSU

Ligand systems for coordination chemistry:

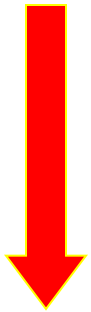
1) macrocycles: N, O-, S- crowns and their mixed donor analogs
2) aromatic macrocycles: porphyrins, phtalocyanins, texaphyrins
3) pyrazolylboranes, other tripodal ligands
4) heterocycles and heterocyclic mono-, polyamines
5) Schiff-bases

and many, many others…

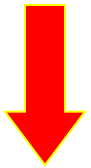
Unusual geometry, crystal structures



Interesting chemical properties, catalysis



Biological activity, modeling of biological systems, etc.



Interesting physical properties: magnetism…

Boring set of tools…

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Universal, better set of tools for different applications!

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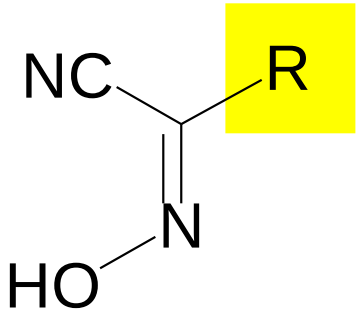
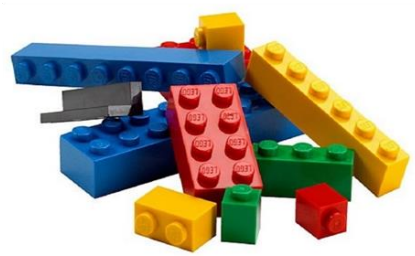
Since moving to Springfield:

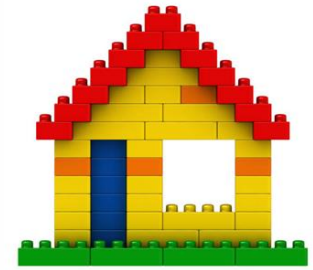
Started developing chemistry and applications of oxime-based organic ligands – nitrosonaphtoles and cyanoximes - and their metal complexes.



Cyanoximes = molecular lego



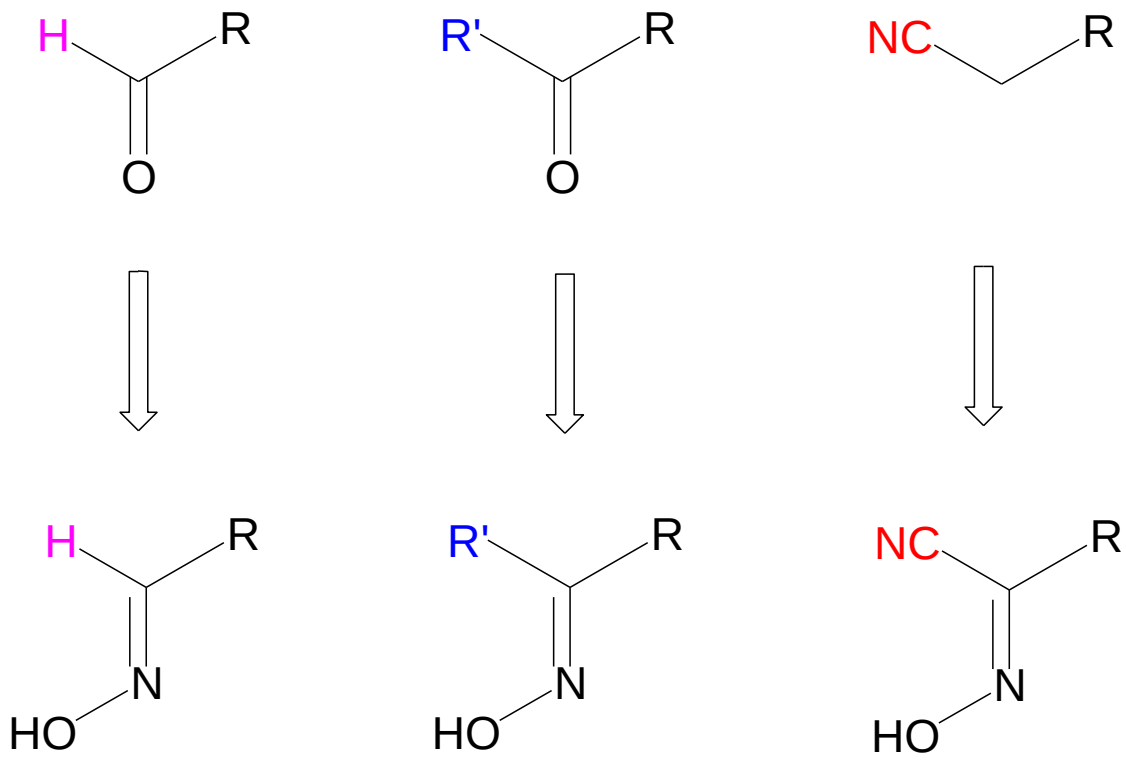
simple



complex

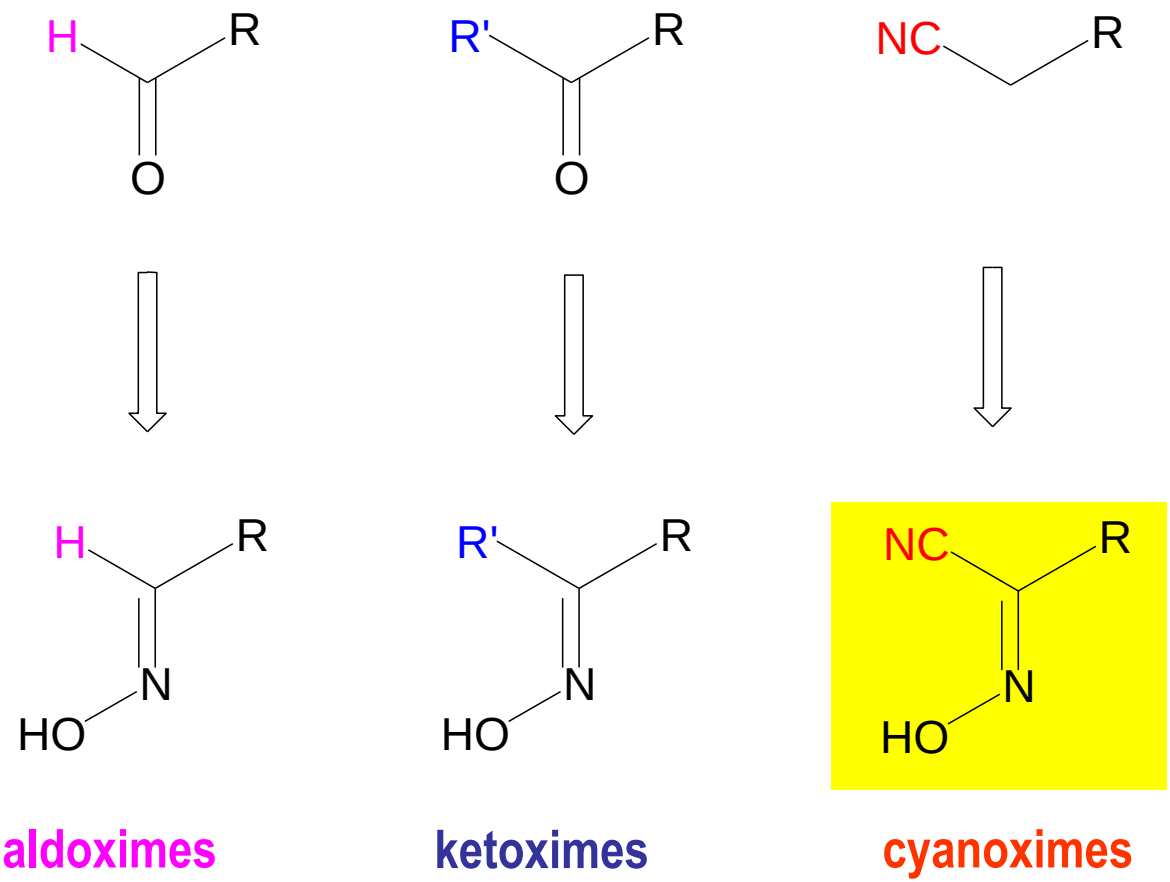
complex
multifunctional

Types of oxime and their precursors.

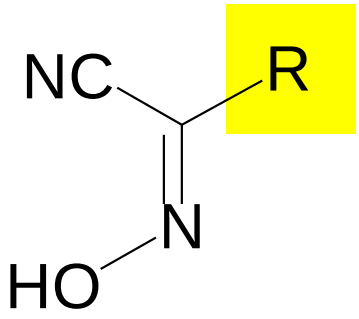


aldoximes ketoximes cyanoximes

Types of oxime and their precursors.



Cyanoximes



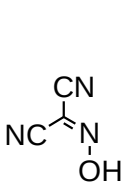
R - electronwithdrawing group

pK ~ 3.9 – 7.4

presence of the CN-group:

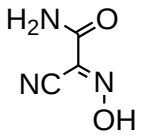
- significantly increases acidity of the oxime (100 - 10,000 times) which makes cyanoximes better ligands
- provides adequate solubility in organic and aqueous media (as CH_3CN, $CH_2(CN)_2$, $(CN)_2$)
- helps in crystallization of ligands and metal complexes
- allows further chemical modification of the ligand (hydrolysis, and formation of amides, carboxylic acids; addition of H_2S, H_2Se)

Large libraries of mono-, bis- and tris- cyanoximes for studies:



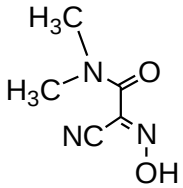
1

CCO



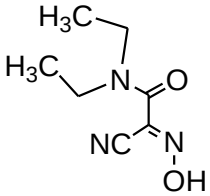
2 *

HACO



3 *

HDCO



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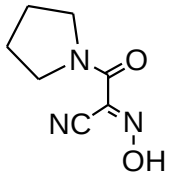
HDECO



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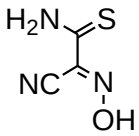
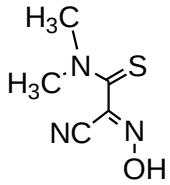
HPyrCO



6

HTCO



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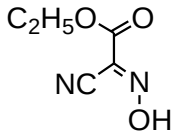
HTDCO

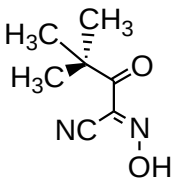


8 *

HECO

9 *

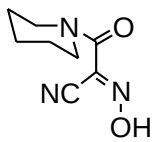
HBCO



10 *

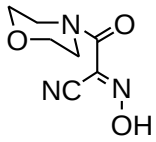
HPiCO

Amido- / ester- and keto- cyanoximes



11 *

HPiPCO



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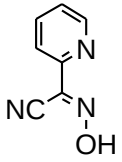
HMCO



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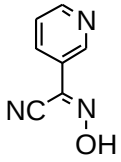
H2PCO



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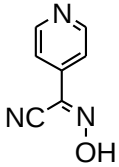
H3PCO



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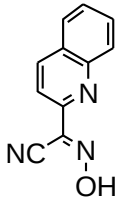
H4PCO



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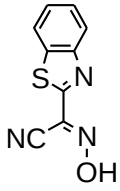
HQCO



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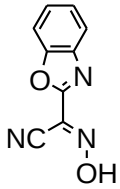
HBTCO



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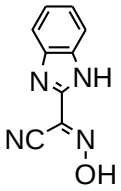
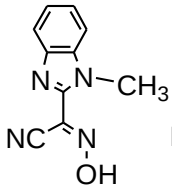
HBOCO



19

HBIHCO



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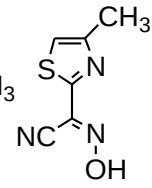
HBIMCO



21 *

HTLCO

Heterocyclic cyanoximes

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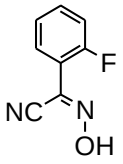
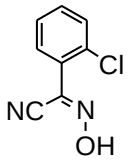


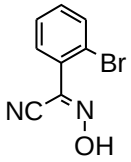
22

H2F-PhCO



23

H2Cl-PhCO



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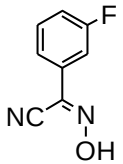
H2Br-PhCO



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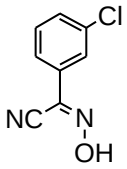
H3F-PhCO



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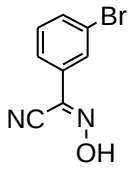
H3Cl-PhCO



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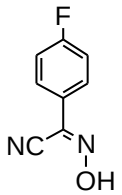
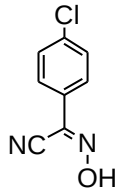


28

H4F-PhCO



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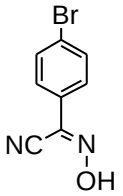
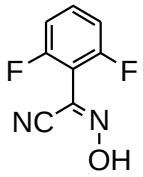
H4Cl-PhCO



30

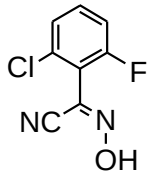
H4Br-PhCO

Monosubstituted arylcyanoximes



31*

H2,6-diF-PhCO

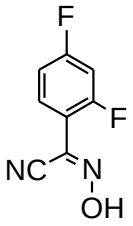


32 *

H2F6Cl-PhCO

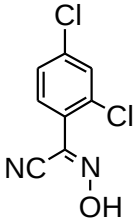
33 *

H3,5-diF-PhCO



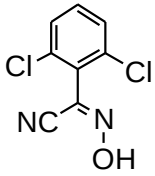
34*

H2,4-diF-PhCO



35*

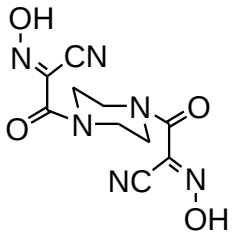
H2,4-diCl-PhCO



36 *

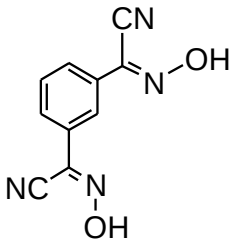
H2,6-diCl-PhCO

Disubstituted arylcyanoximes



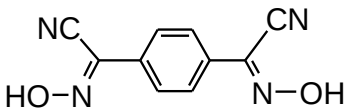
37 *

H_2BiPiPCO



38 *

$H_2$1,3-BCO



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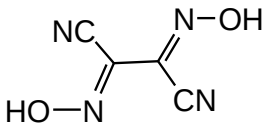
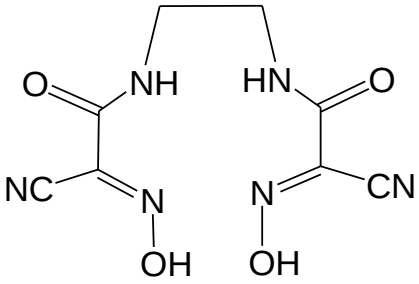
$H_2$1,4-BCO



40 *

H_2DCDO

Bis-cyanoximes



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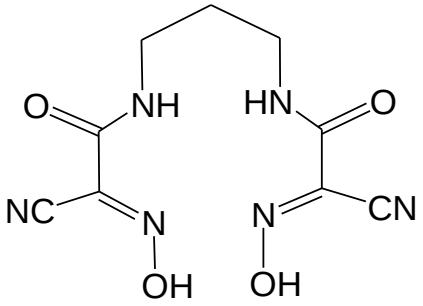
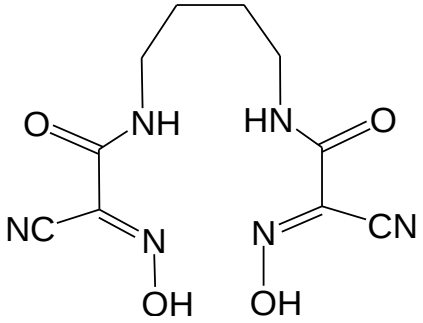
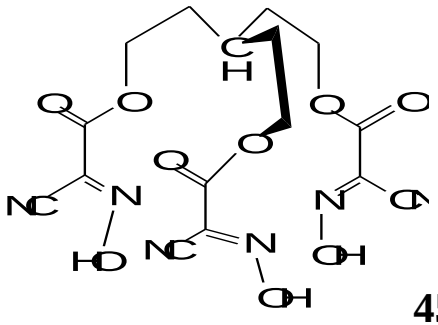


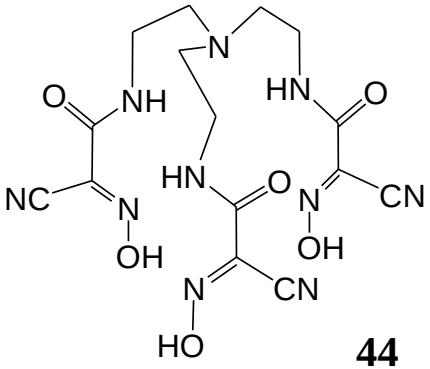
42



43



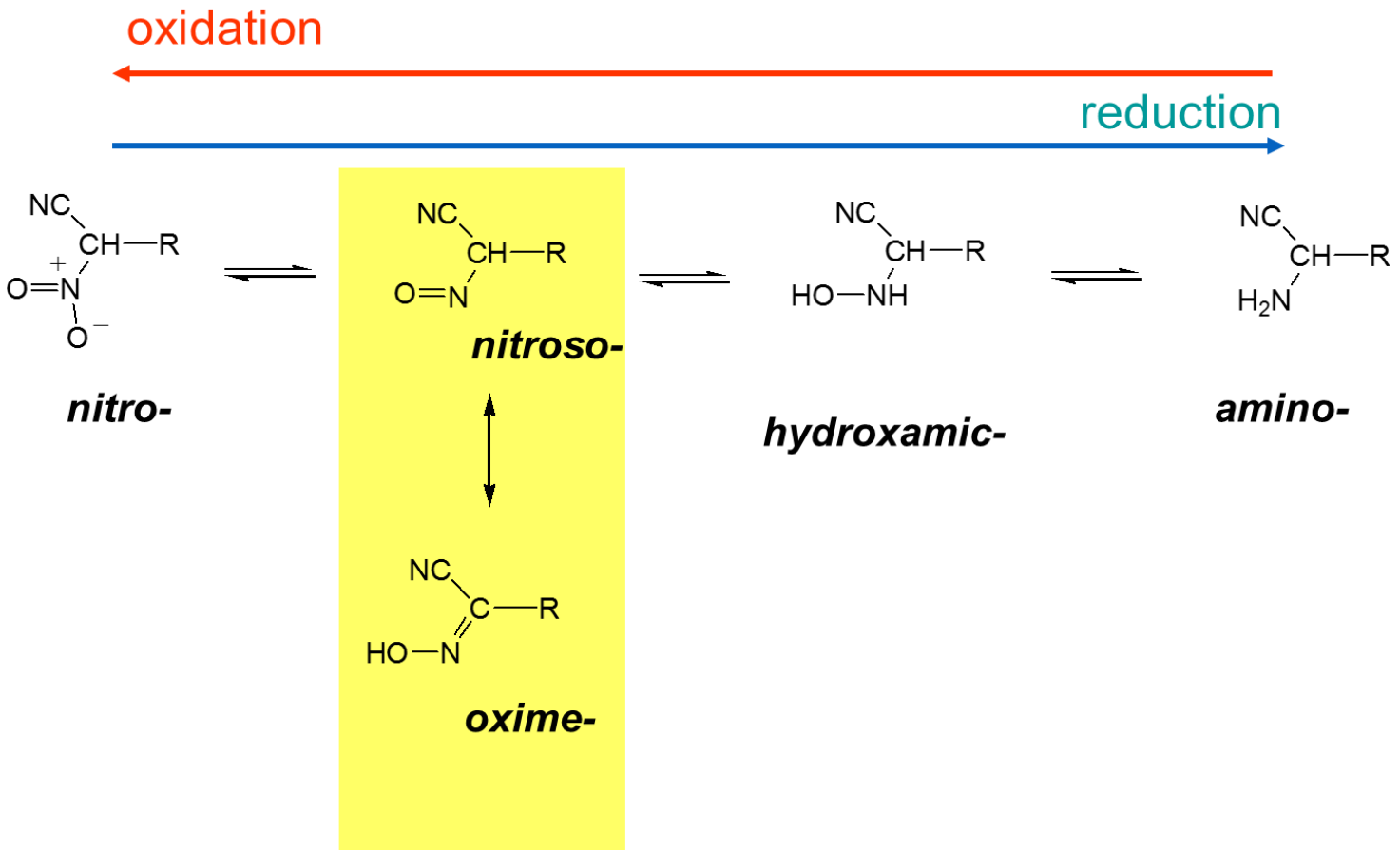
45



44

Tris-cyanoximes

Redox flexibility of compounds with >C-N-O groups.

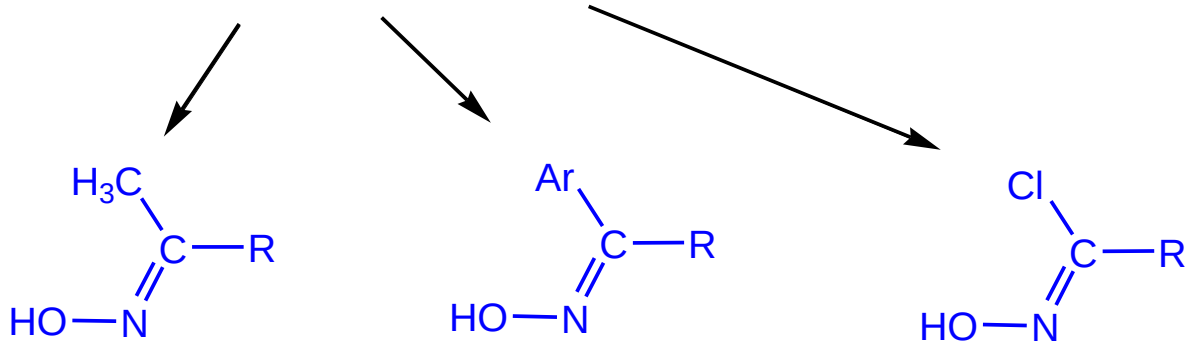


Inorg. Chem. **2015**, *54* (4), 1890

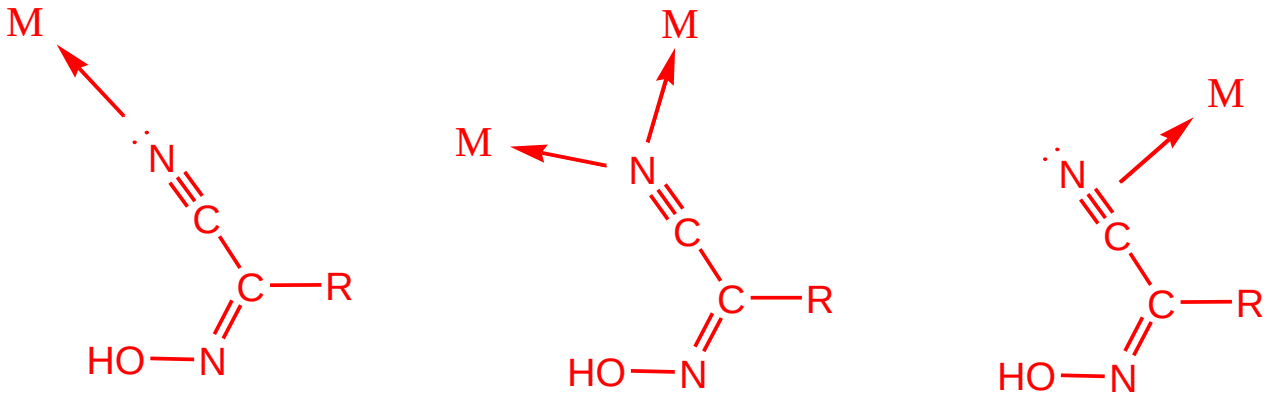
Dalton Trans., **2017**, *46*(39), 13562-13581

alkyl-, aryl-, chloro-oximes:

no coordination chemistry...



cyanoximes: rich coordination chemistry!



terminal

side-on

Cyanoximes:

42 cyanoximes are known today

more than **250+** crystal structures are reported in > **160** papers

Groups in the world are working with cyanoximes:

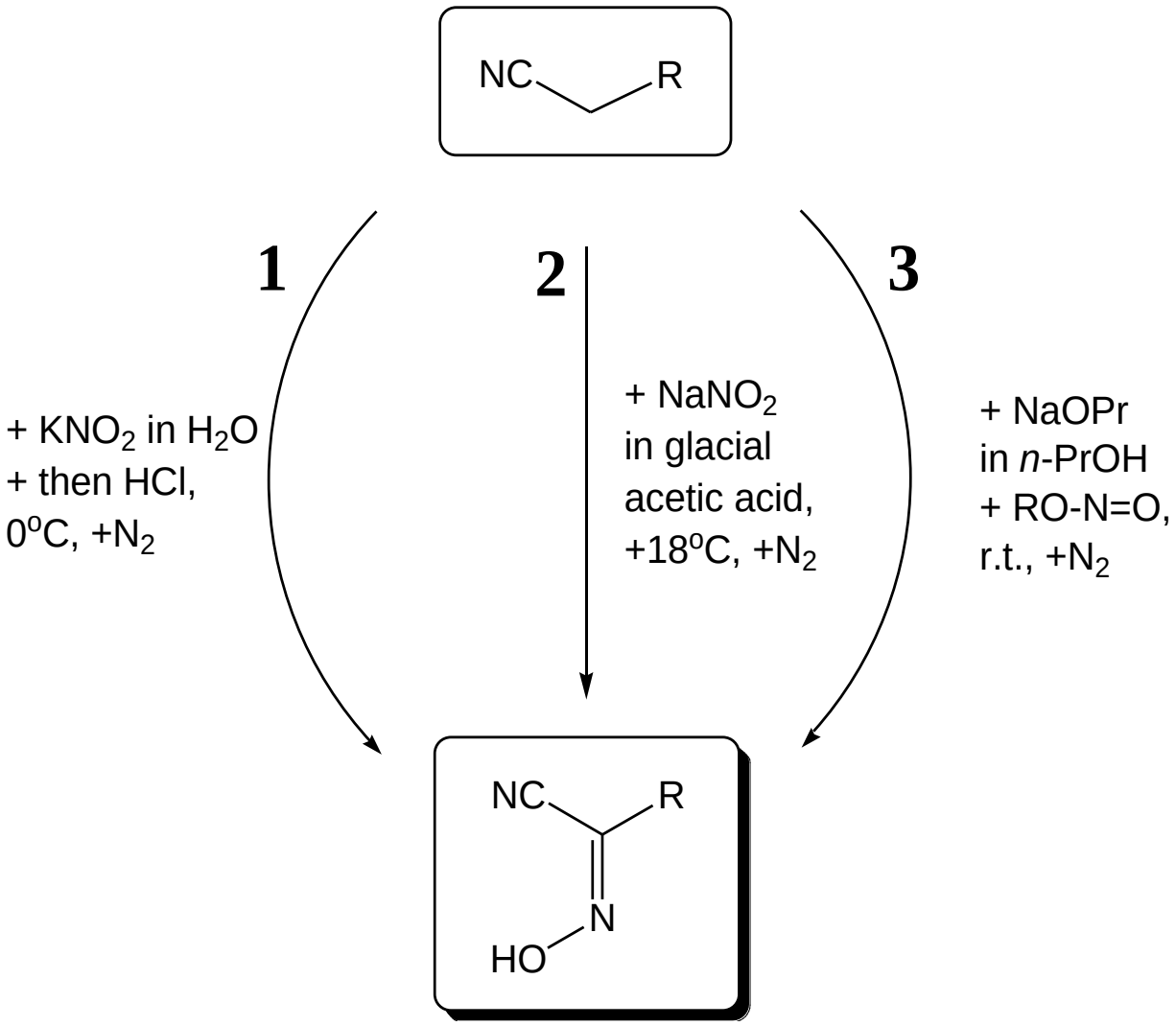
- Australia (S. Batten)
- Canada (S. Bohle)
- Ukraine (K. Domasevitch, R. Lampeka, V. Pavlischuk, S. Kolotilov, I. Fritskiy, T. Sliva)
- Poland (H. Kozlowski, E. Gumiena-Kontezka)
- South Africa (I. Nikolaenko)
- Spain (A. Escuer)
- Greece (S. Perlepes)
- USA (N. Gerasimchuk, G. Christou)

Cyanoxime ligands:

synthesis, structure and properties.

Fancy, unnecessary expensive, useless tools…

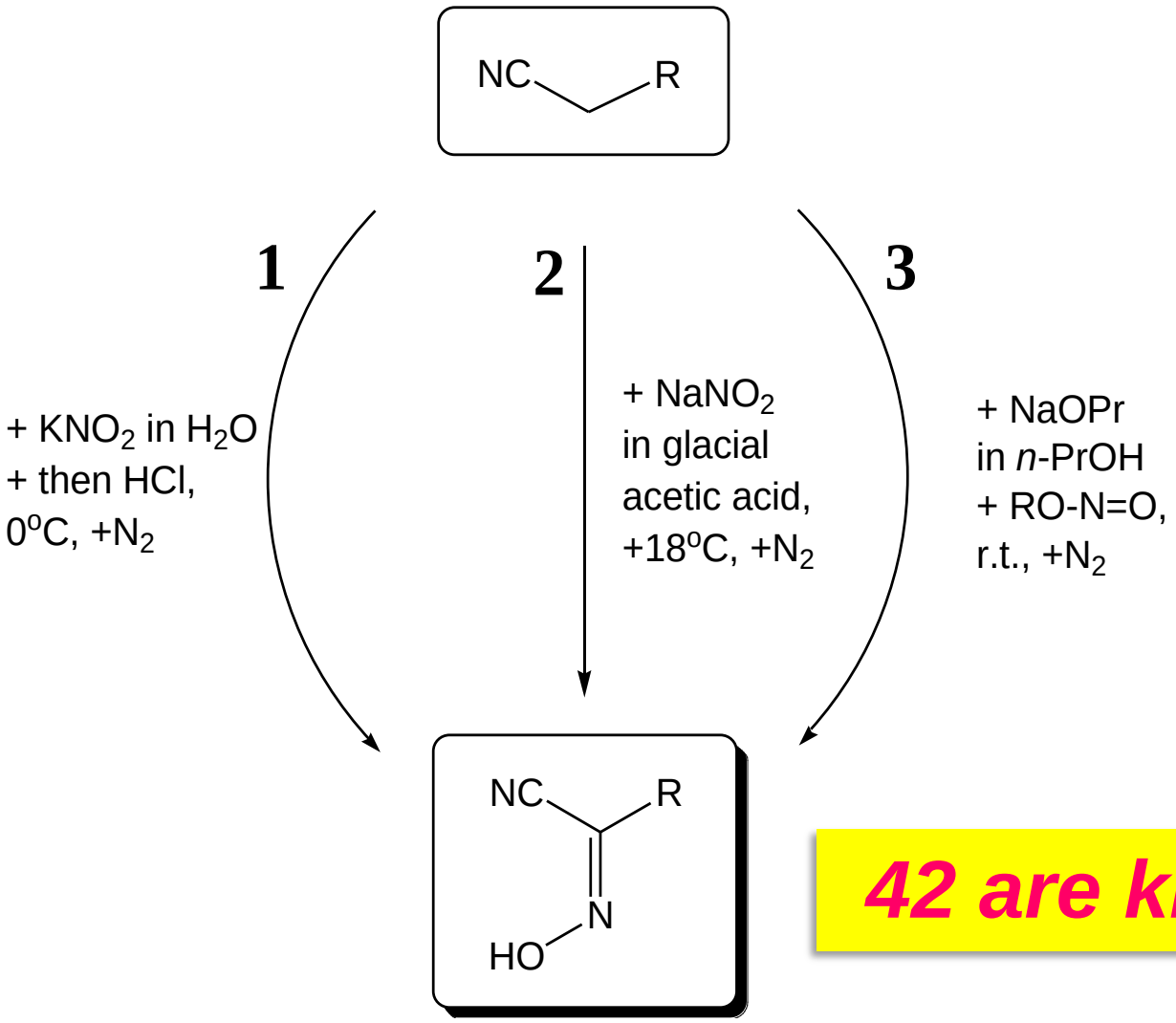
Development of the Meyer reaction for synthesis of cyanoximes.



J. Coord. Chem., **2004,** 57, 1205

NG-group

Development of the Meyer reaction for synthesis of cyanoximes.



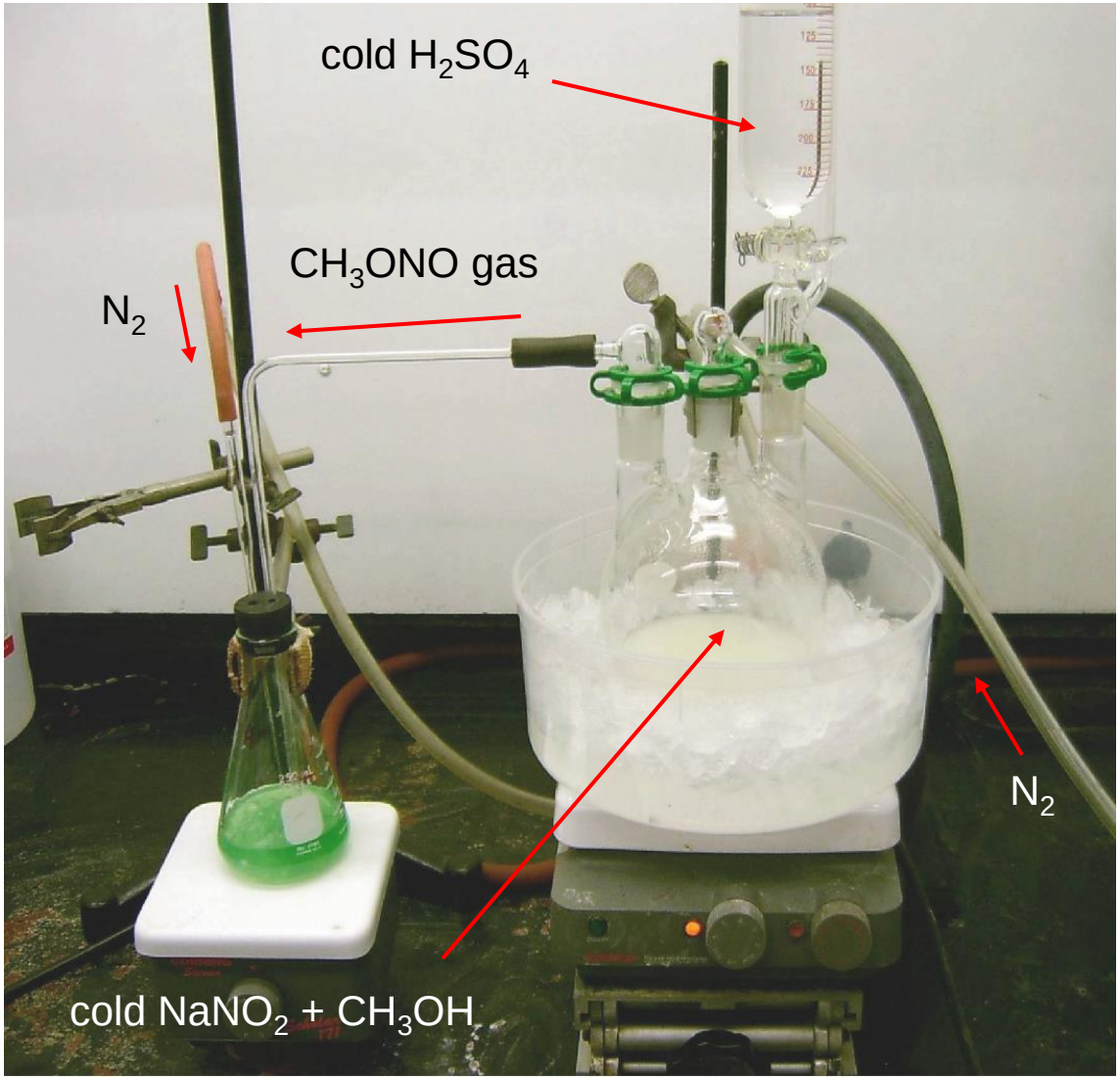
42 are known

J. Coord. Chem., **2004,** 57, 1205

NG-group

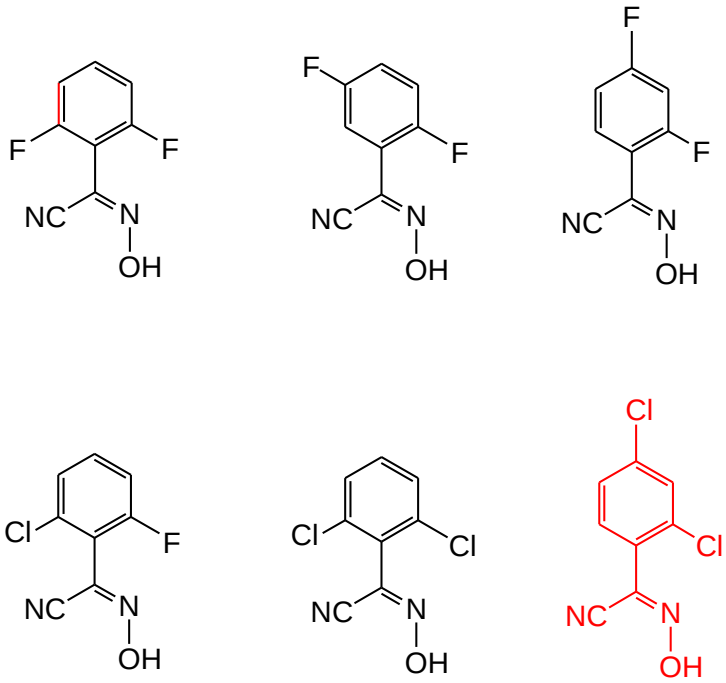
Nitrosation with CH_3ONO.

$$NaNO_2 + CH_3OH + H_2SO_4 = CH_3ONO + Na_2SO_4 + H_2O$$



A patent on a method of synthesis of biologically active cyanoximes…

Received:
June 2010

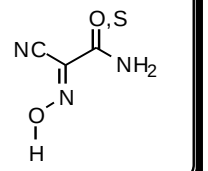


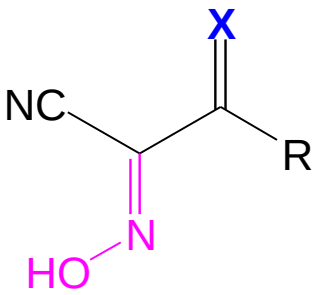
very potent and specific *carbonyl reductase* inhibitor

NG-group

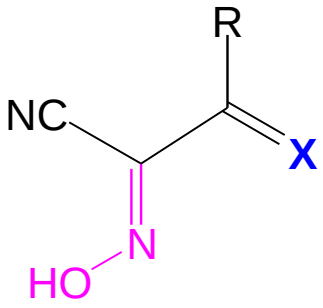
Geometrical isomerism of cyanoximes

was found in:



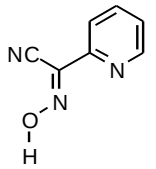


trans- anti

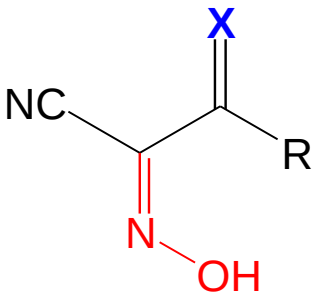


cis- anti

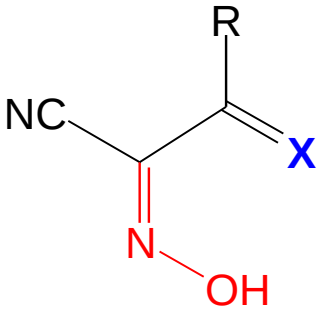
was found in:



was found in:

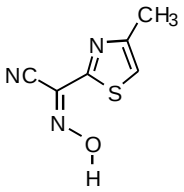


trans- syn



cis- syn

was found in:



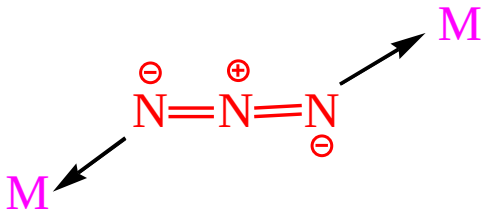
Inorg. Chim. Acta, **1999**, 284, 85.

Dalton Trans., **2008**, 5715.

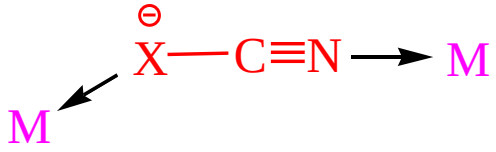
NG-group

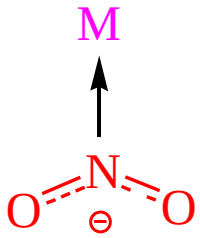
Ambidentate ligands:

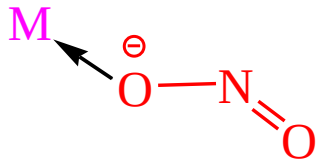
classic, typical pseudohalides monoanions

N_3^-, 

CN^-, 

NCX^- (X = O, S, Se, Te) 

and NO_2^- 



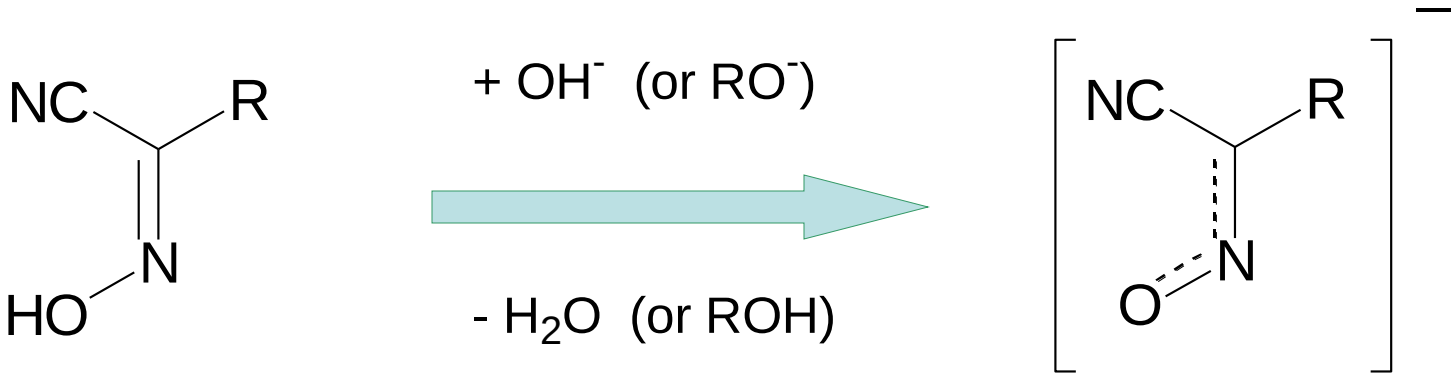
coordination modes: *nitro-* vs *nitrito-*

Cyanoximes are ***ampolidentate*** ligands

The Latin root word **am** means “love.”

Amphiphilic
Amphoteric
Ambivalent
Ambidentate
Amateur
Amorous
……..

Deprotonation of cyanoximes

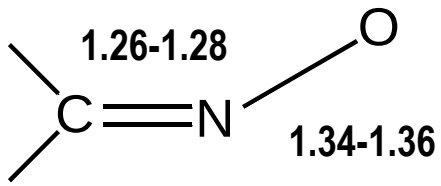


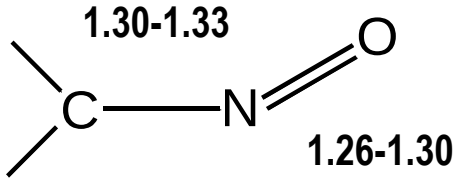
colorless ***yellow***

metal carbonates, hydroxides, oxides in aqueous and polar organic solvents

Inorg. Chimica Acta. **1991,** 188 (11), 45 *Dalton Trans*. **2008**, 5715 *Inorg. Chem*. **2005**, *44*(23), 8331

Geometrical relationships between two groups.



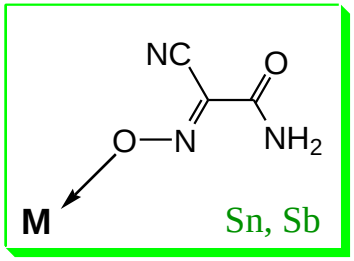


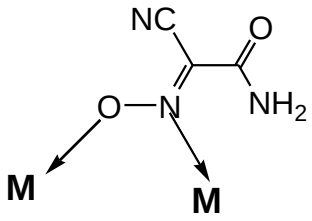
$$\sum (NO) + (CN) = 2.60 - 2.64\ \text{Å}$$

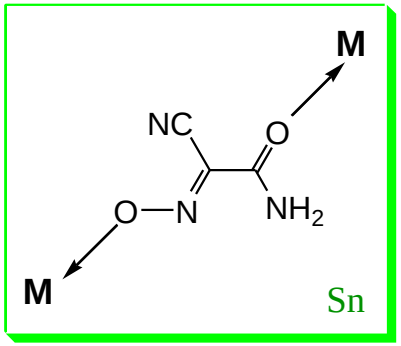
Electron density :

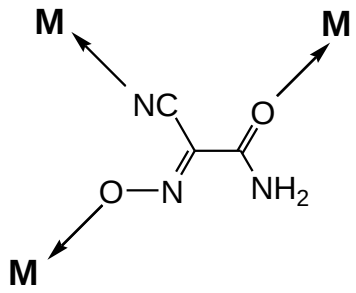
oxime- ***nitroso-***

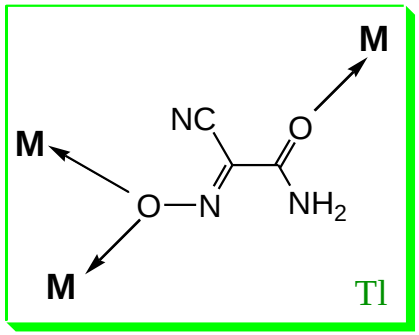
Ampolydentate ligands: schizophrenics of coordintion chemistry.

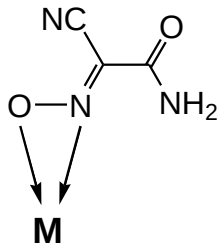


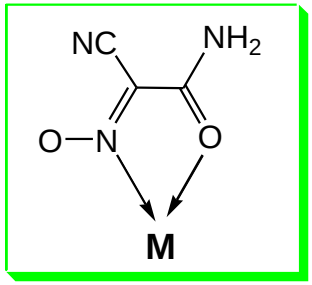




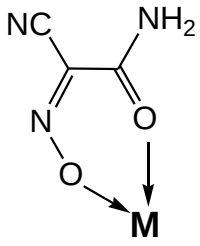


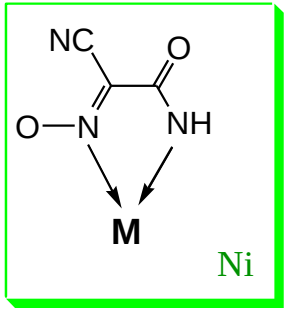






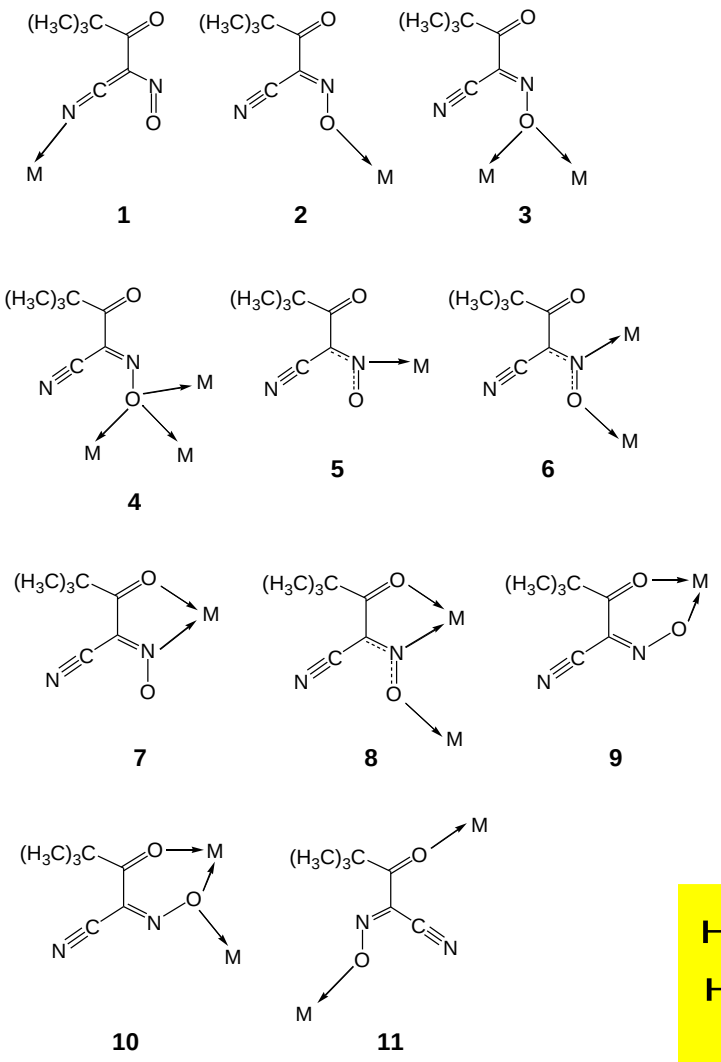
Ni, Co, Pb, Cu, Fe

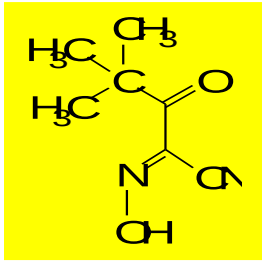


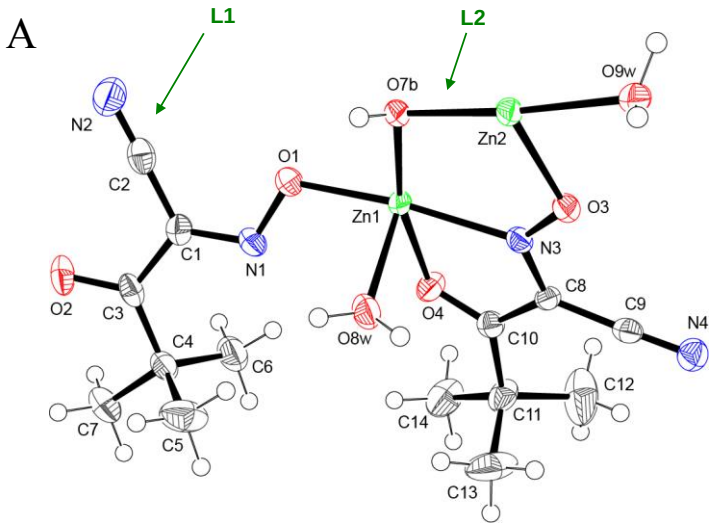


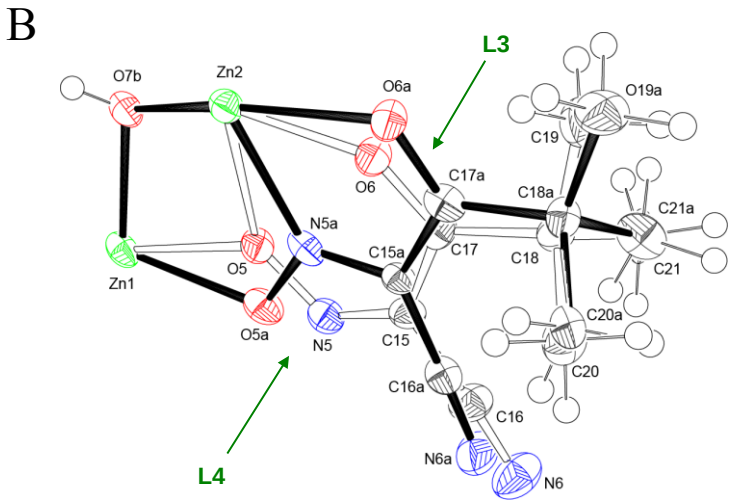
NG-group

Two binding modes in ONE complex!



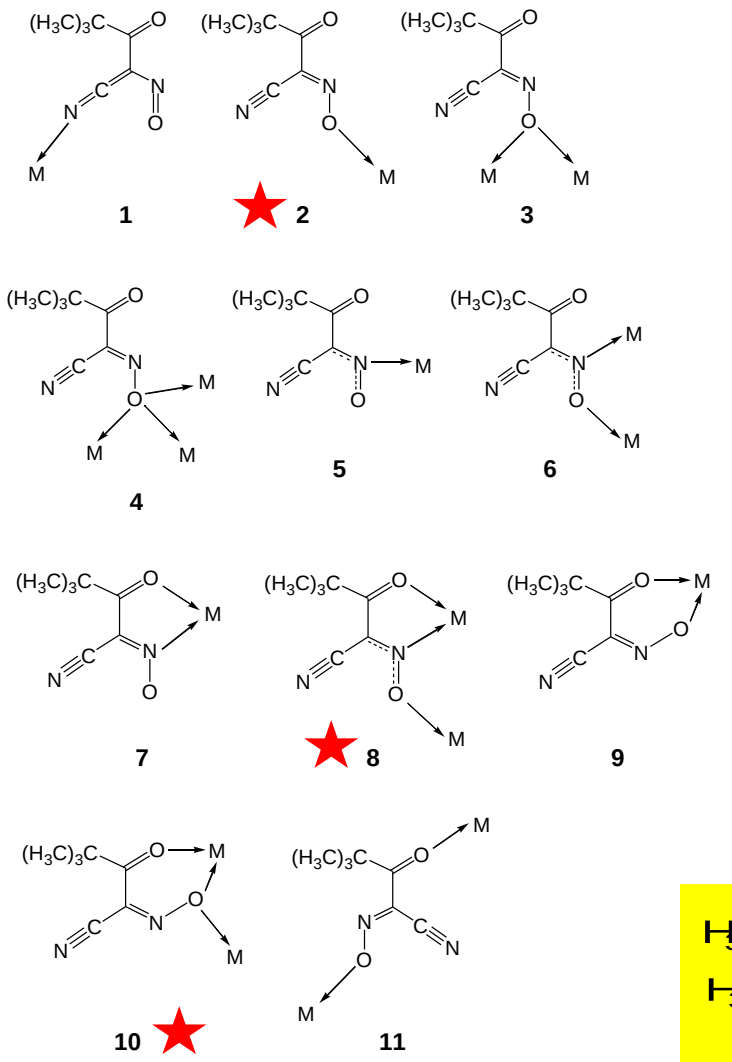


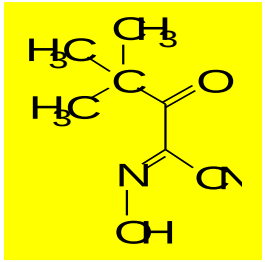


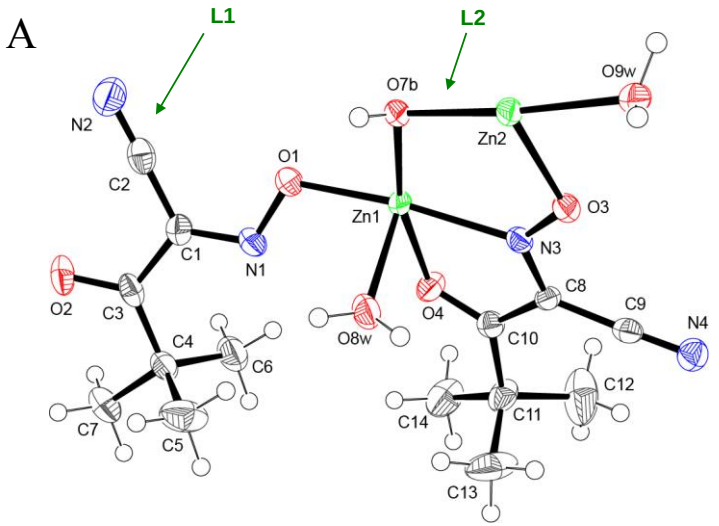


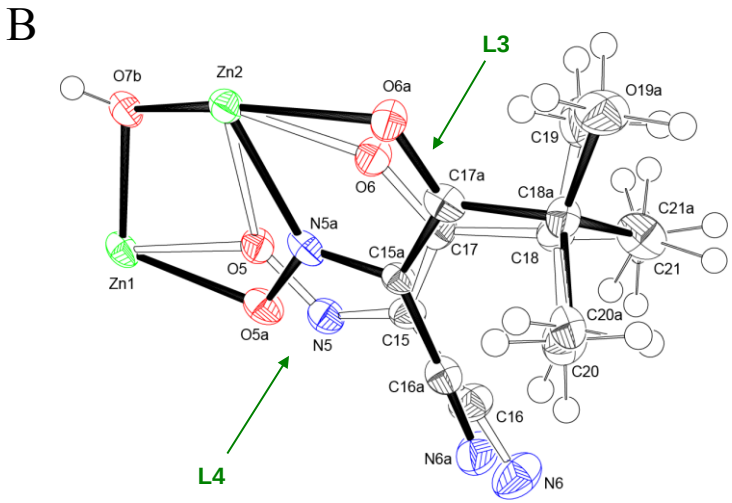
Inorg. Chem. **2017**, *46*(18), 7268

Two binding modes in ONE complex!







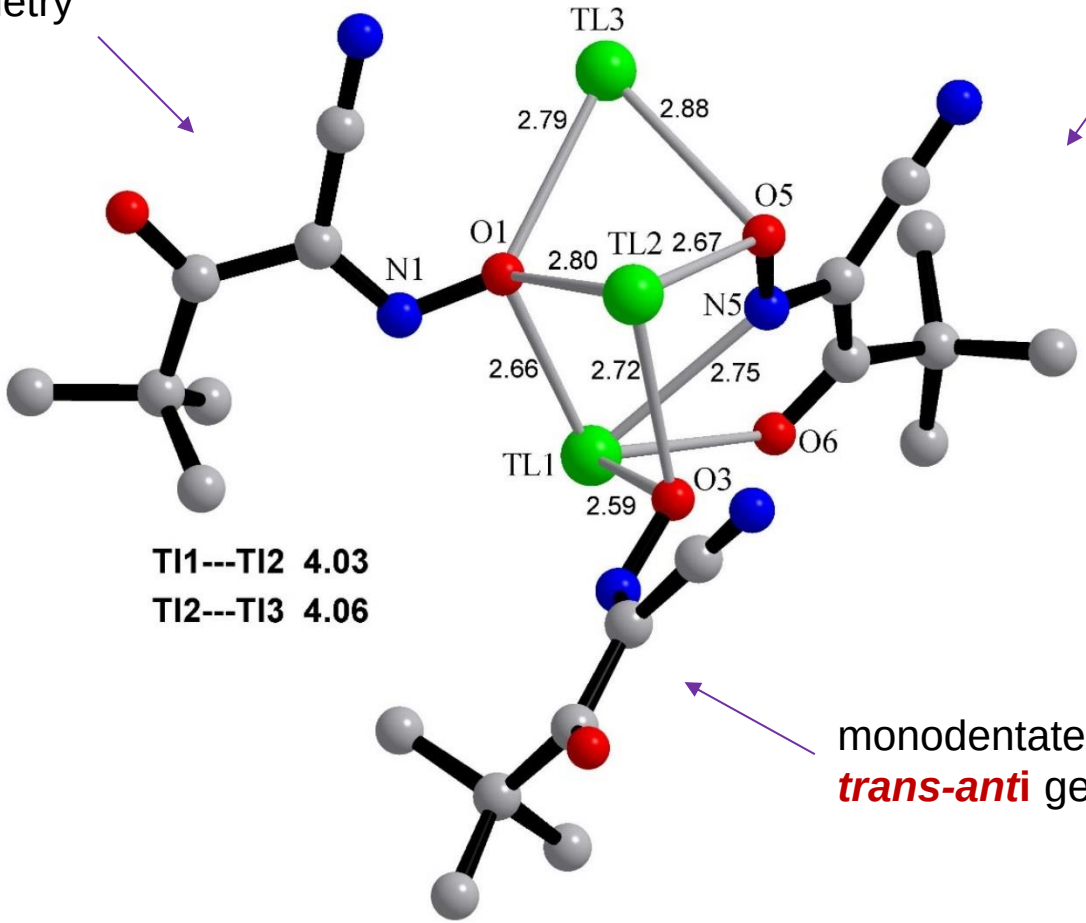


Inorg. Chem. **2017**, *46*(18), 7268

Multiple binding modes in ONE complex!

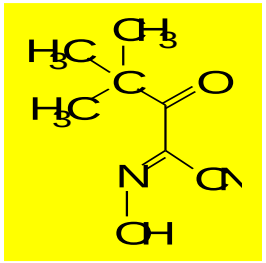
monodentate, but μ^3-bridging
trans-anti geometry

bidentate chelate, + μ^2-bridging
cis-anti geometry



monodentate, but μ^2-bridging
trans-anti geometry

Domasevitch, K.V



Russ. J. Gen. Chem. 1997, **67**(9), 1572-1575.

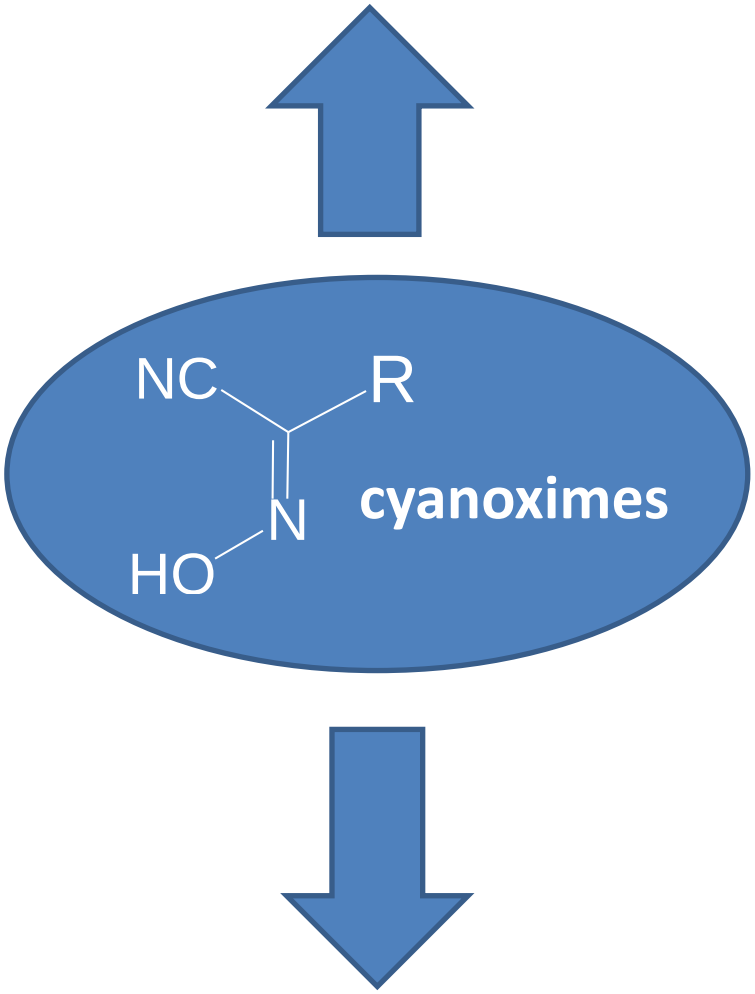
NG-group

Current research projects

involving new class of ligands

“Scientific work must be done for itself, for **the beauty of science**, and then there is always the chance that a scientific discovery may become like the radium, a benefit.”

New non-antibiotic antimicrobial compounds

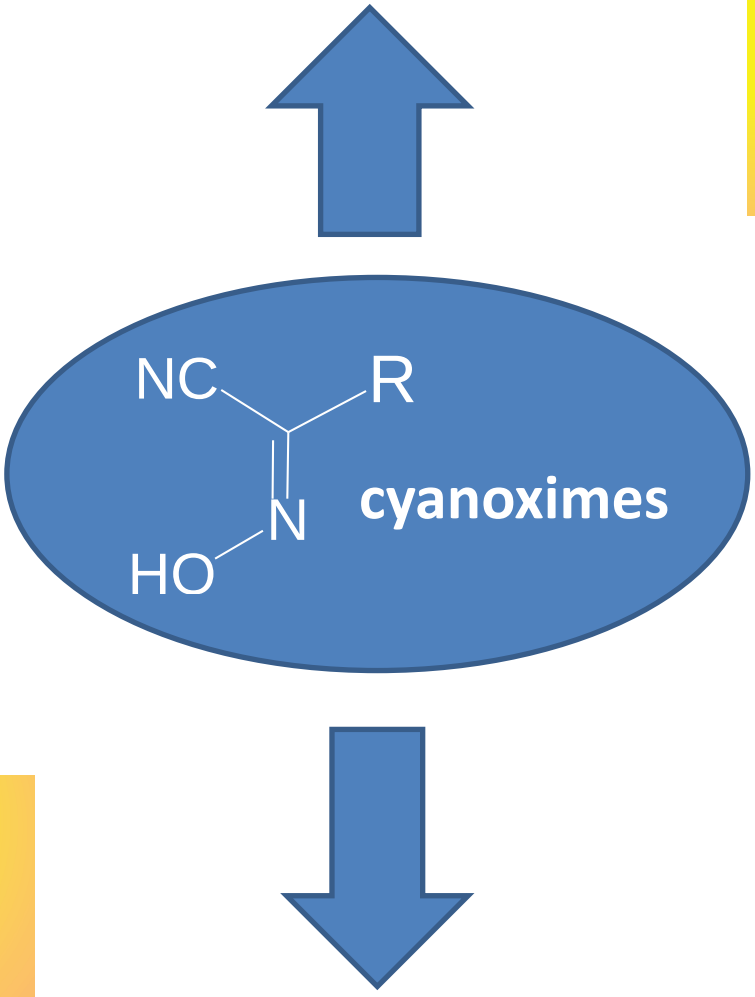


New anti-cancer active compounds

New non-antibiotic antimicrobial compounds

47
Ag
Silver
107.868

51
Sb
Antimony
121.760



46
Pd
Palladium
106.42

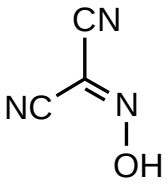
78
Pt
Platinum
195.08

New anti-cancer active compounds

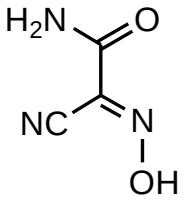
NG-group

Visible light insensitive antimicrobial silver(I) cyanoximates

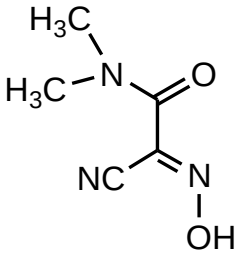
Cyanoximes that form stable towards visible light Ag(I) complexes.



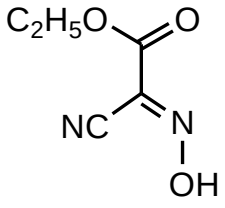
HCCO



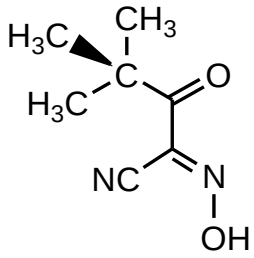
HACO



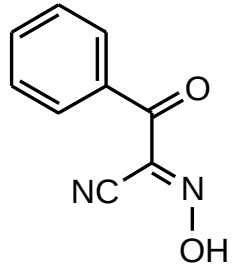
HDCO



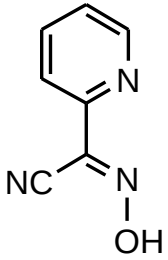
HECO



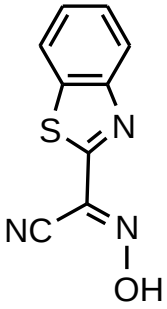
HPiCO



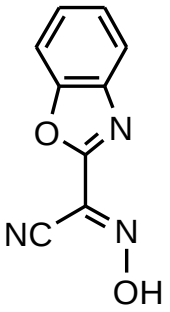
HBCO



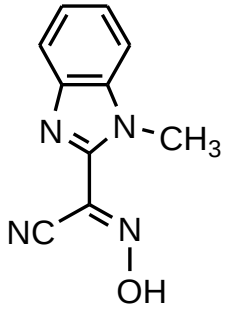
H2PCO



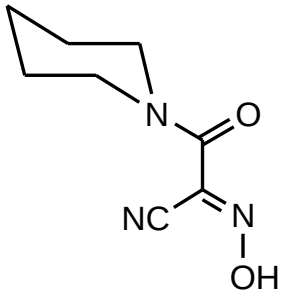
HBTCO



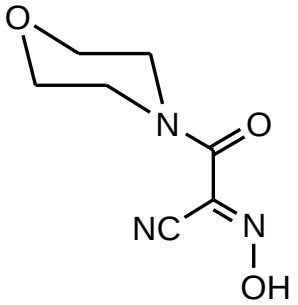
HBOCO



HBIMCO



HPiPCO



HMCO

Garrett Glover, David Lewis, Jeff Morton, Courtney Riddles

Inorg. Chem., **2007**, *46* (18), 7268 *Inorg. Chem.* **2009,** *48*(6), 2371

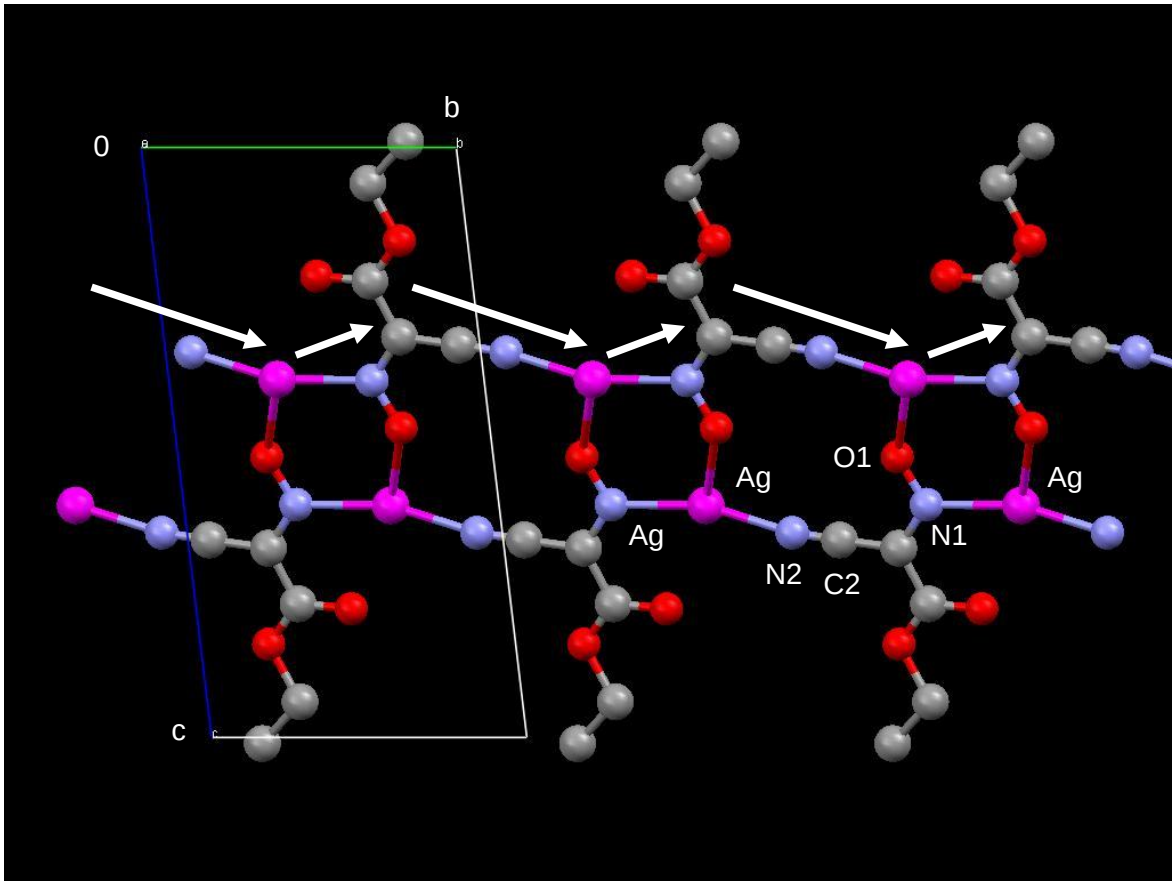
NG-group

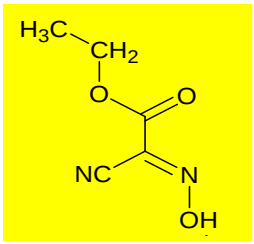
AgL used in our studies so far:

Mark Whited

Crystal packing in the structure of Ag(ECO)

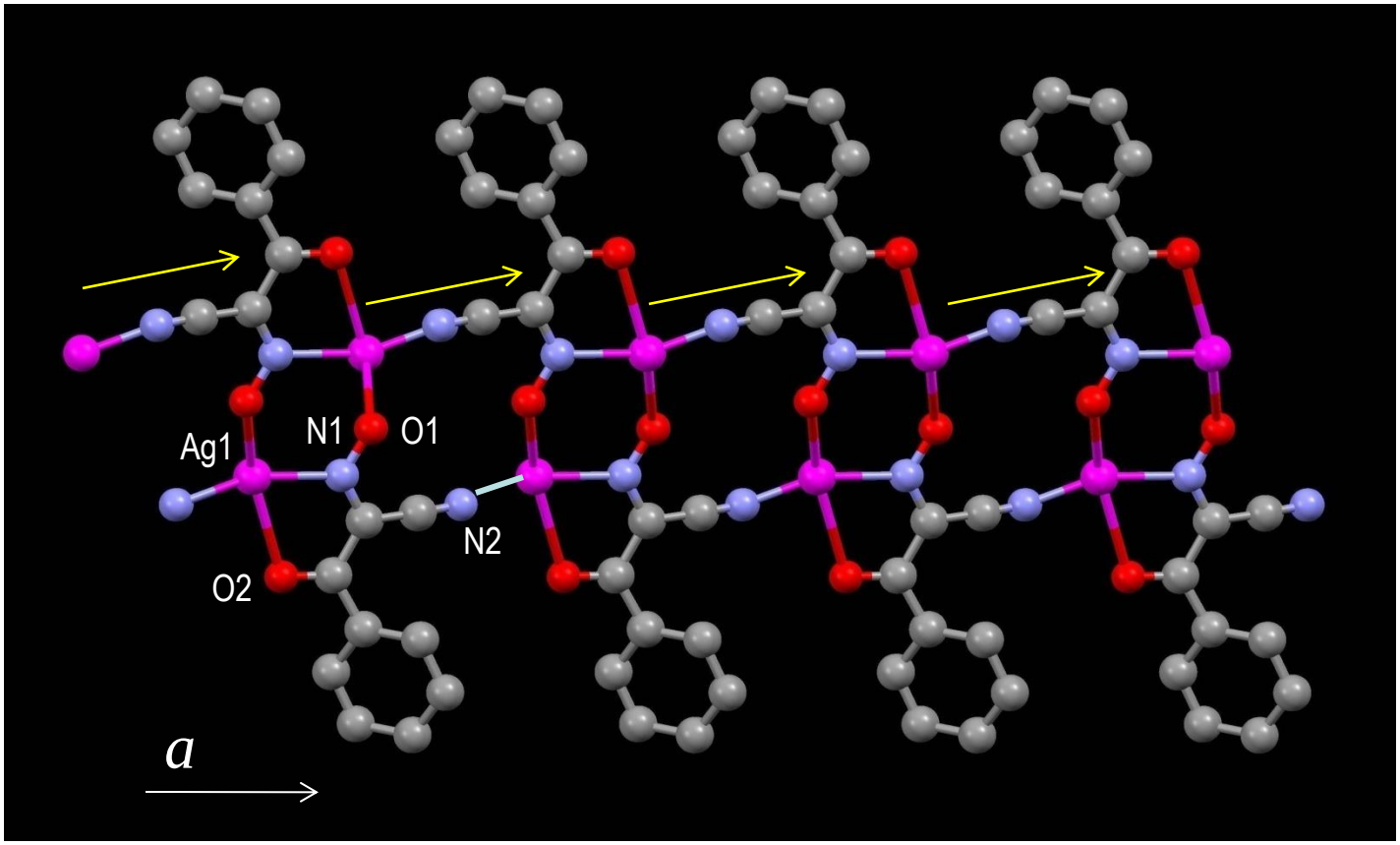
P-1, R1 = 0.028
GOF: 1.033



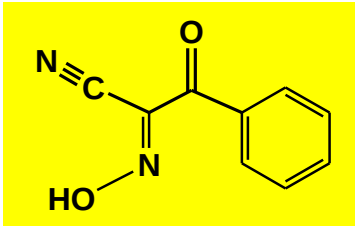


Inorg. Chem. **2010,** *49*, 21, 9863

Crystal packing diagram for the structure of Ag(BCO)



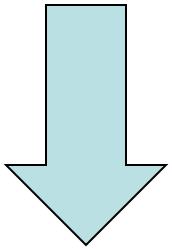
Jeff Morton



$P2_1/c$, R1 = 0.075
GOF: 1.246

NG-group

The origin of such high stability of AgL towards UV-radiation is in their solid state structures!



Short, covalent bonds between metal centers and surrounding bridging ligands.

These bonds shorter than the sum of ionic radii of elements:

Ag-N = 2.97 Å

Ag-O = 2.58 Å

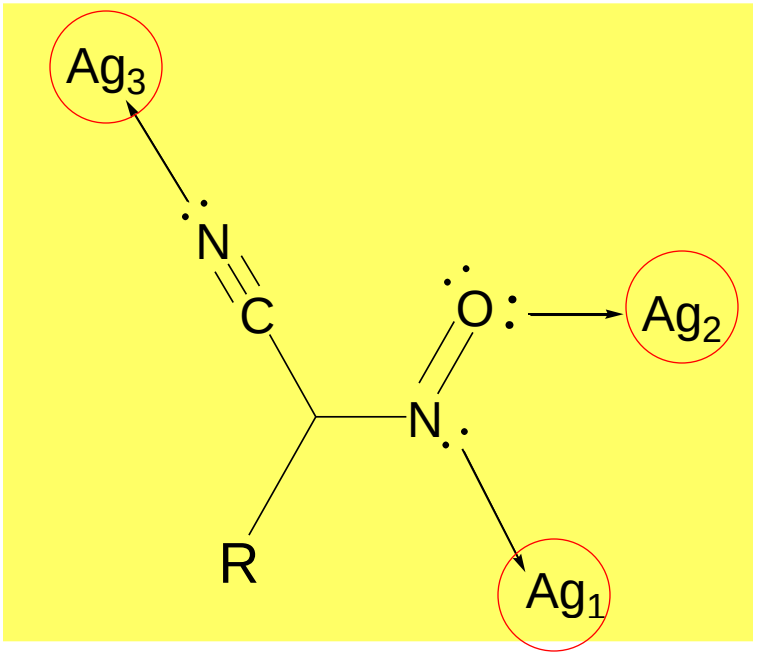
Polymers. **2011**, *3*, 2

NG-group

“Light-insensitive” structural motif:

includes bridging nitroso-group (8 out of 8 cases!) and metal to CN-group coordination (6 out of 8 cases)

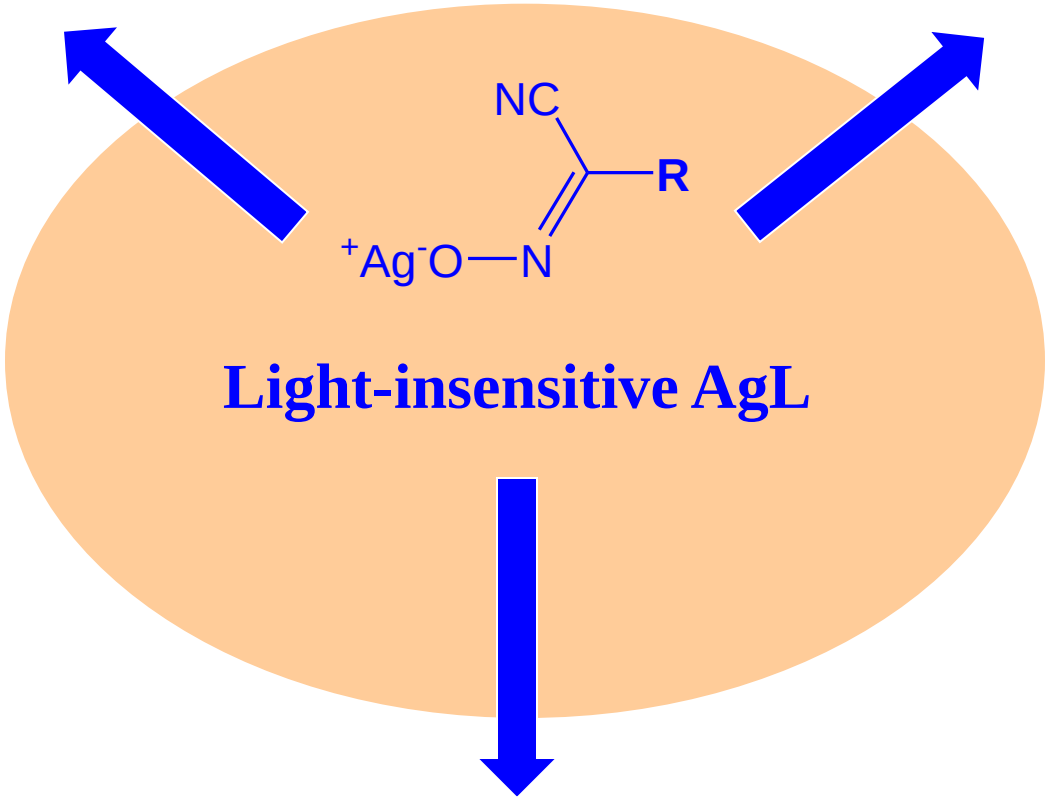
More covalent bonding in the cyanoxime fragment !



Polymers. **2011**, *3*, 2

Battery-less
detectors of UV-radiation

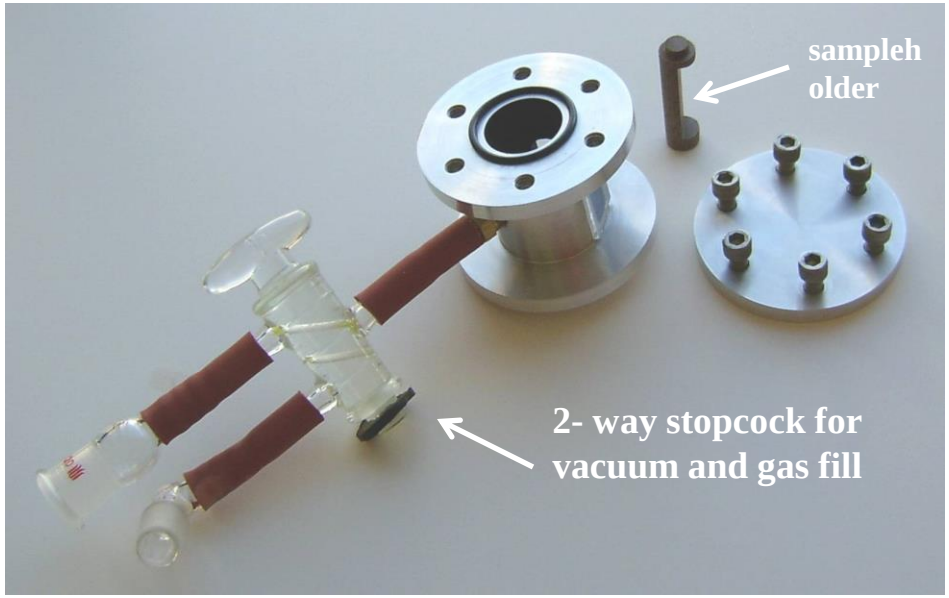
Non-electrical sensors of
gases industrial importance

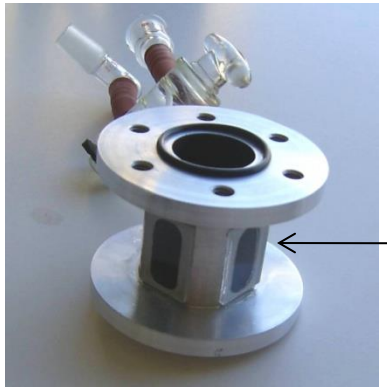


Antimicrobial compounds as
additives to implants adhesives

Inorg. Chem. **2009,** *48*(6), 2371
Dalton Trans.**2010,** *39*, 749-764

A special gas cell for studies of PL from solid samples

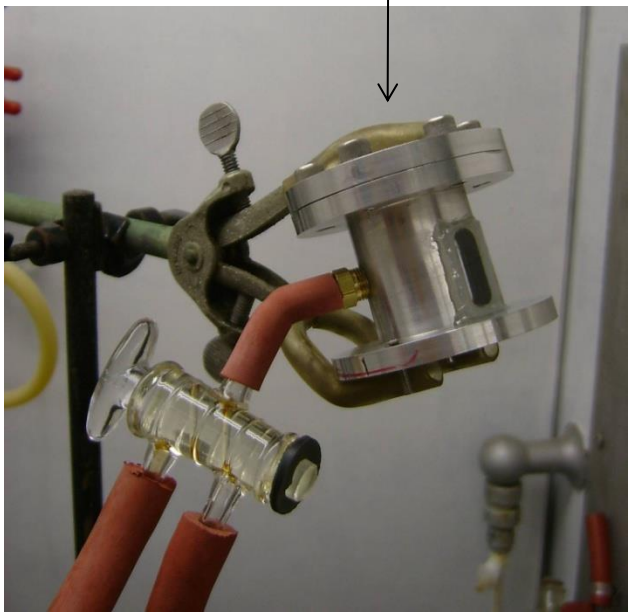




Quartz windows, 90^{o} apart

how it works:

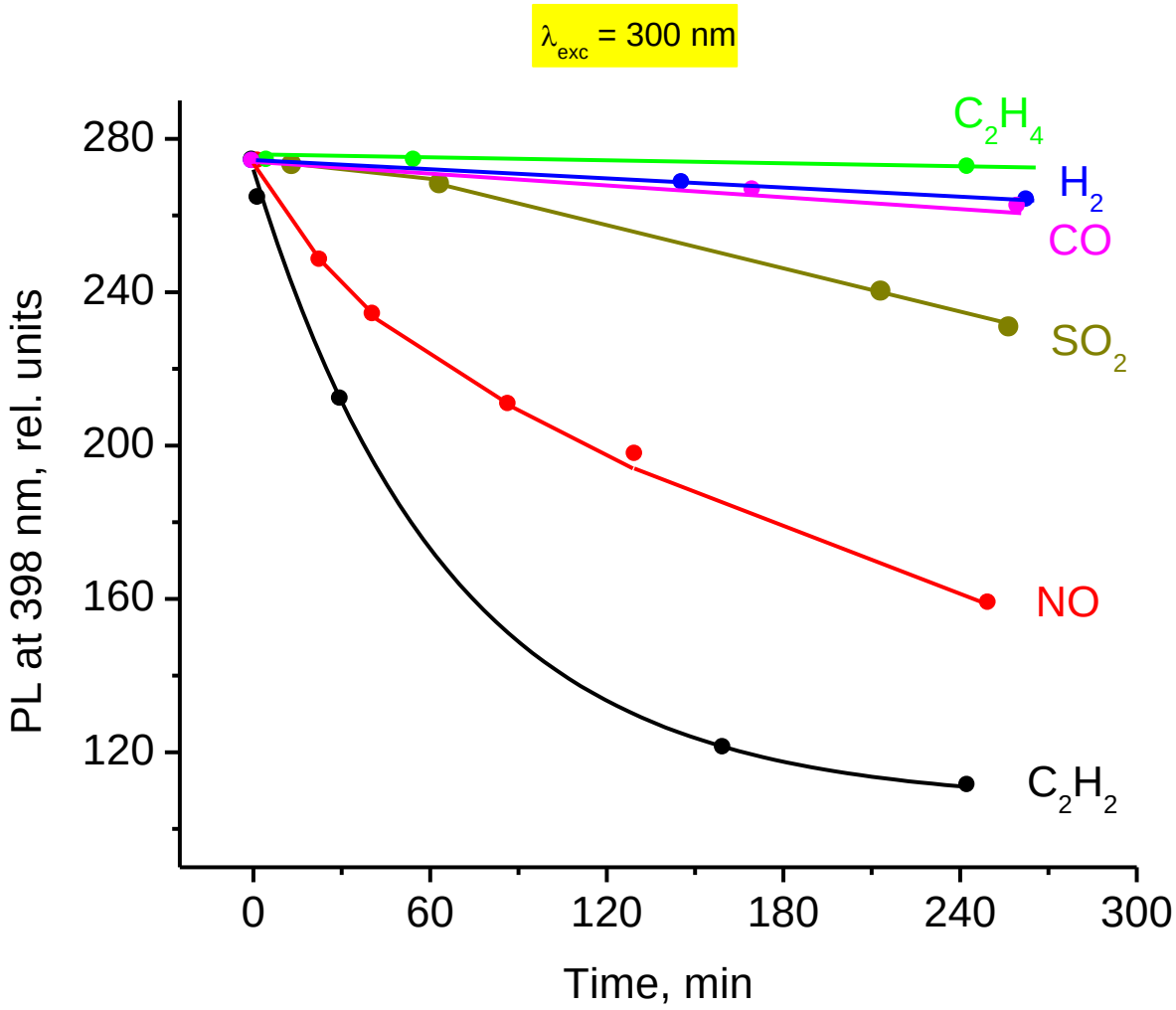
the cuvette with powdery **AgL** is filled with the gas of interest prior to measurements



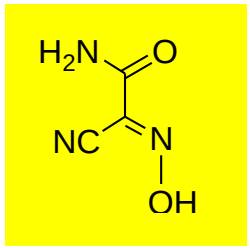
Inorg. Chem. **2009,** *48*(6), 2371
Dalton Trans.**2010,** *39*, 749-764

NG-group

Change in PL with time for powders of Ag(ACO) in the presence of gases of industrial importance.



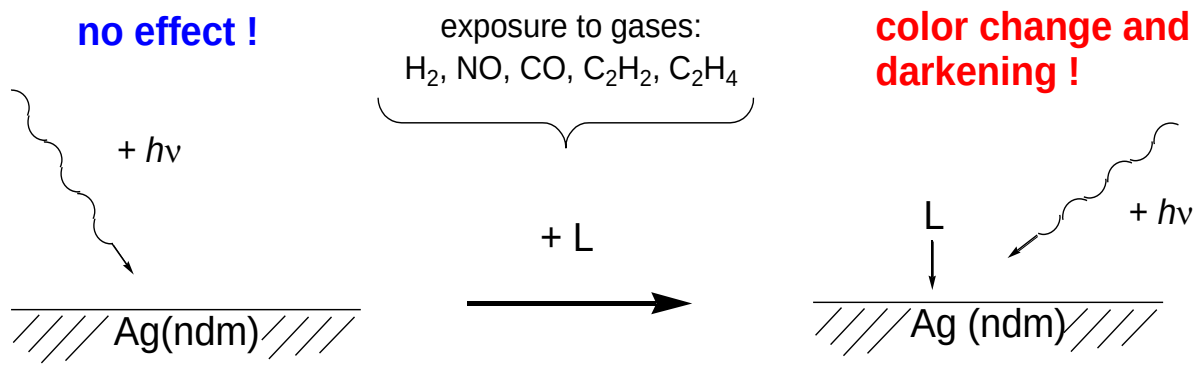
Garrett Glover



*Dalton Trans.***2010,** *39*, 749-764

NG-group

The effect of sensitization of samples of Ag(CCO) by several gases



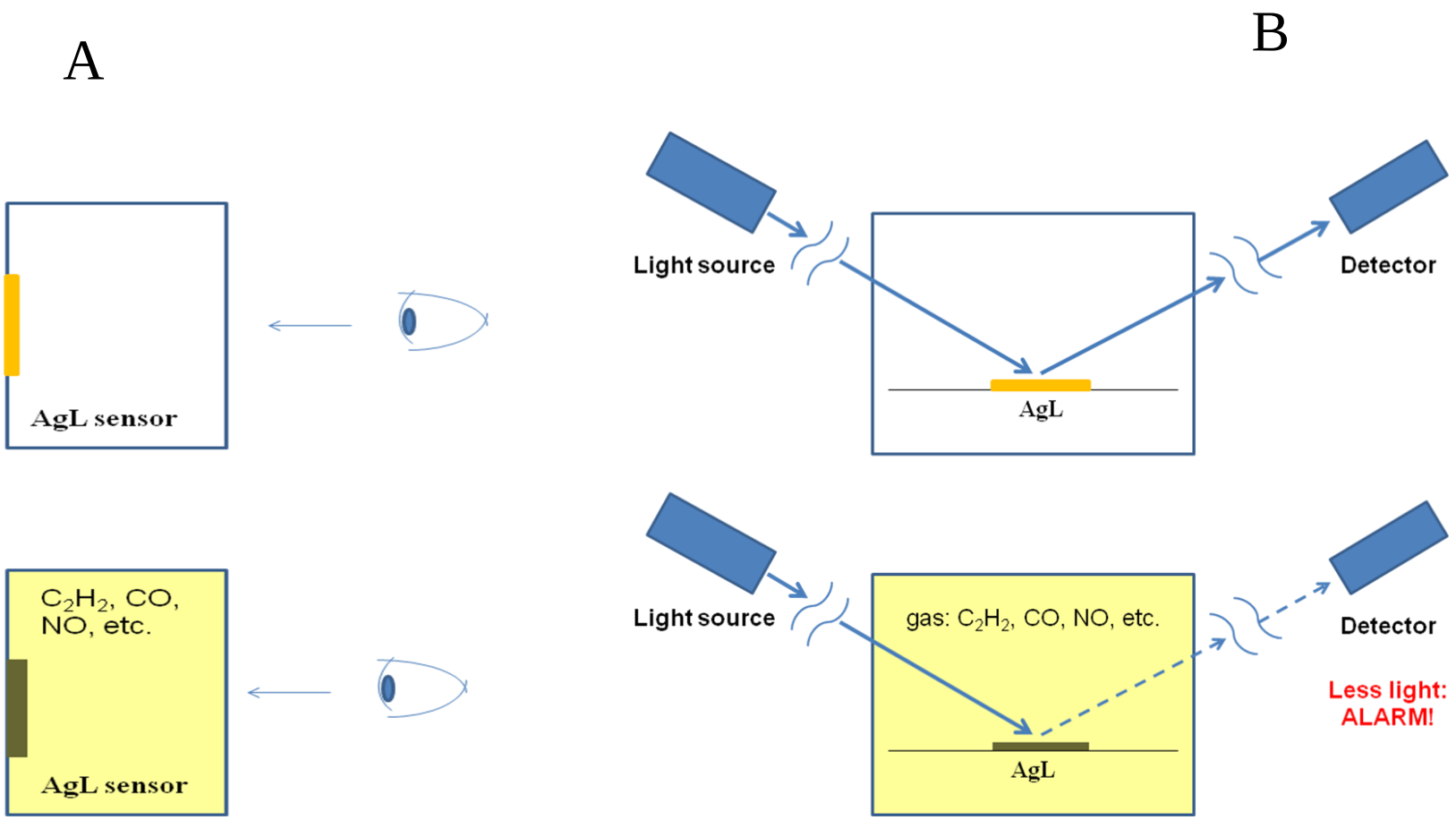
visible light insensitive **visible light sensitive**

Garrett Glover

Inorg. Chem. **2009,** *48*(6), 2371

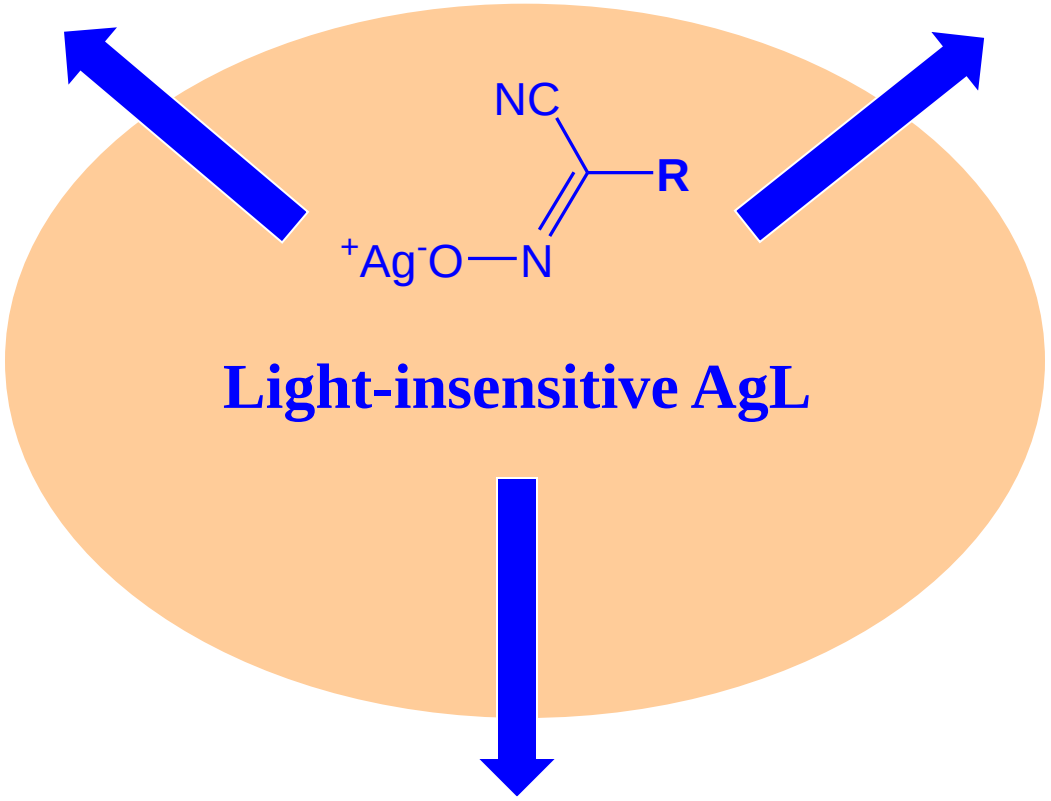
NG-group

Schematic diagram for the *visual inspection* (A), *<u>or</u> quantitative measurements* using the optoelectronic pair (B) working in closed, illumined premises.



Battery-less
detectors of UV-radiation

Non-electrical sensors of
gases industrial importance



Light-insensitive AgL

Antimicrobial compounds as
additives to implants adhesives

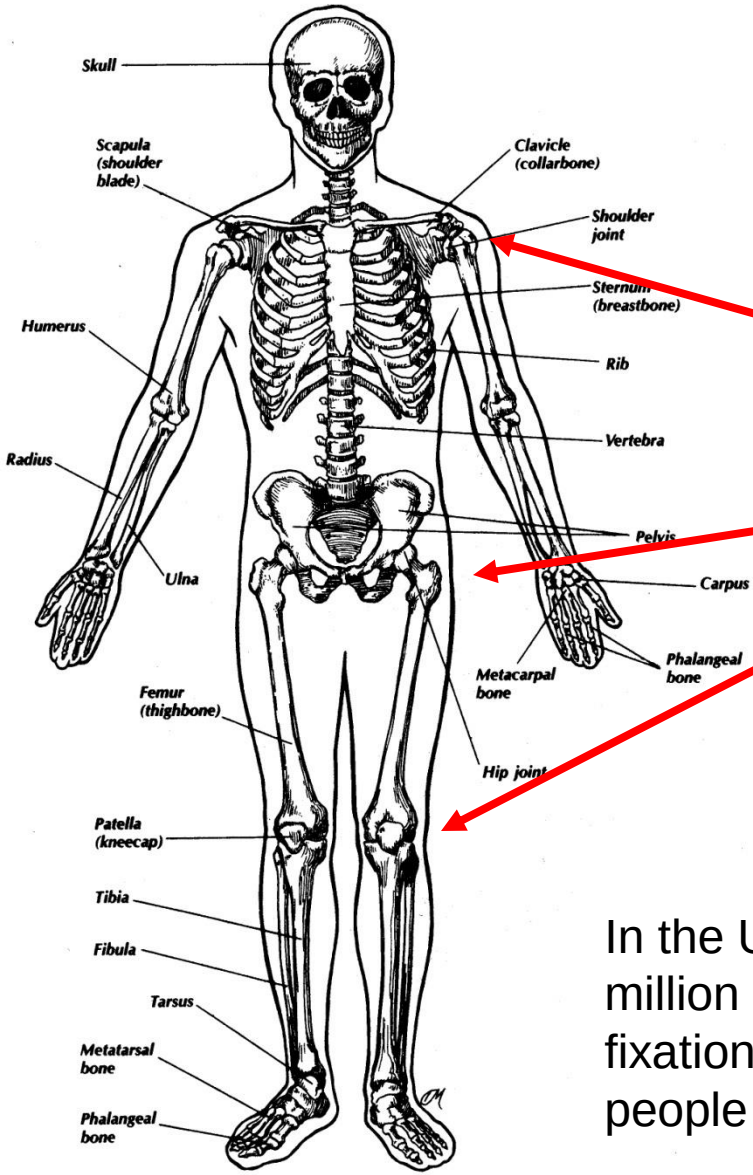
Polymers. **2011**, *3*, 2

Inorg. Chem. **2010,** *49*, 21, 9863

Inorg. Chim. Acta. **2014**, *412*, 94

NG-group

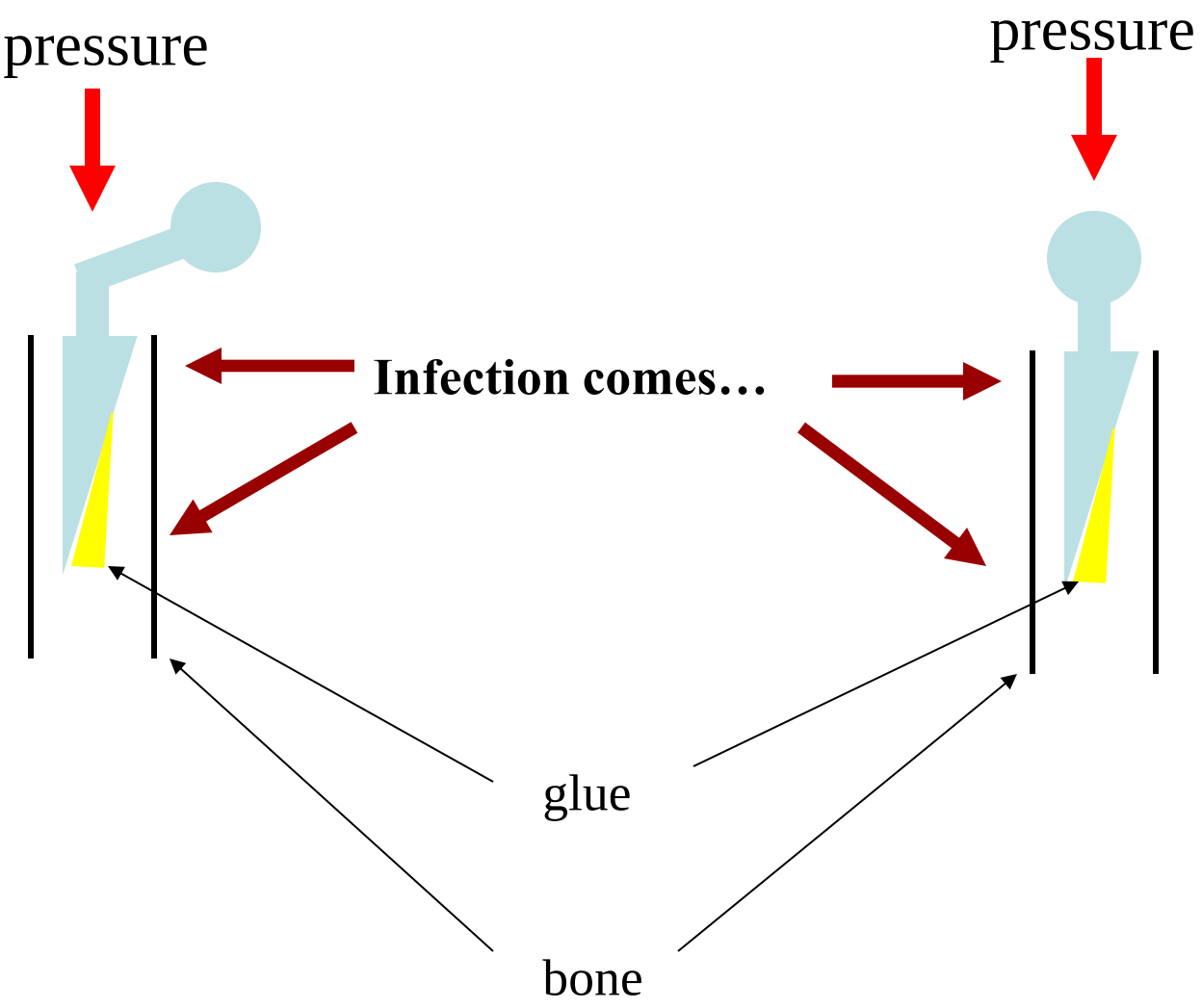
When we get old…



Joint replacement therapy

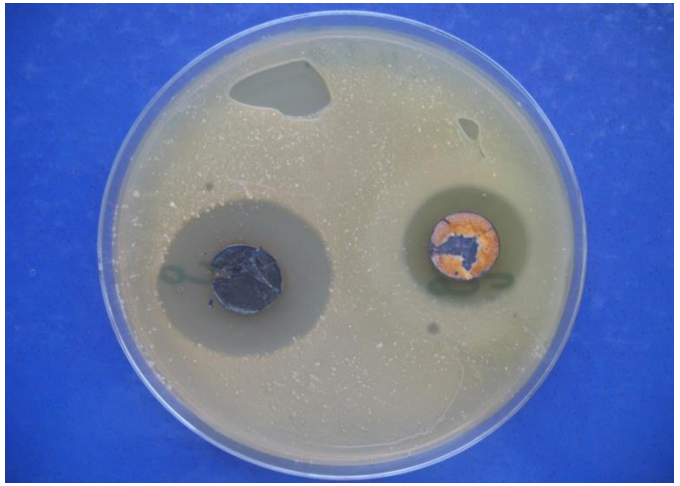
In the United States alone, more than 4.4 million people have at least one internal fixation device and more than 1.3 million people have an artificial joint

Artificial joints: problems…



Testing of pellets of Ag(I) cyanoximates against

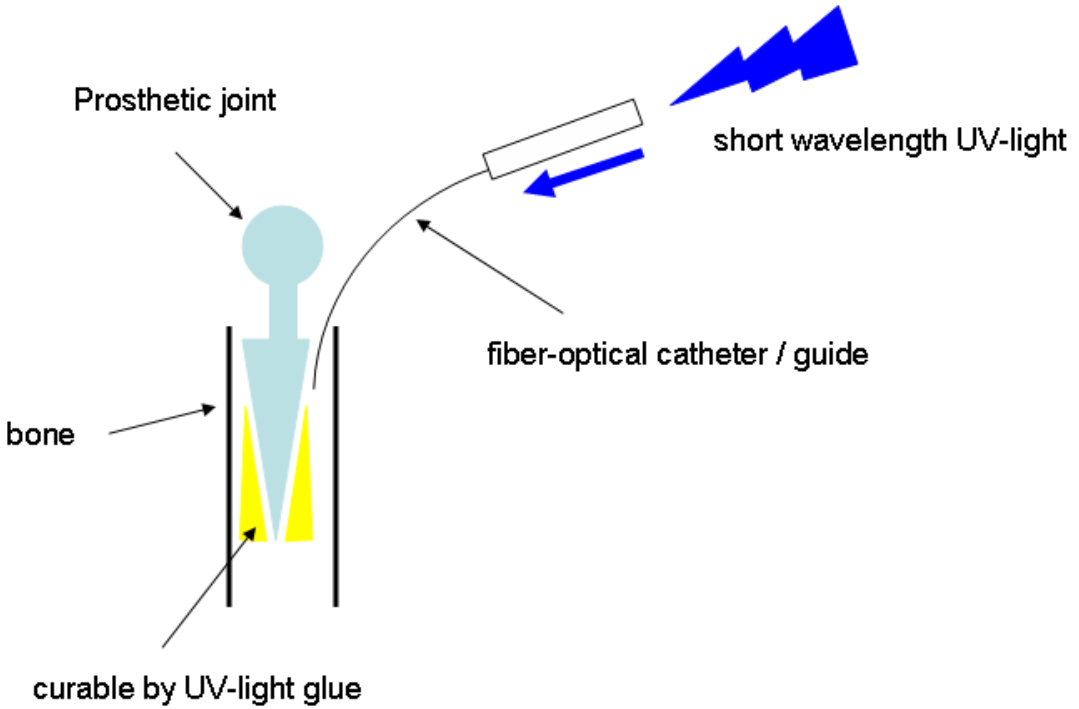
Candida albicans :

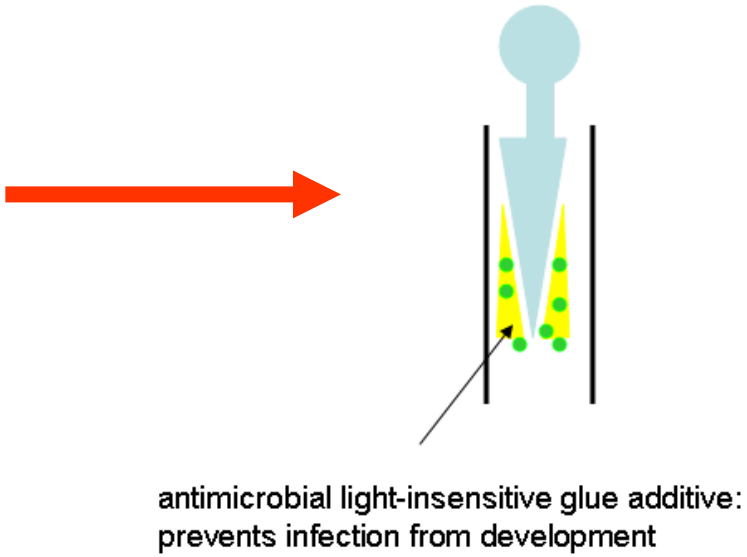


Inorg. Chem. **2010,** *49*, 21, 9863

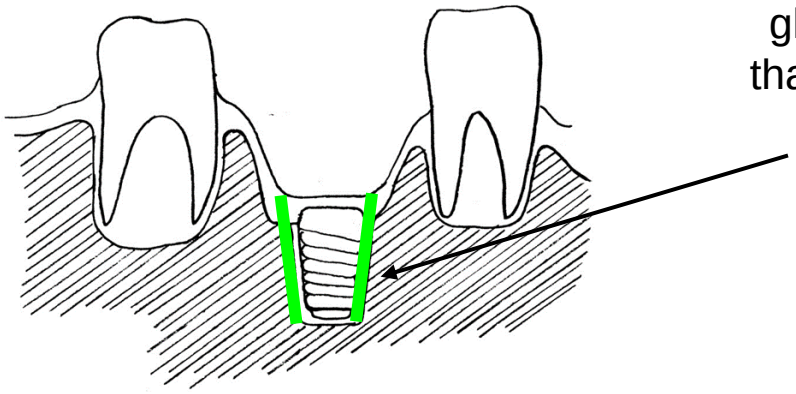
NG-group

Indwelling devices: artificial joints, and





dental implants



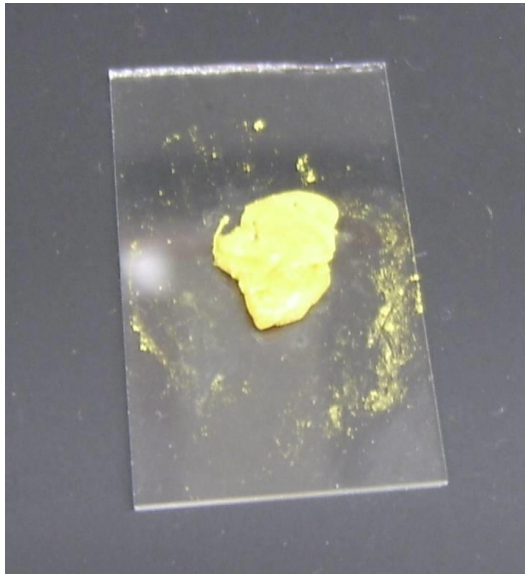
glue (to fix implant in place) that contains water insoluble antimicrobial additive Ag(I) compound

Inorg. Chem. **2010,** *49*, 21, 9863

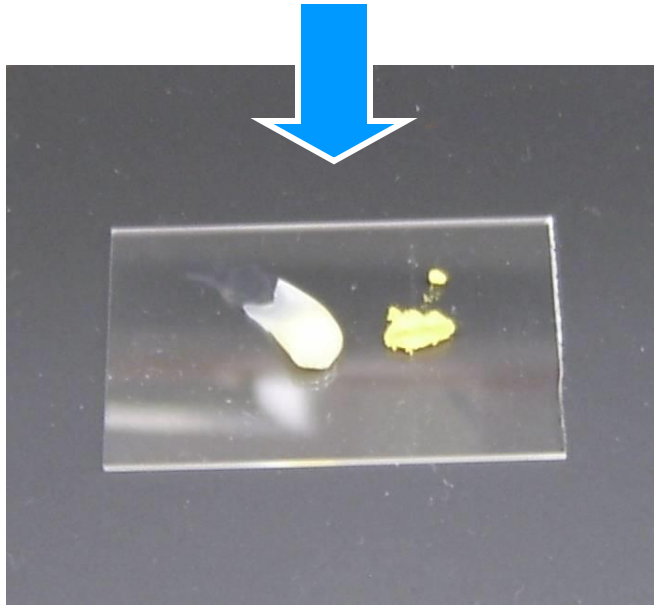
NG-group

Commercial flowable dental composites and AgL: testing of concept.

+

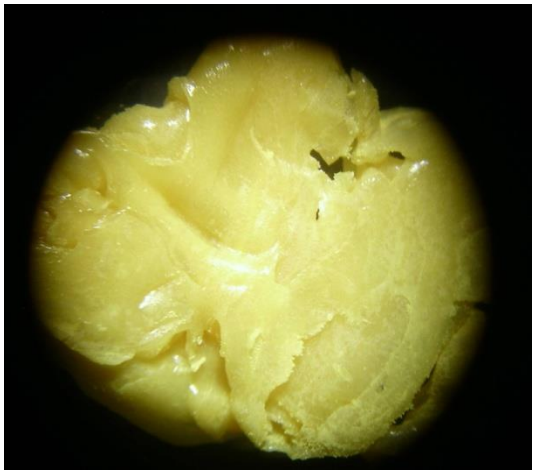


extrusion



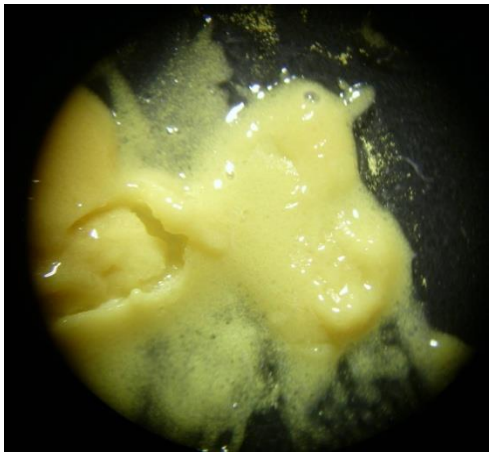
Mark Whited

Making solid composite with Ag(I) cyanoximate via light curing.



40 sec

140 sec

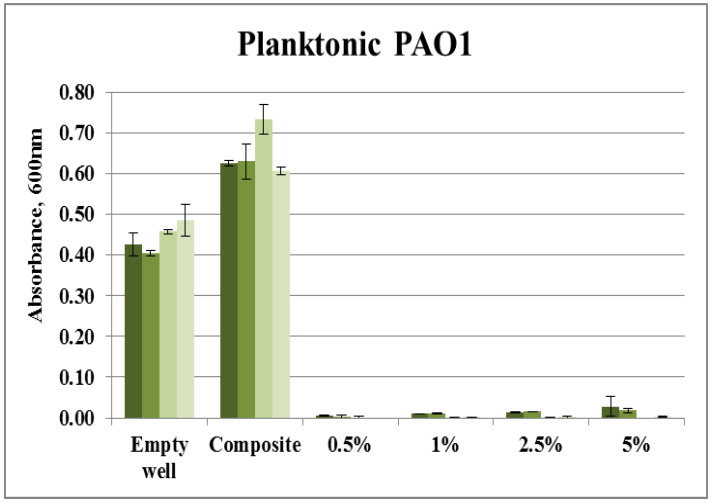


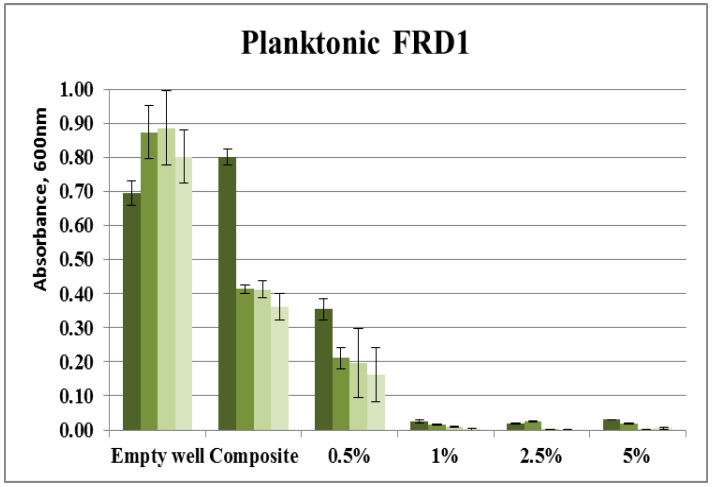
Mark Whited

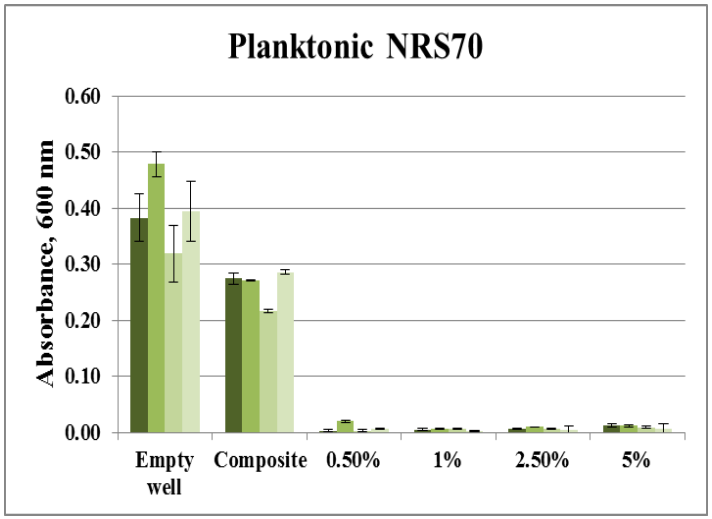
Polymers. **2011**, *3*, 2

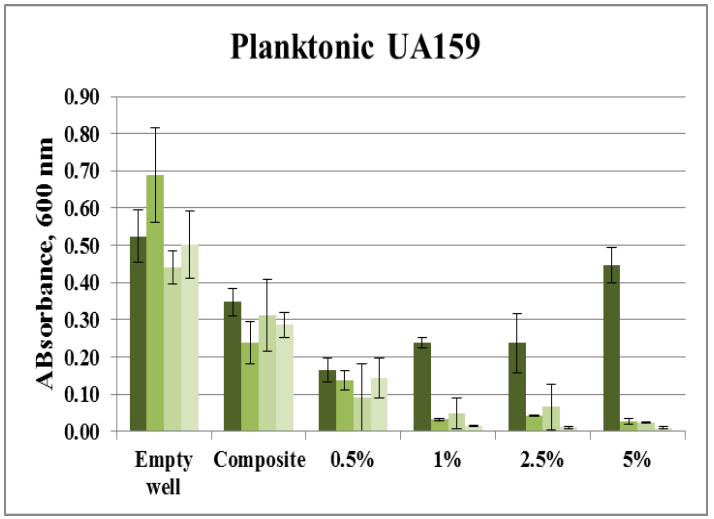
Antimicrobial studies.

M. Patrauchan







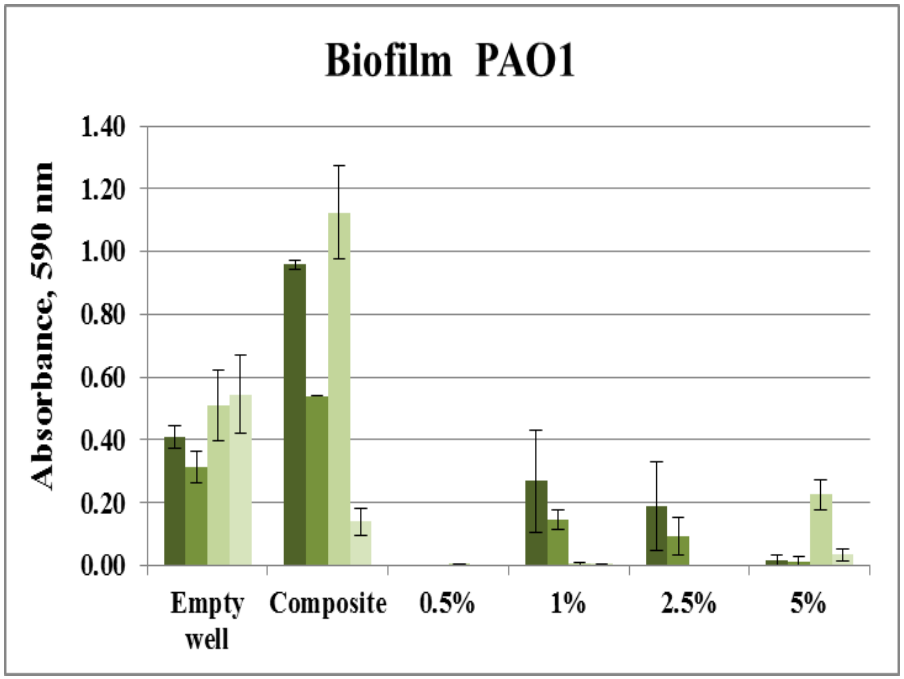


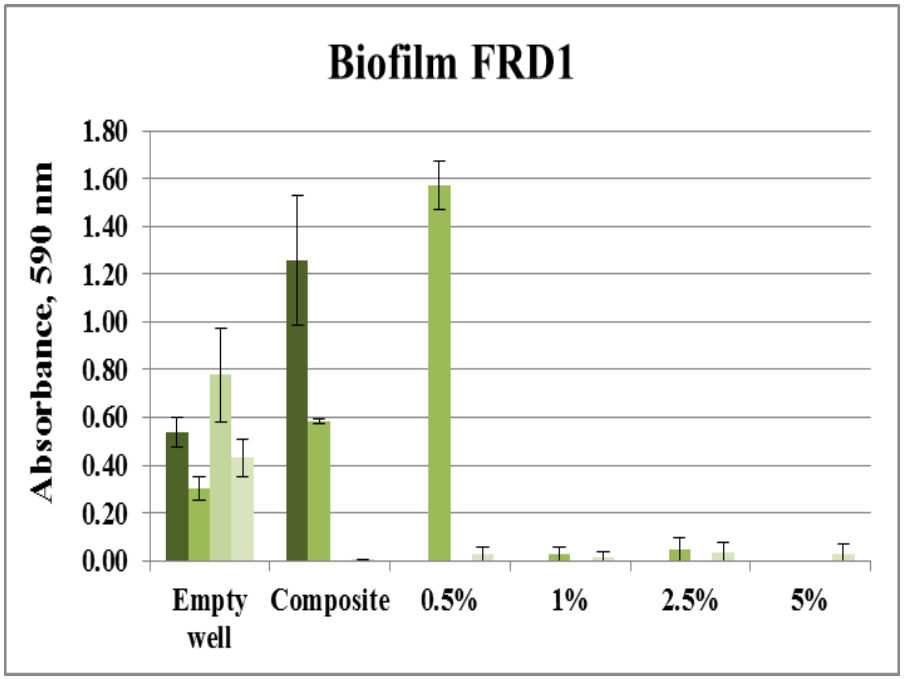
Planktonic growth of *P. aeruginosa* PAO1, FRD1, *S. aureus* NRS70, and *S. mutans* UA159 in the wells containing composites with embedded compounds: Ag(ACO), Ag(BCO), Ag(CCO), and Ag(PiCO). Empty wells and in the wells containing composites alone were used as positive controls.

Inorg. Chim. Acta. **2014**, *412*, 94

Biofilm studies.

M. Patrauchan





Biofilm growth of *P. aeruginosa* PAO1, FRD1, in the wells containing composites with embedded compounds: Ag(ACO), Ag(BCO), Ag(CCO), and Ag(PiCO). Empty wells and in the wells containing composites alone were used as positive controls.

Inorg. Chim. Acta. **2014**, *412*, 94 *Dalton Trans*, **2018**, submitted

leaching

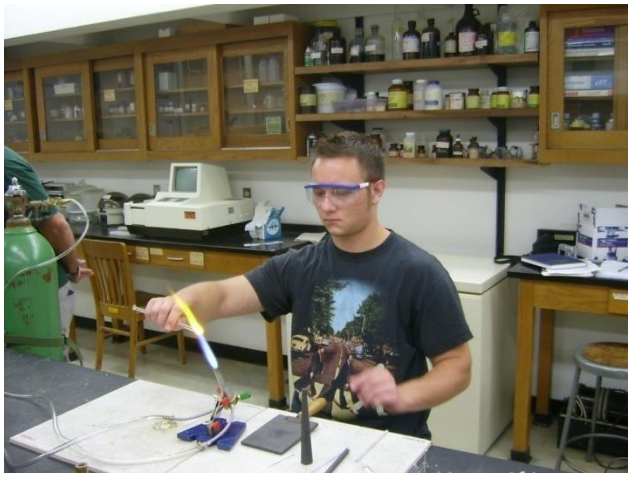
“Silver students”:

Daniel Eddings,

Tiffany Maher,

Jennifer Snyder

Garrett Glover



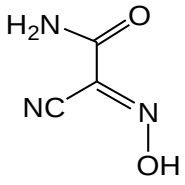
Jeff Morton

New organoantimony(V) antimicrobial cyanoximates

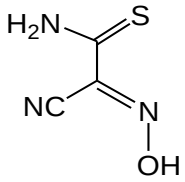
NG-group

Ligands used in this project

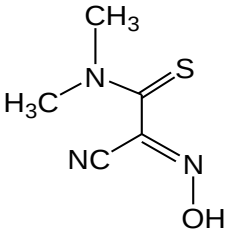
- These molecules showed biological activity and possess some degree of water solubility



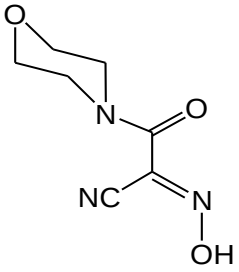
HACO



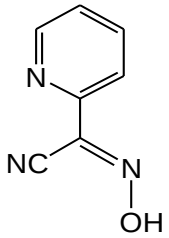
HTCO



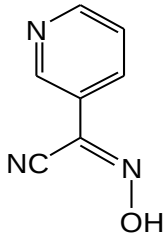
HTDCO



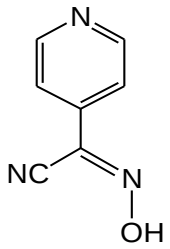
HMCO



H2PCO

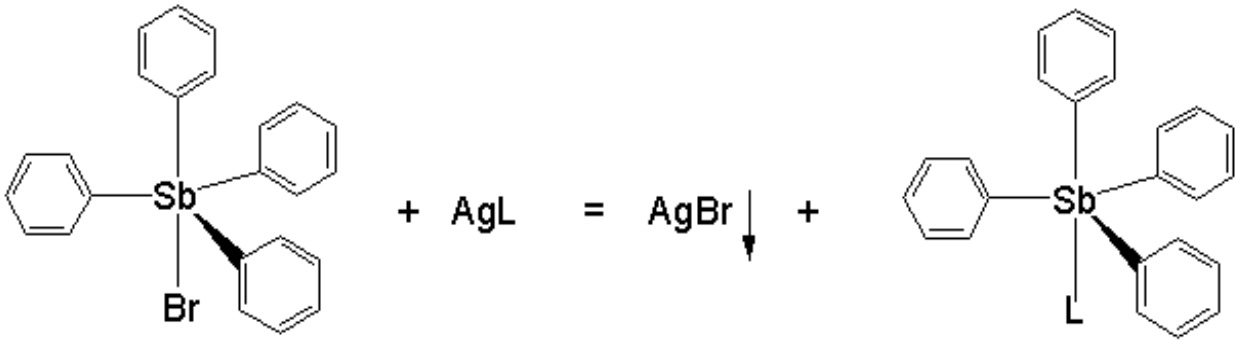


H3PCO

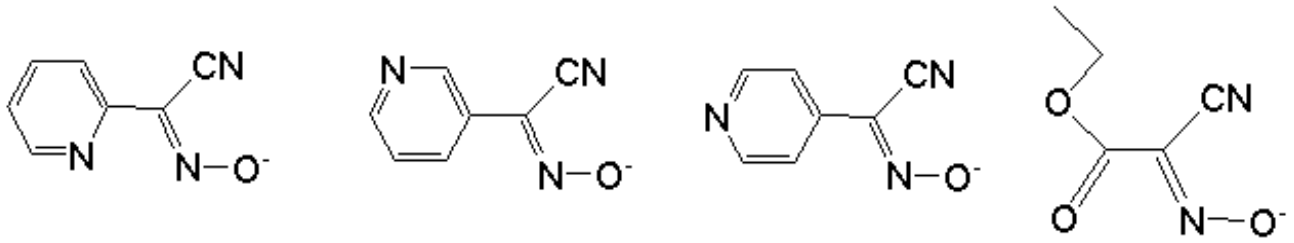


H4PCO

We decided to start this project with making lipophilic tetraphenyl Sb(V) complexes.
The best way of preparation is the metathesis reaction:

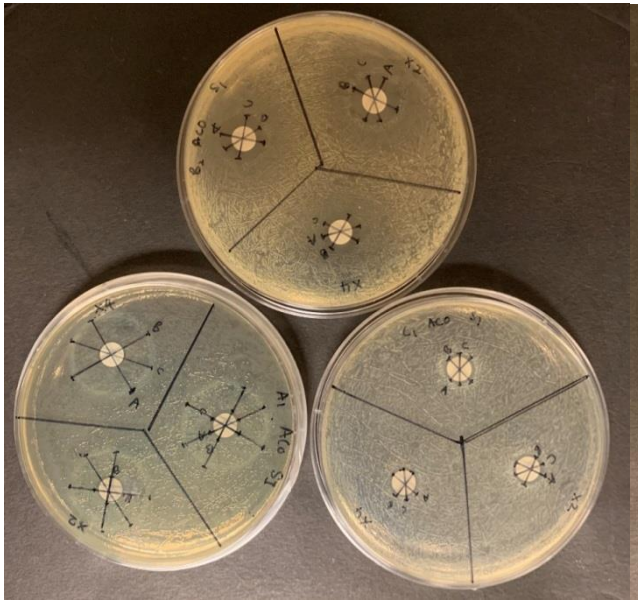


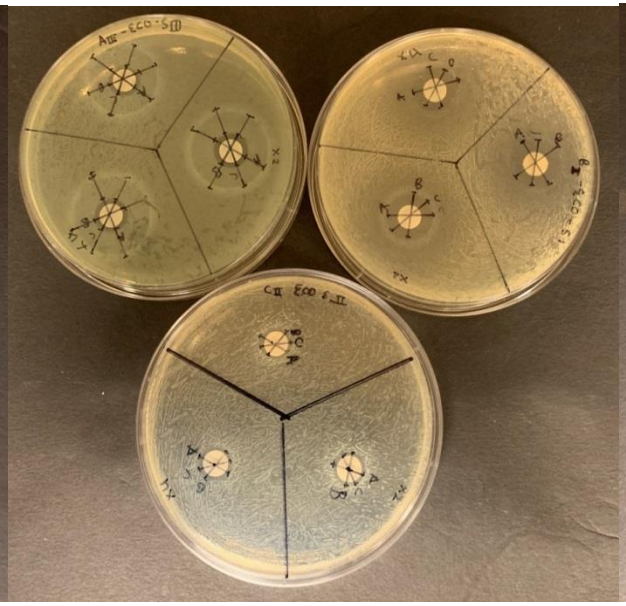
L = 2PCO, 3PCO, 4PCO ECO

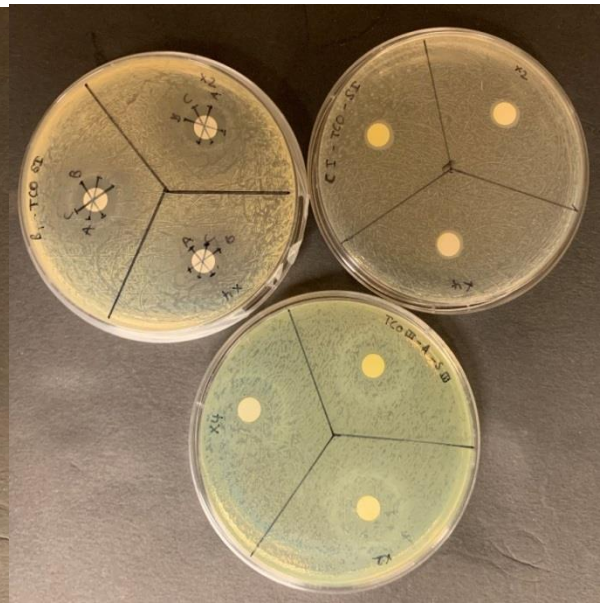


Kevin Pinks

Representative images

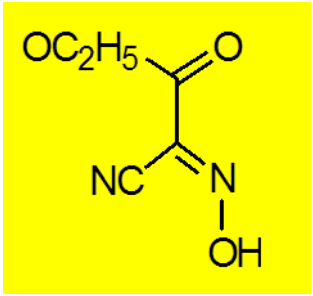




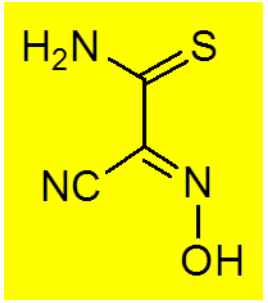


ACO

ECO

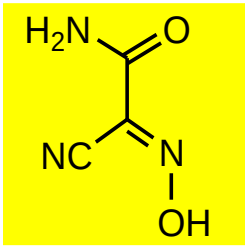


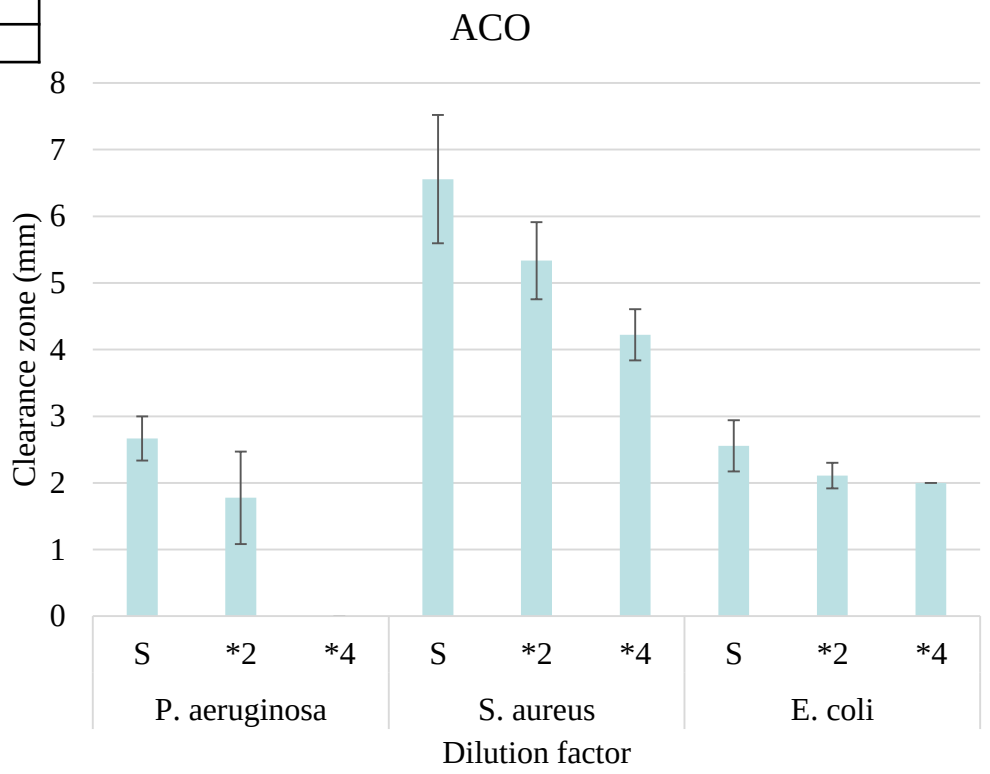
TCO



$SbPh_4$(ACO) complex

Organism		Dilution factor	Average	SD
A	*P. aeruginosa*	S	2.666667	0.333333
		*2	1.777778	0.693889
		*4	0	0
B	*S. aureus*	S	6.555556	0.96225
		*2	5.333333	0.57735
		*4	4.222222	0.3849
C	*E. coli*	S	2.555556	0.3849
		*2	2.111111	0.19245
		*4	2	0

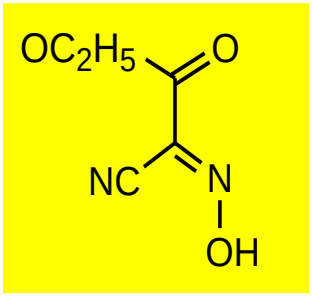


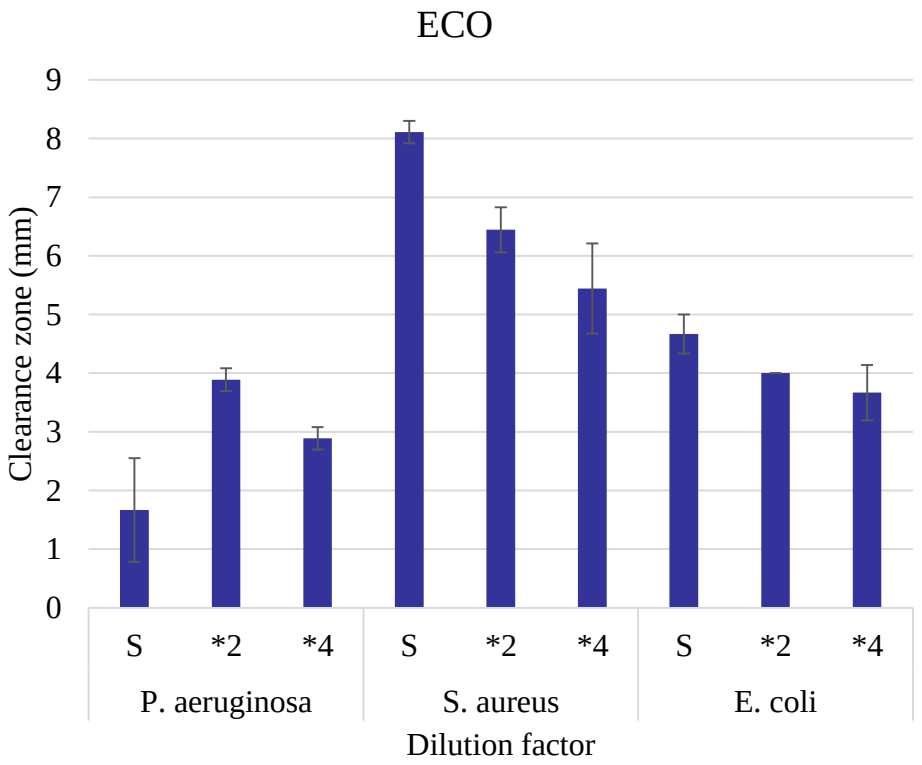


Kevin Pinks
Marianna Patrauchan

$SbPh_4(ECO)$ complex

Organism		Dilution factor	Average	SD
A	*P. aeruginosa*	S	1.666667	0.881917
		*2	3.888889	0.19245
		*4	2.888889	0.19245
B	*S. aureus*	S	8.111111	0.19245
		*2	6.444444	0.3849
		*4	5.444444	0.7698
C	*E. coli*	S	4.666667	0.333333
		*2	4	0
		*4	3.666667	0.471405

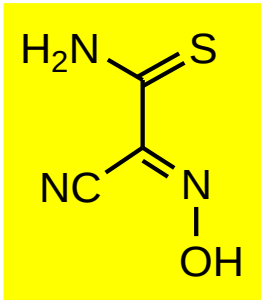


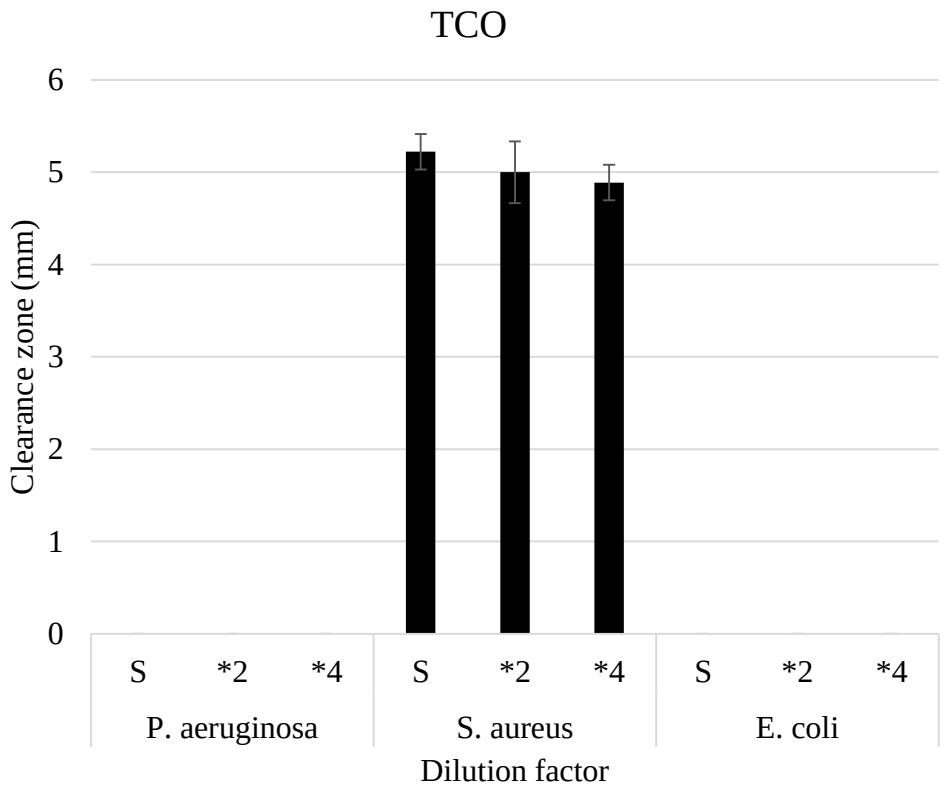


Kevin Pinks
Marianna Patrauchan

$SbPh_4(TCO)$ complex

Organism		Dilution factor	Average	SD
A	*P. aeruginosa*	S	0	0
		*2	0	0
		*4	0	0
B	*S. aureus*	S	5.222222	0.19245
		*2	5	0.333333
		*4	4.888889	0.19245
C	*E. coli*	S	0	0
		*2	0	0
		*4	0	0





Kevin Pinks
Marianna Patrauchan

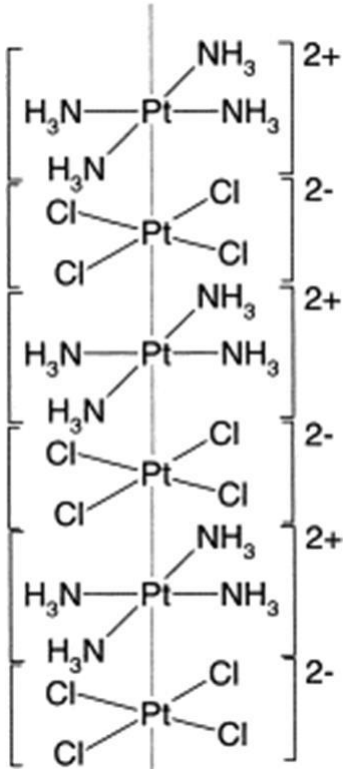
New anti-cancer active compounds

- *self-assembled 1D coordination polymers*
- *cytotoxic NIR emitters for theranostics applications*

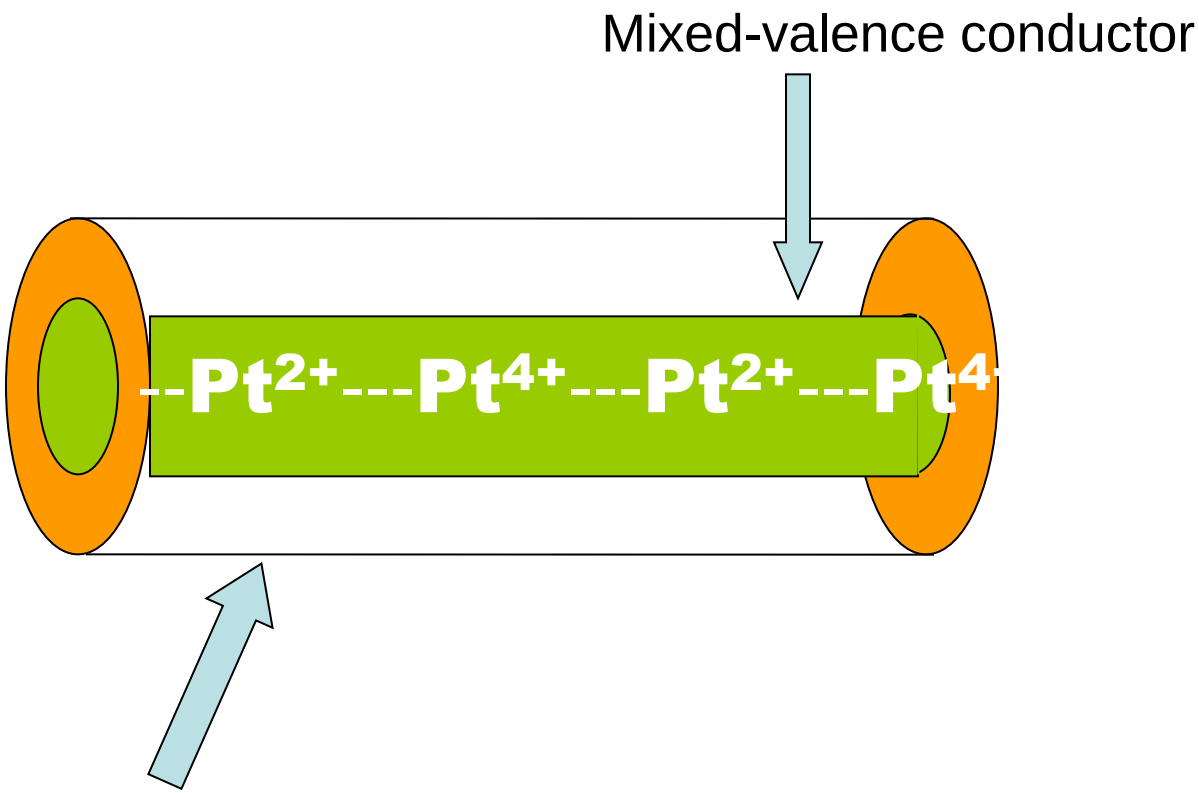
NG-group

Magnus' Green Salt (MGS): $[Pt(NH_3)_4][PtCl_4]$

1832



Coordination polymeric compounds as electric conductors.



An insulator: protective organic ligands. No H-bonding !

Jessica Ratcliff, Carl Cheadle

Heat dissipation is the most pressing problem in miniature electronic devices…

Potential applications:

- molecular electronics:
  thin, conducting films that can be deposited from solutions

Preparation of **partially oxidized tetracyanoplatinates** from $K_2[Pt(CN)_4]$

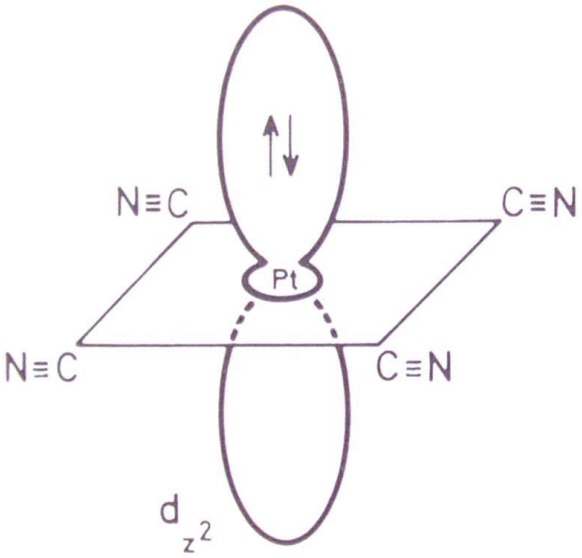
Oxidize Pt (II) polymer chemically:

- with H_2O_2
- with halogens (Br_2, Cl_2 or I_2)

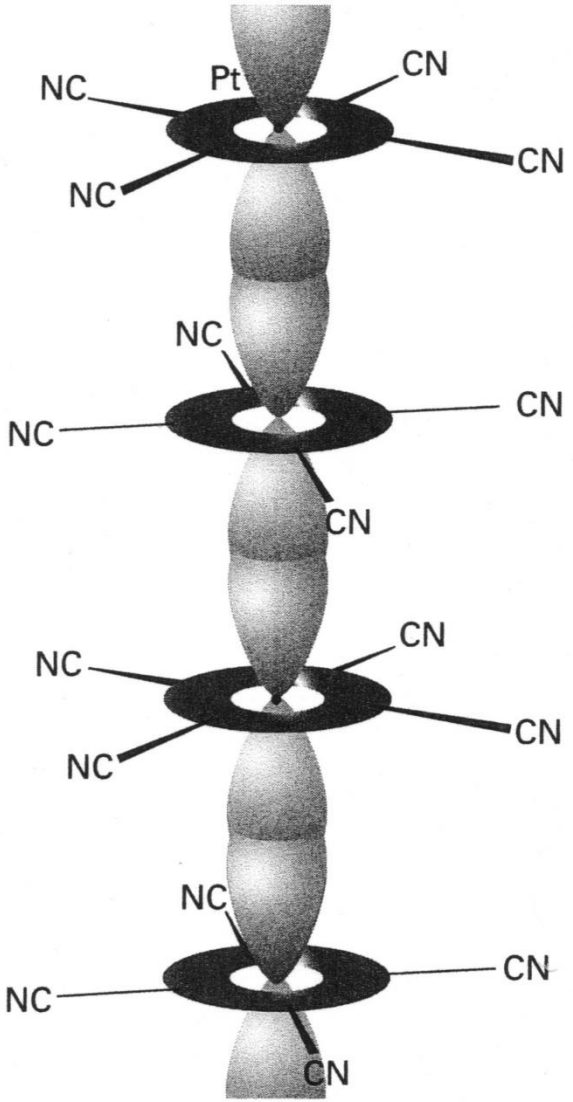
Oxidize formed Pt (II) coordination polymer with an electric current on Pt electrod

From mixture of Pt (II) and Pt (IV) monomers

Pt d_{z^2} orbitals (a) and overlap between stacked complex ions (b) in POCP. The ions are staggered to reduce Coulomb repulsion between ligands.



a

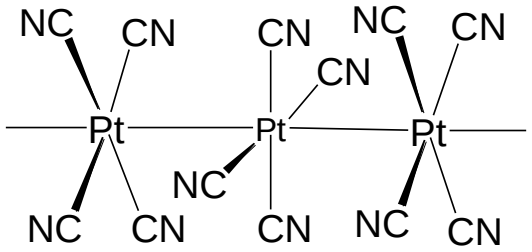


b

Classical systems: room temperature metal-type conductors

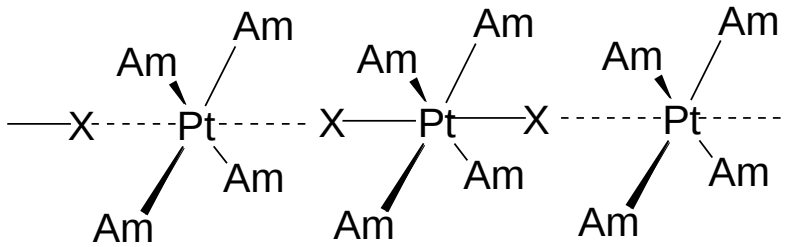
----Pt^{2+}-----Pt^{4+}-----Pt^{2+}-----Pt^{2+}----

KCP



non-stoichiometric Br, 2 K^+, 3 H_2O

MX

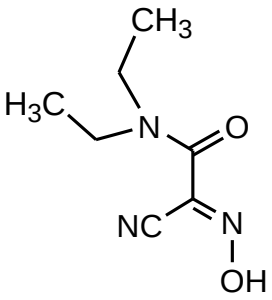


Am = NH_3, H_2N NH_2 , NH_2 NH_2 X = Cl, Br or I

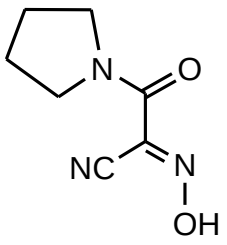
50% Pt^{2+}– 50% Pt^{4+})

Pt-cyanoximates:
synthesis and properties

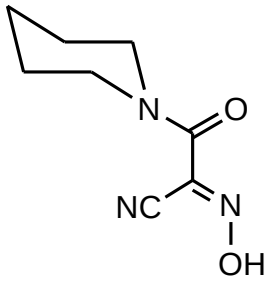
Out of 42 known cyanoximes only those form a very unusual dark-green colored 1D polymeric $[PtL_2]_n$ complexes



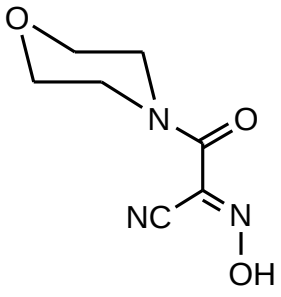
HDECO



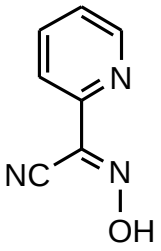
HPyRCO



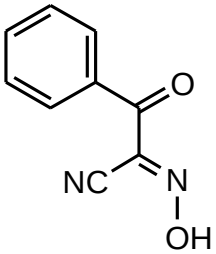
HPiPCO



HMCO



H2PCO



HBCO

Inorg. Chem. **2004**, *43 (13), p.3894*

2018, *US Patent # 9,982,188 B2*

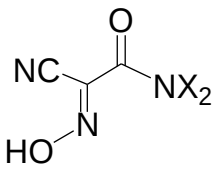
Inorg. Chim. Acta. **2012**, *385*, p.1-11

Dalton Trans., **2017**, *46*(39), 13562-13581

NG-group

Preparation of PtL_2

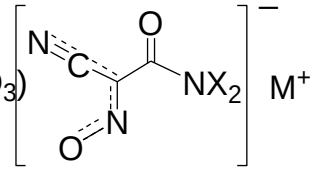
colorless



ligand: *trans-anti*

R.T., + base
(MOH or M_2CO_3)
- H_2O

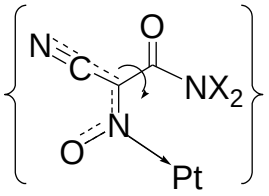
bright-yellow



(M = Li, Na, K, Cs;
X = $(CH_2)_5$ for **PiPCO**, $(CH_2)_4O$ for **MCO**)

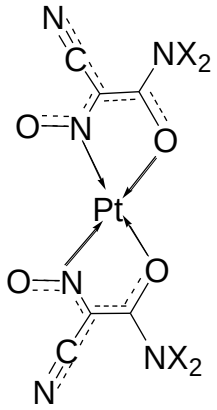
R.T., in H_2O
+ K_2PtCl_4

red-orange solution



10 - 30 min

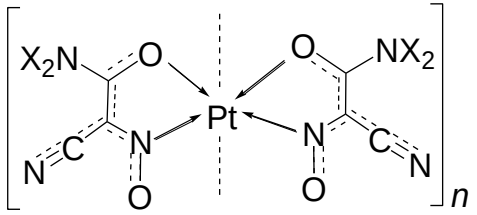
orange-brown solution



ligand: *cis-anti*

1 - 8 hrs

green precipitate:
1D polymer

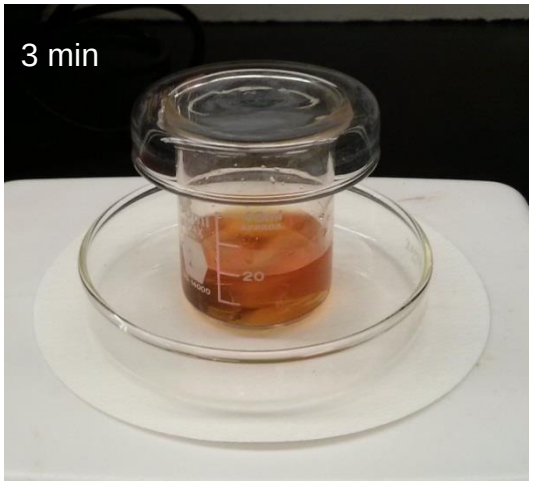


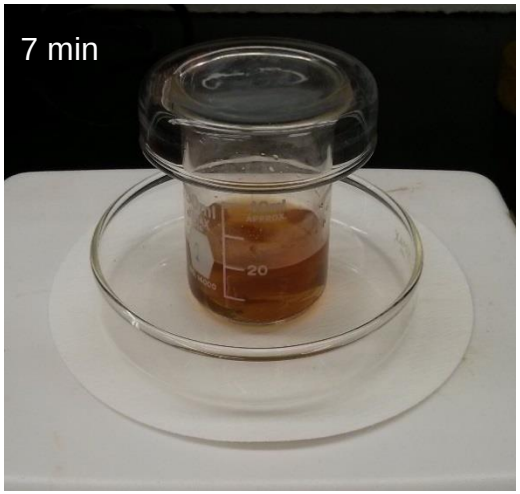
Inorg. Chem. **2004**, *43 (13), p.3894*

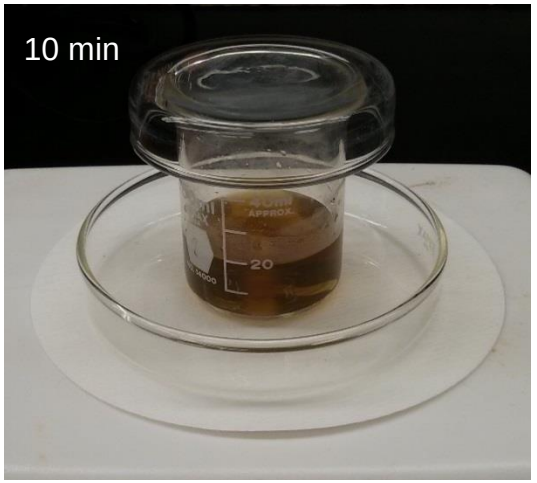
Inorg. Chem. **2015**, *54* (4), 1890

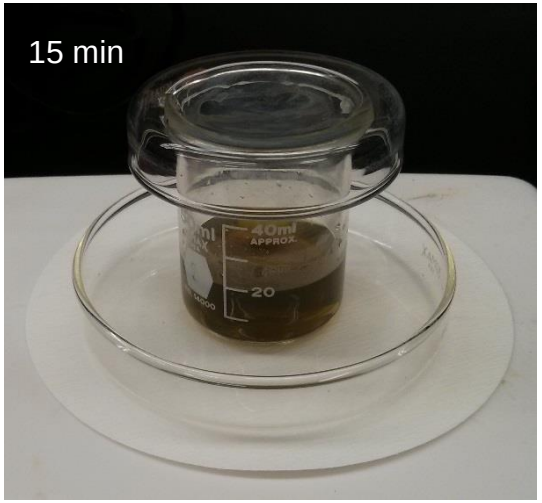
Dalton Trans., **2017**, *46*(39), 13562-13581

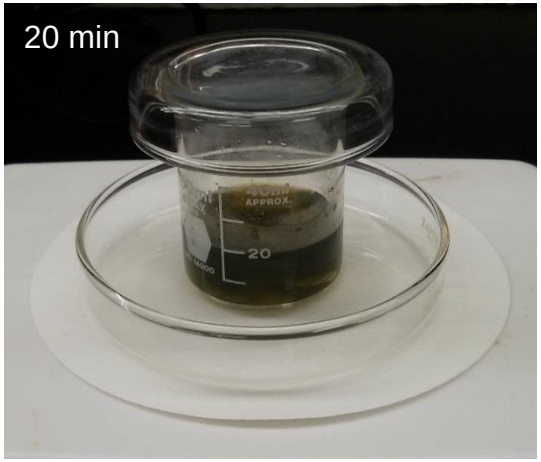
Actual photographic monitoring of polymeric $Pt(PiPCO)_2$ formation.

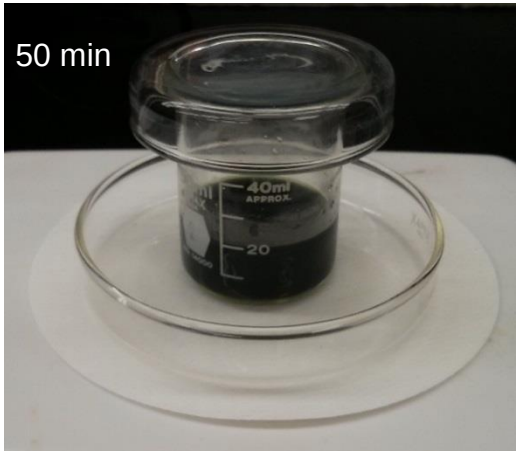












Dalton Trans., **2017**, *46*(39), 13562-13581

NG-group

Pictures at 40x magnification

$Pt(MCO)_2$

$Pt(PiPCO)_2$

$Pt(2PCO)_2$

$Pt(BCO)_2$

$Pt(PyrCO)_2$

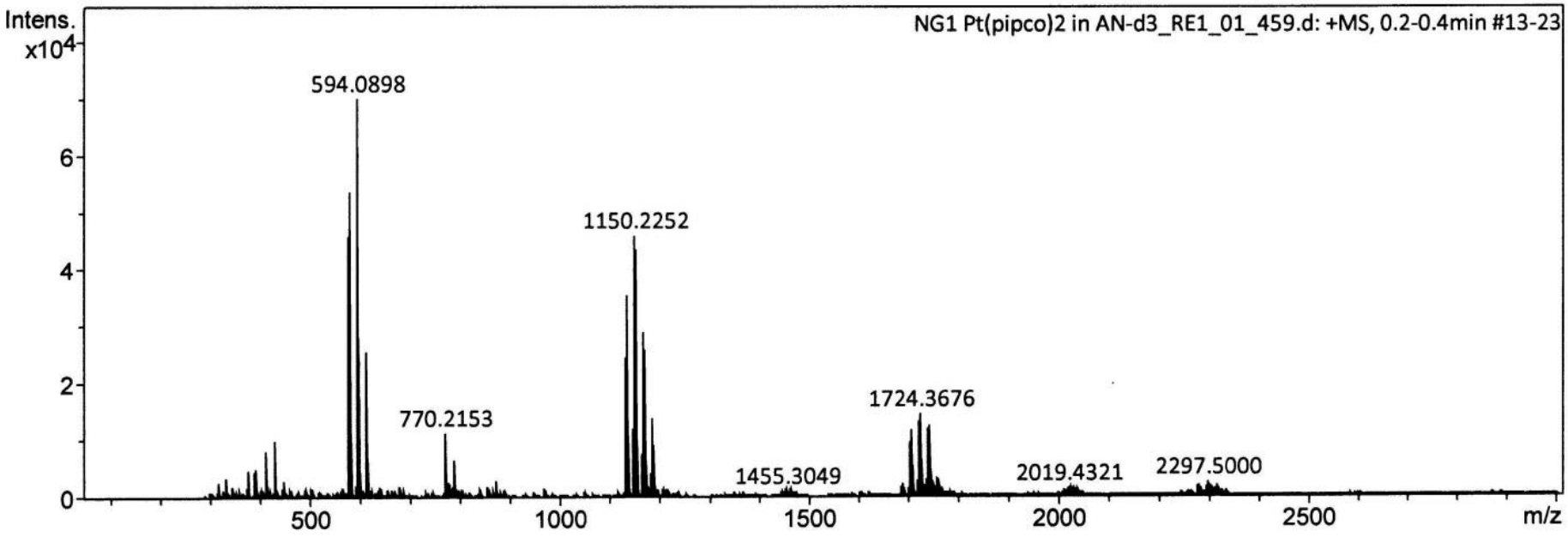
$Pt(DECO)_2$

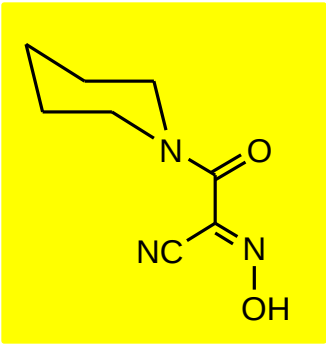
2018, *US Patent # 9,982,188 B2*

Dalton Trans., **2017**, *46*(39), 13562-13581

Mass-spectrum of solution of $[Pt(PiPCO)_2]_n$ in CH_3CN: presence of polynuclear species is evident.

Victor Nemykin

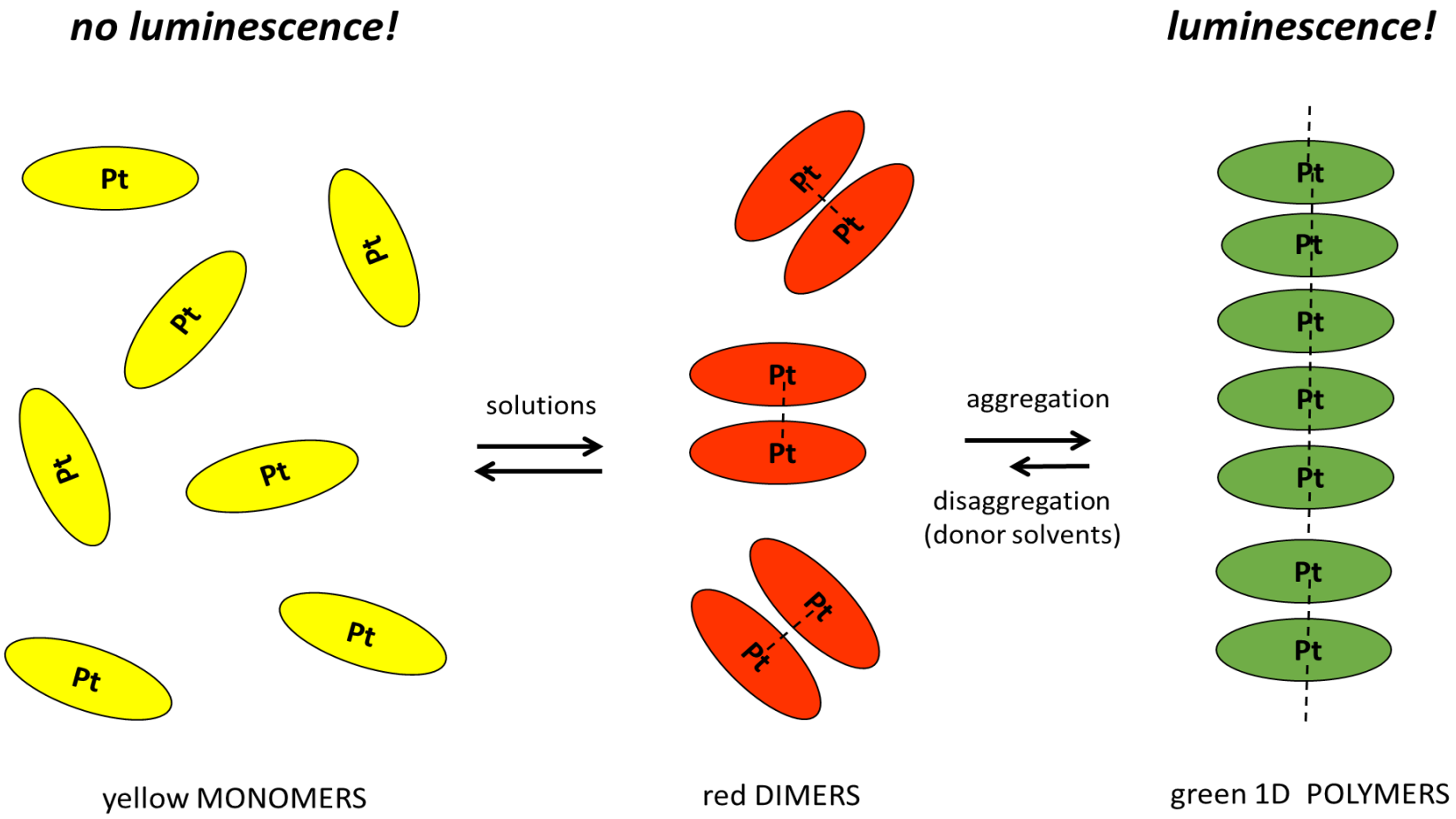




monomeric dimeric trimeric tertameric

NG-group

Spontaneous aggregation PtL_2 complexes into dark-green luminescent 1D polymers.

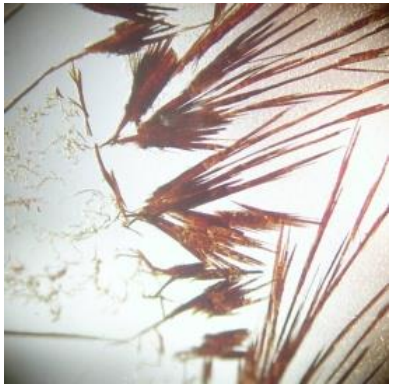


Dalton Trans., **2017**, *46*(39), 13562-13581

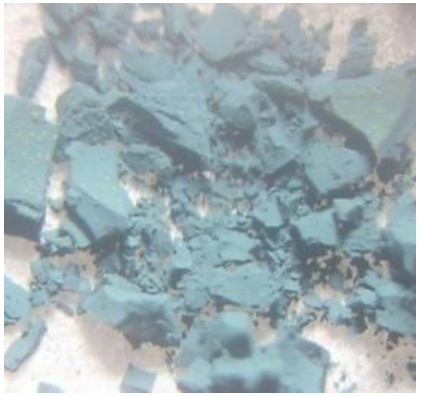
NG-group

$Pt(DECO)_2$ system:

yellow - monomer



red - dimer

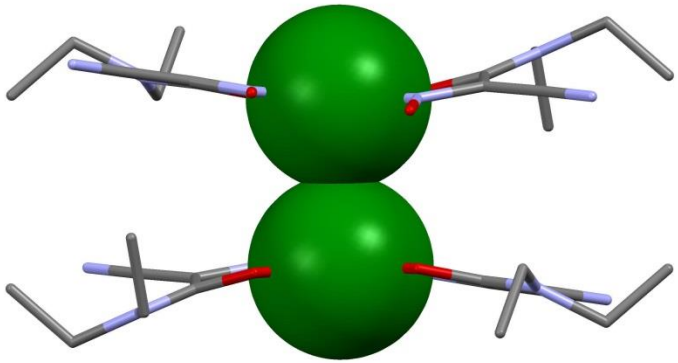


dark-green - polymer

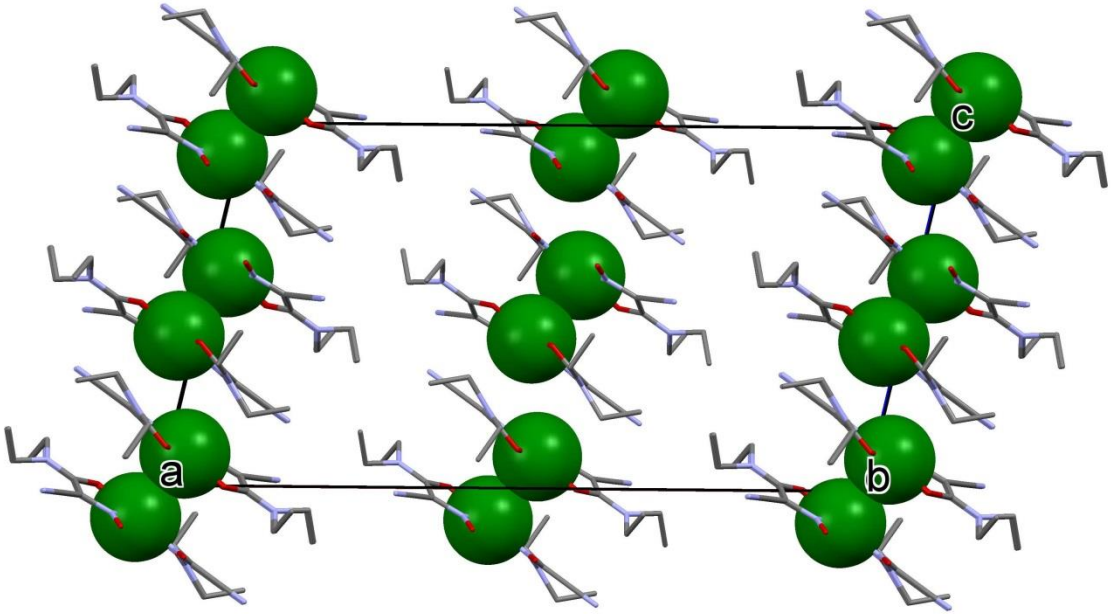
D. Klaus

Inorg. Chem. **2015**, *54* (4), 1890

Crystal structure of **red-dimer**

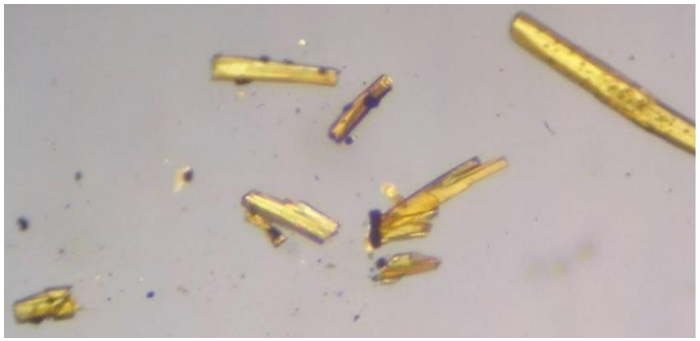


Pt---Pt = 3.1208 Å

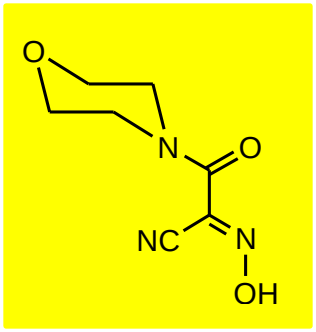


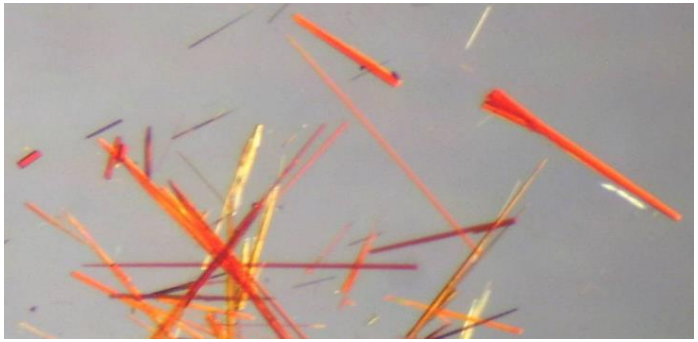
Inorg. Chem. **2015**, *54* (4), 1890

$Pt(MCO)_2$ system:



yellow - monomer





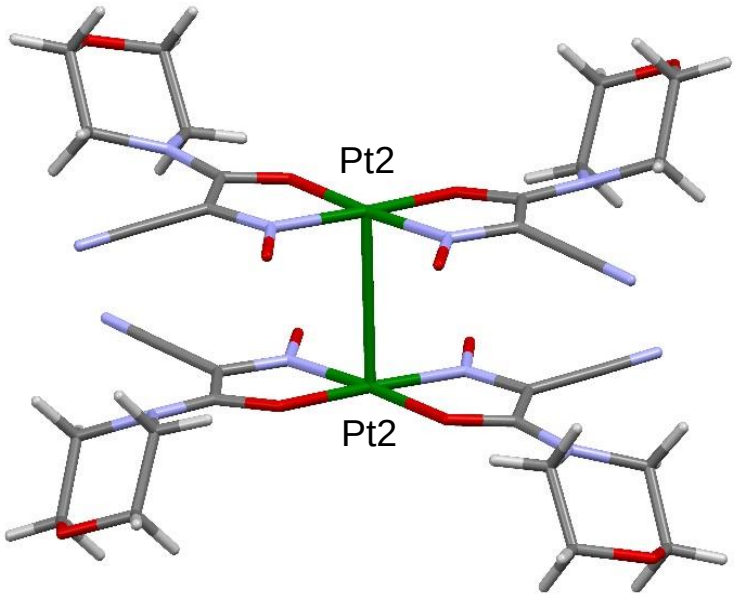
red - dimer

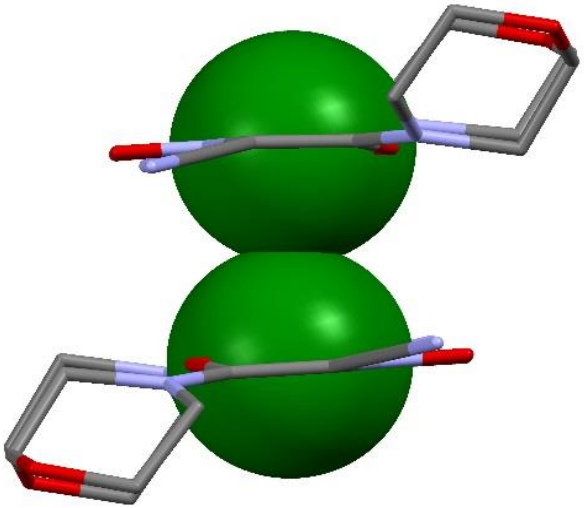
dark-green - polymer

Dalton Trans., **2017**, *46*(39), 13562-13581

Available crystal data for $Pt(MCO)_2$ complexes: red-dimer

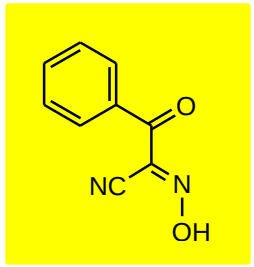
(solvent DMSO omitted for clarity)

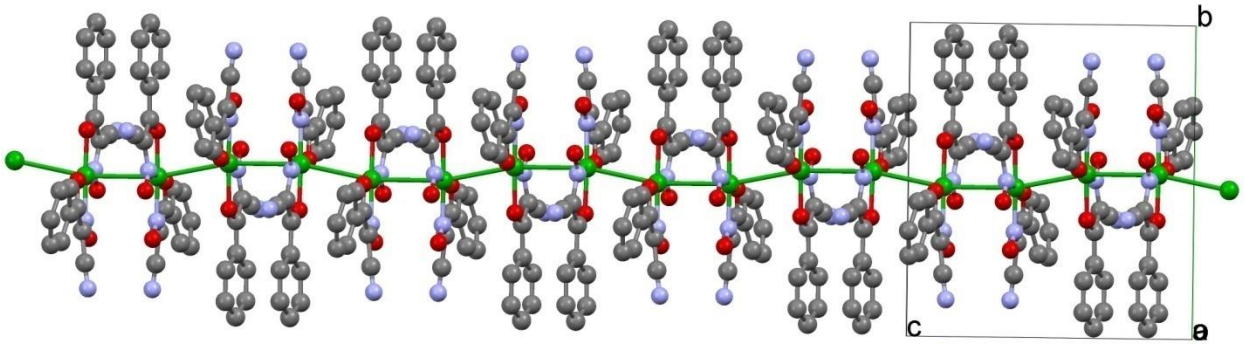




Pt---Pt = 3.133 Å

Dalton Trans., **2017**, *46*(39), 13562-13581

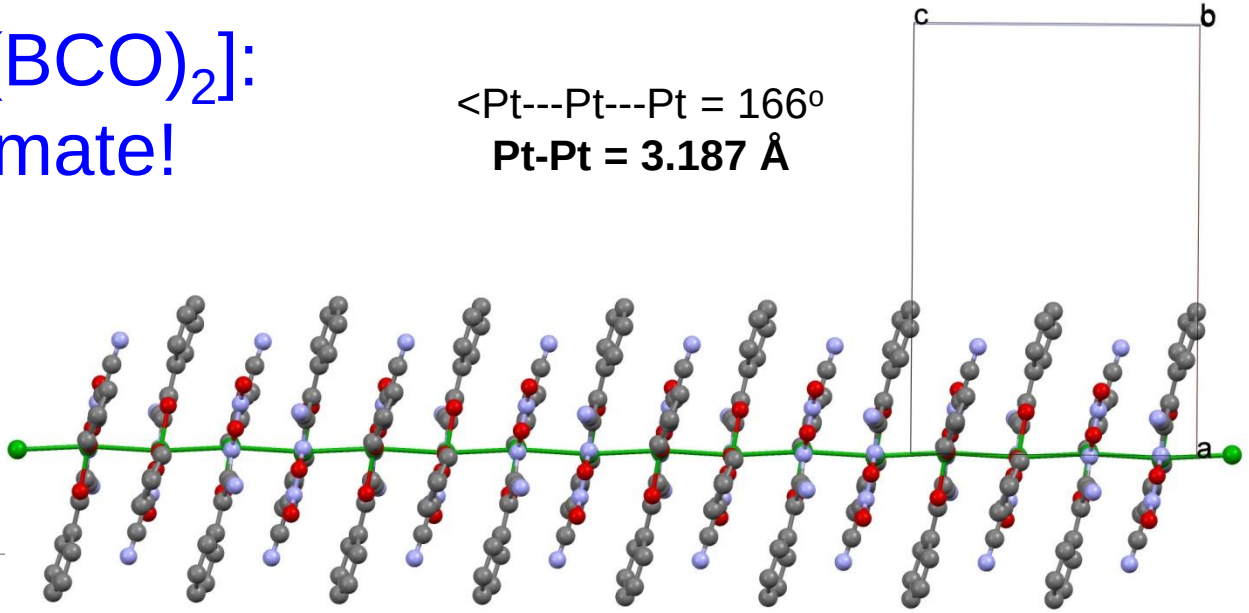


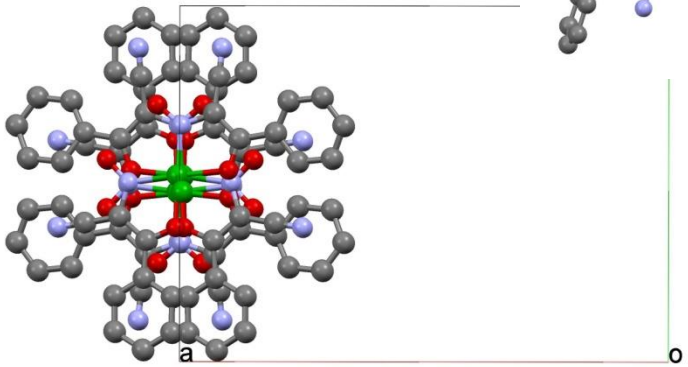


Structure of $[Pt(BCO)_2]$: first 1D cyanoximate!

<Pt---Pt---Pt = 166°
Pt-Pt = 3.187 Å

M. Hilton

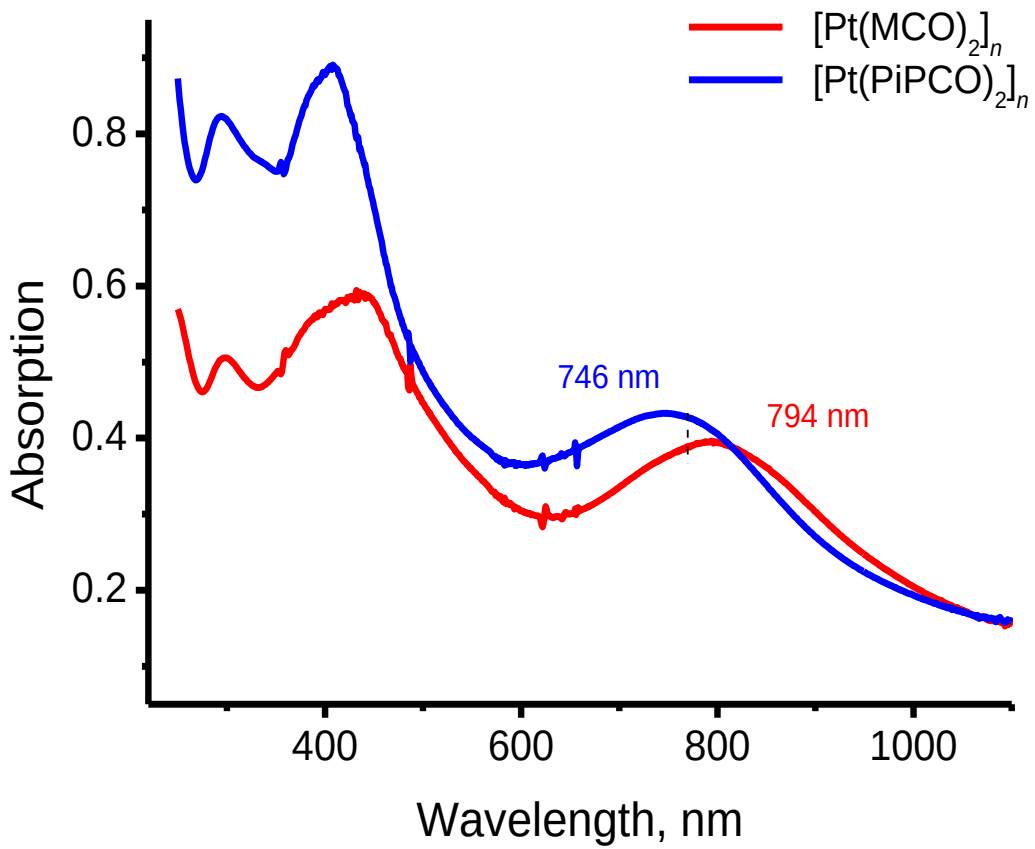




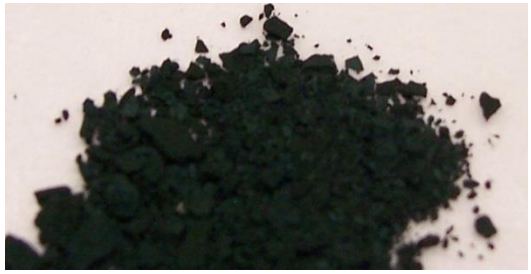
Pbcn, #63, R1 = 0.0470
GOF: 0.996

NG-group

UV-visible spectroscopic signature of solid green PtL_2 : suspensions in mineral oil.



$[Pt(MCO)_2]_n$

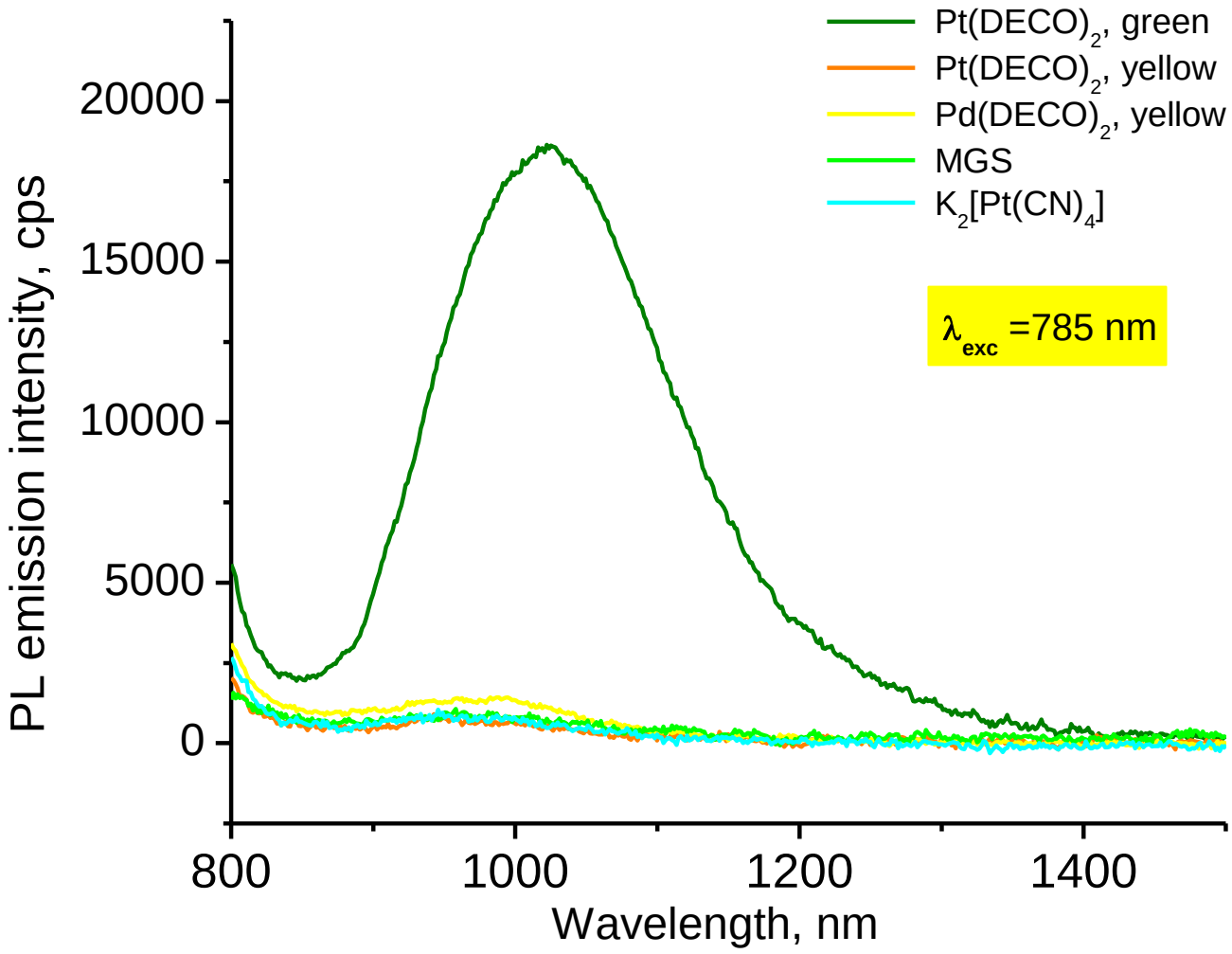


$[Pt(PiPCO)_2]_n$

Dalton Trans., **2017**, *46*(39), 13562-13581

NG-group

NIR emission profile for all studied 1D Pt-complexes.



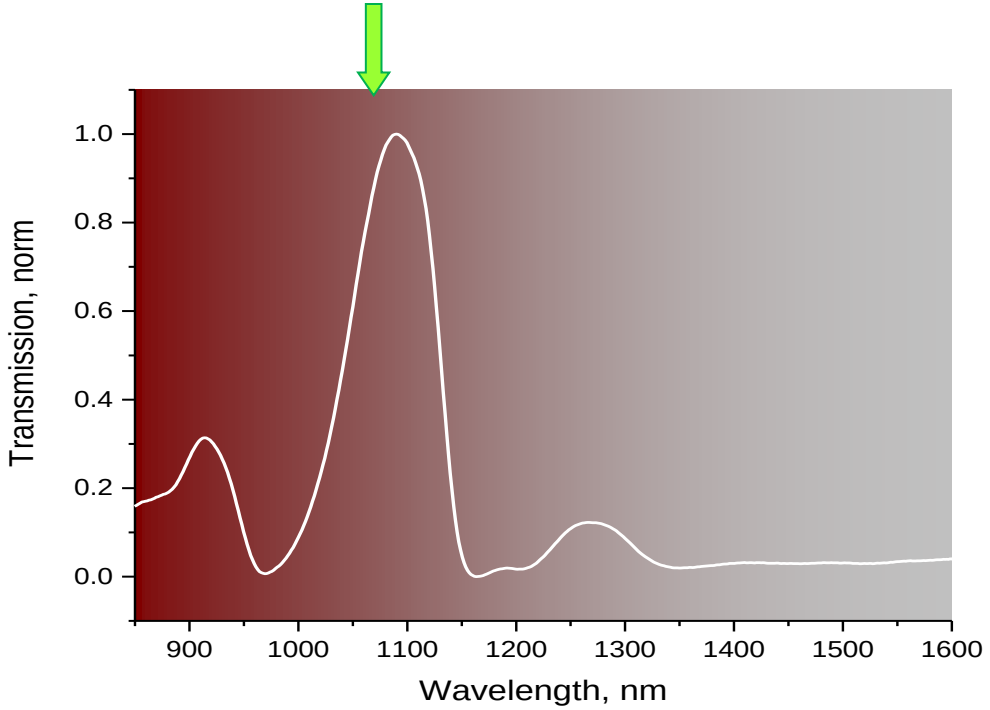
M. Berezin

Inorg. Chem. **2015**, *54* (4), 1890

NG-group

The NIR spectrum of a human finger in the range of 800 – 1600 nm.

M. Berezin



An arrow indicates the area where our polymeric Pt-cyanoximates emit.

2018, *US Patent # 9,982,188 B2*

NG-group

The need for the NIR emitters:

Water is transparent in 1000 – 1200 nm window!
Our tissue is transparent too.

So, either detection of emission in this window, or irradiation with this light (NIR lasers) is important.

Theranostics: a new field of biomedical research.
It is a combination of diagnostics and therapy.

In the case of cancer diagnostics often = imaging,
while therapy = delivery of cytotoxic agent(s) to the cell

2018, *US Patent # 9,982,188 B2*

Potential applications:

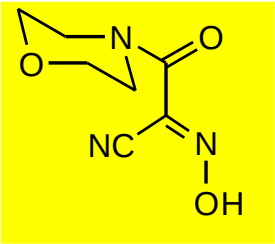
- cytotoxic NIR emitters for theranostics

Received:
May 2018

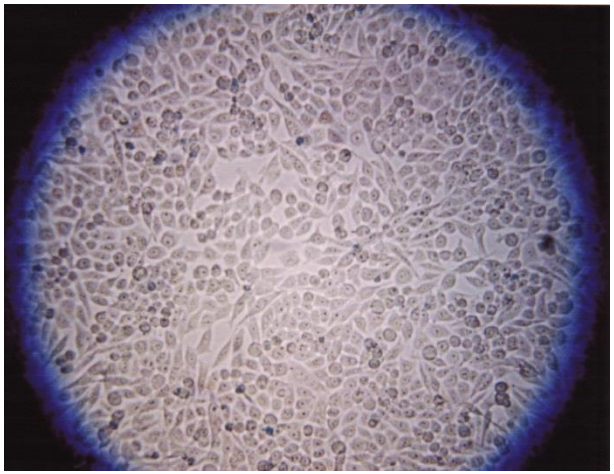
Pt-cyanoximates:
aspects of
practical applications

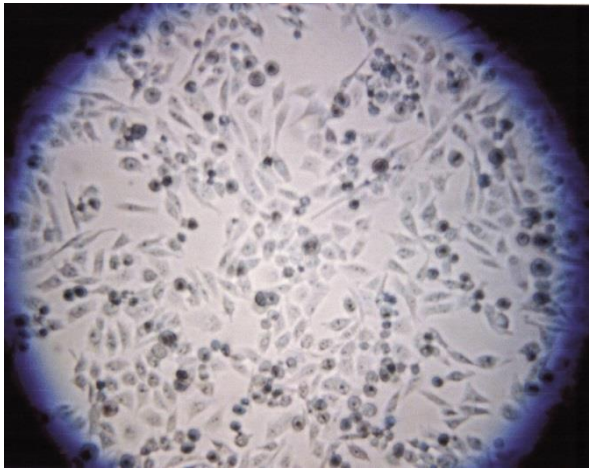
HeLa cells and Pd/Pt-cyanoximates

D. Eddings

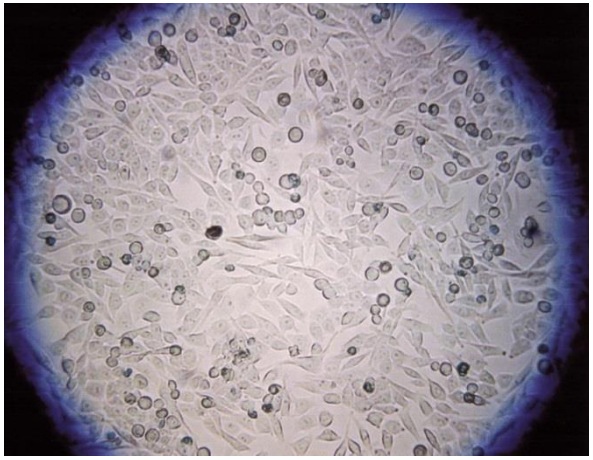


Control: cells with media and 1% DMSO.





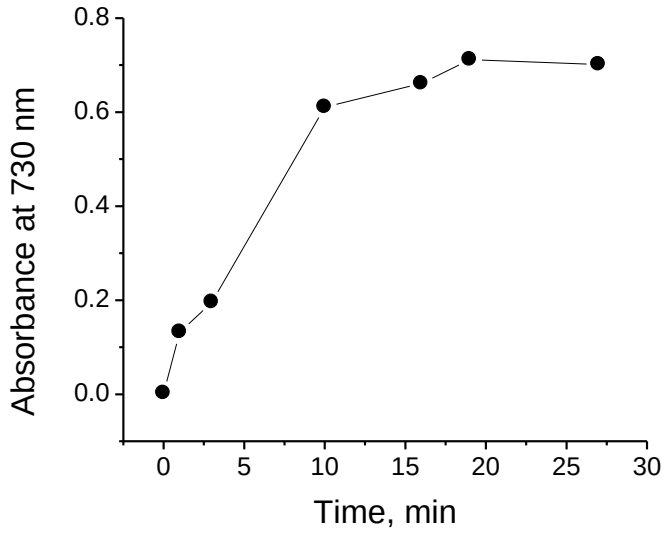
$Pd(MCO)_2$, 0.1 mM, causing 28% cells death

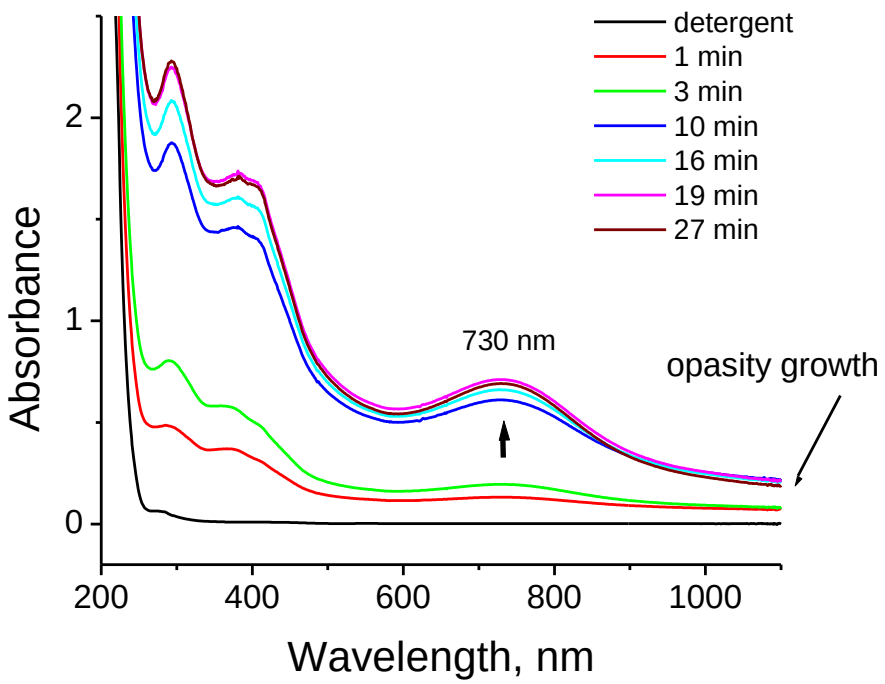


$Pt(MCO)_2$, 0.1 mM, leads to 16% cells death

Inorg. Chem. **2004**, *43* (13), 3899

Formation of micelles: green $Pt(DECO)_2$ polymer and detergents.





2018, *US Patent # 9,982,188 B2*

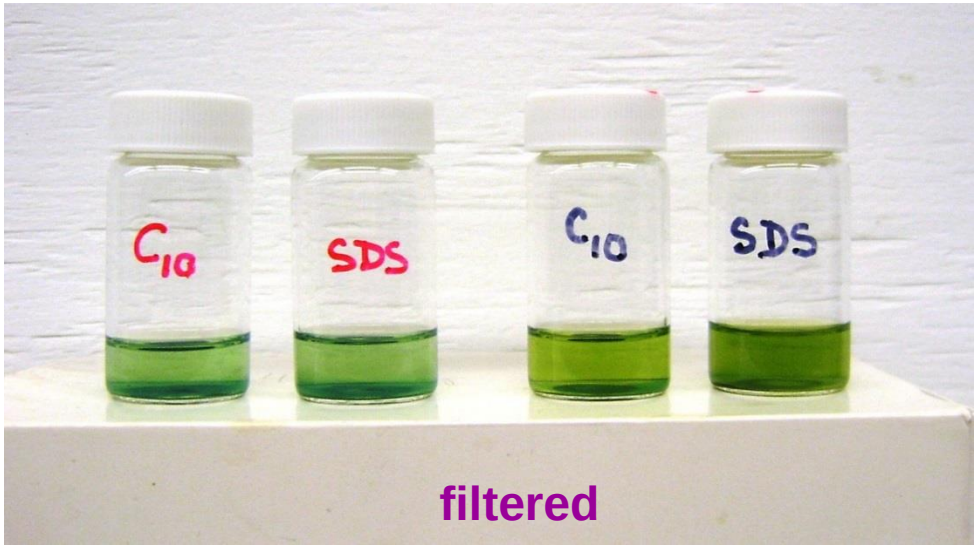
2019 TAMUK

Micelles of polymeric Pt-cyanoximates.

$[Pt(MCO)_2]_n$

left vials

freshly made



filtered

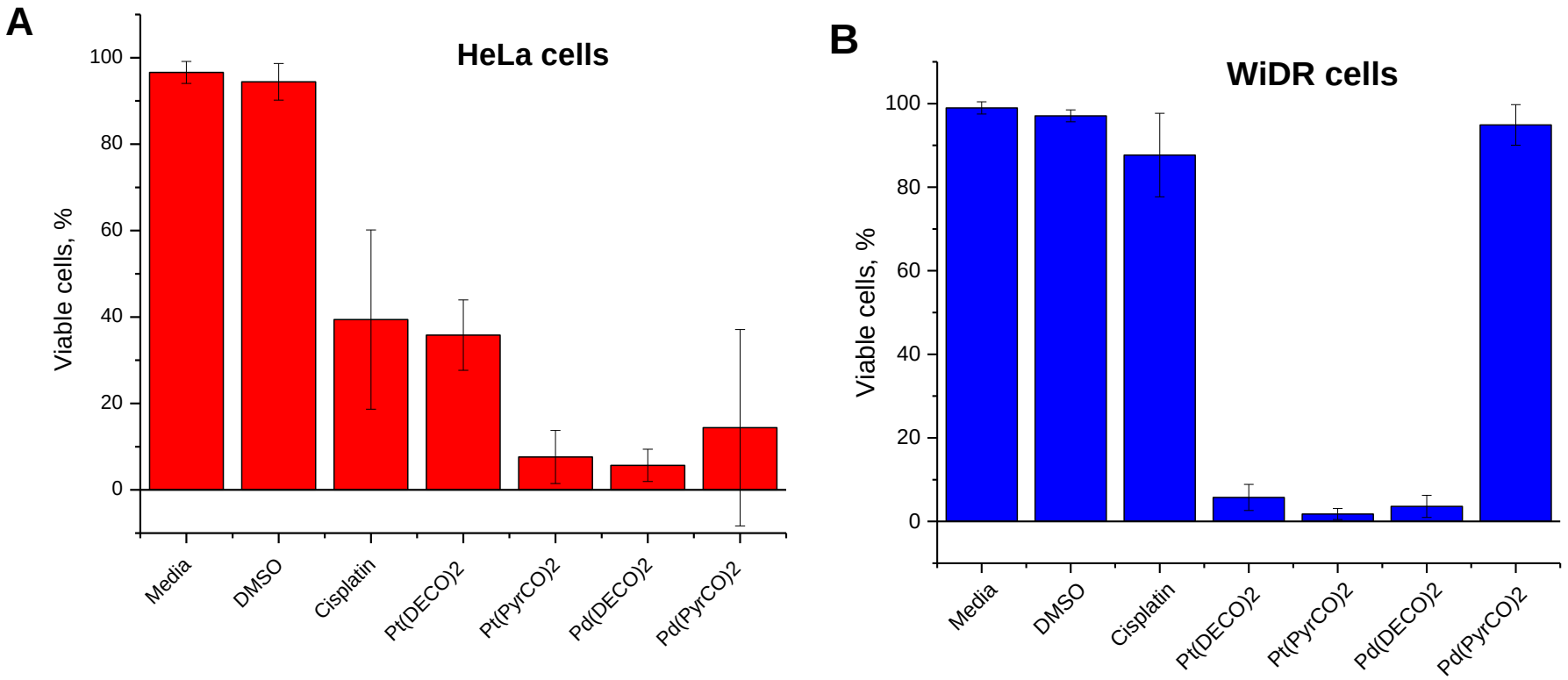
$[Pt(PiPCO)_2]_n$

right vials

Dalton Trans., **2017**, *46*(39), 13562-13581

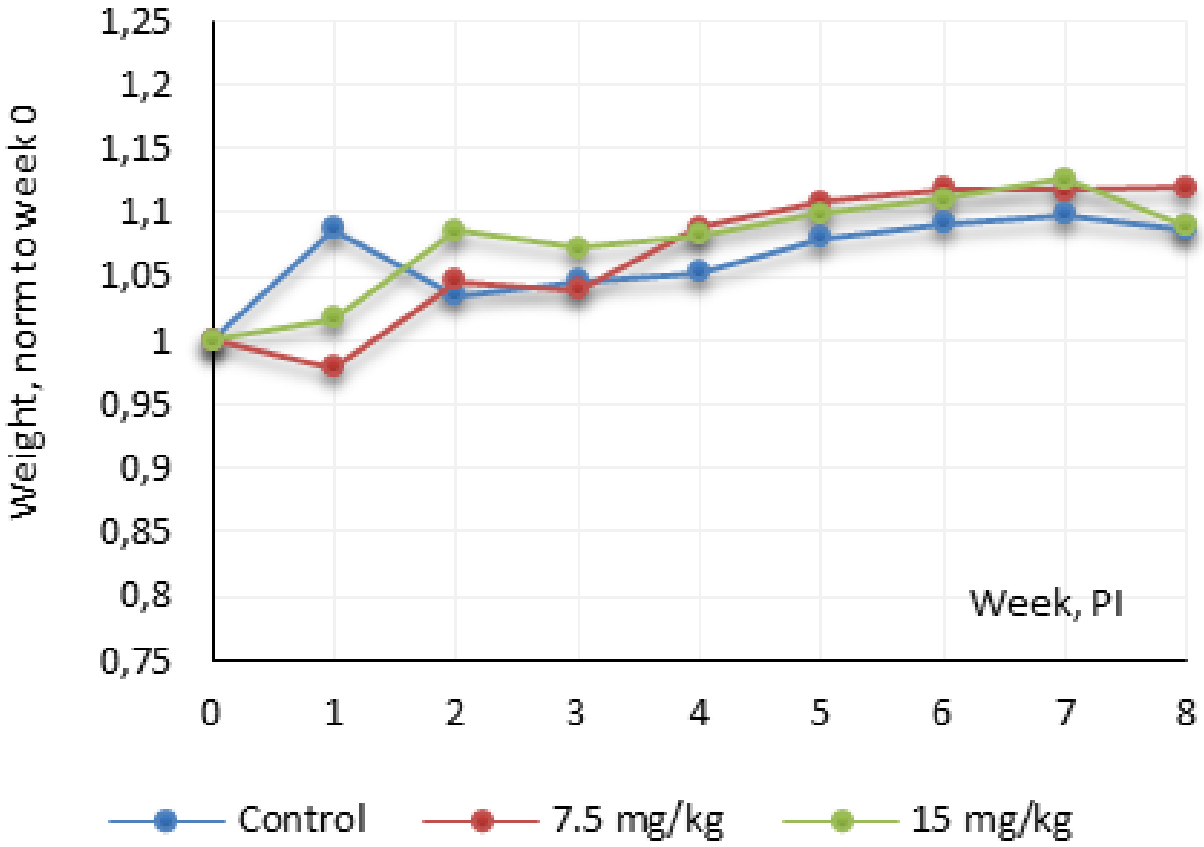
NG-group

Pronounced cytotoxicity in vitro:



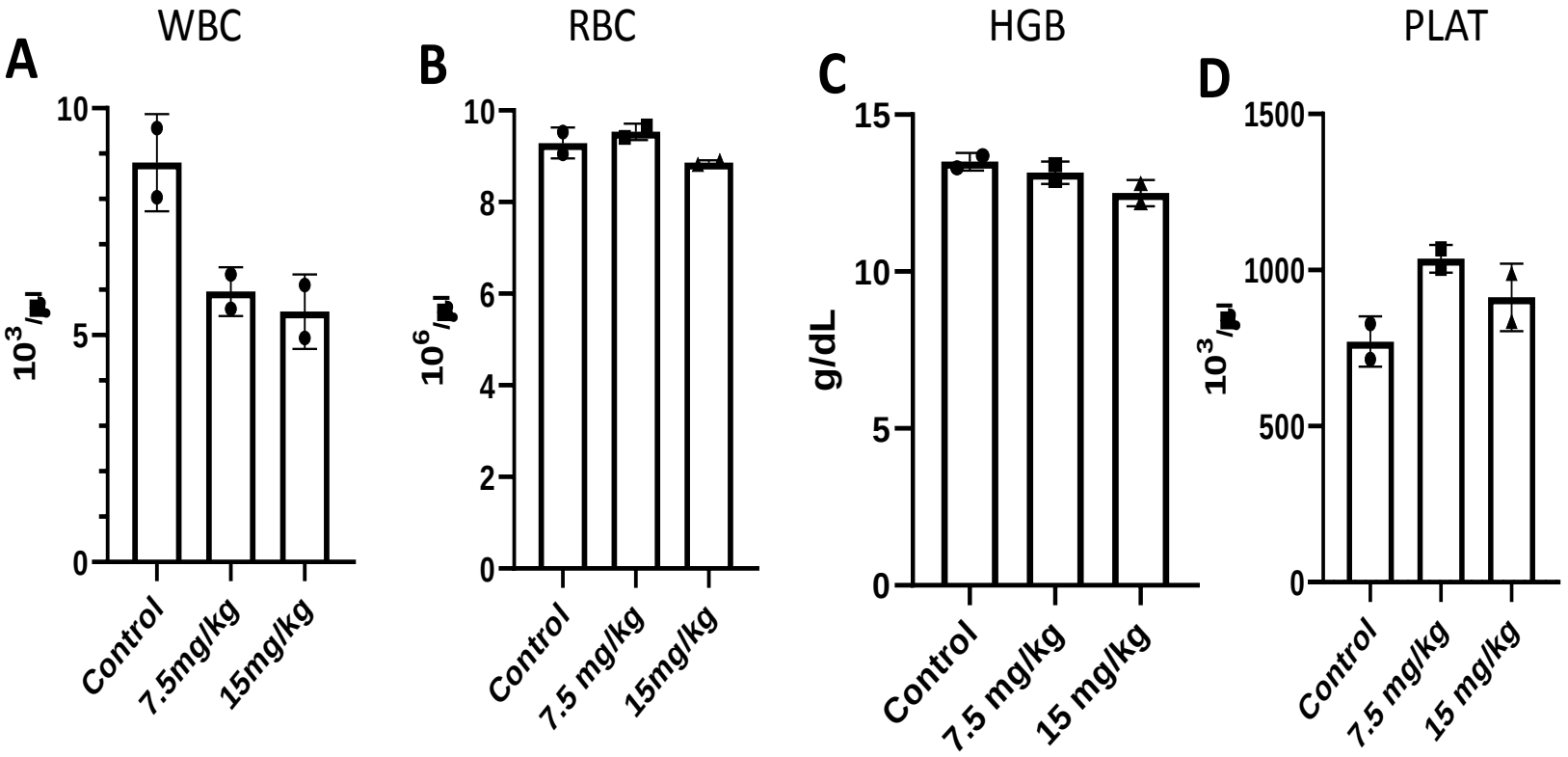
Viability of cells treated with complexes and **A**: HeLa cells and **B**: WiDr cells. All after 24-hour incubation.

No chemotherapy-induced cachexia !



Weight change of the mice treated with $Pt(DECO)_2$ All weights are normalized to the preinjection weight (week zero =1). Control group was treated with a 5% dextrose solution.

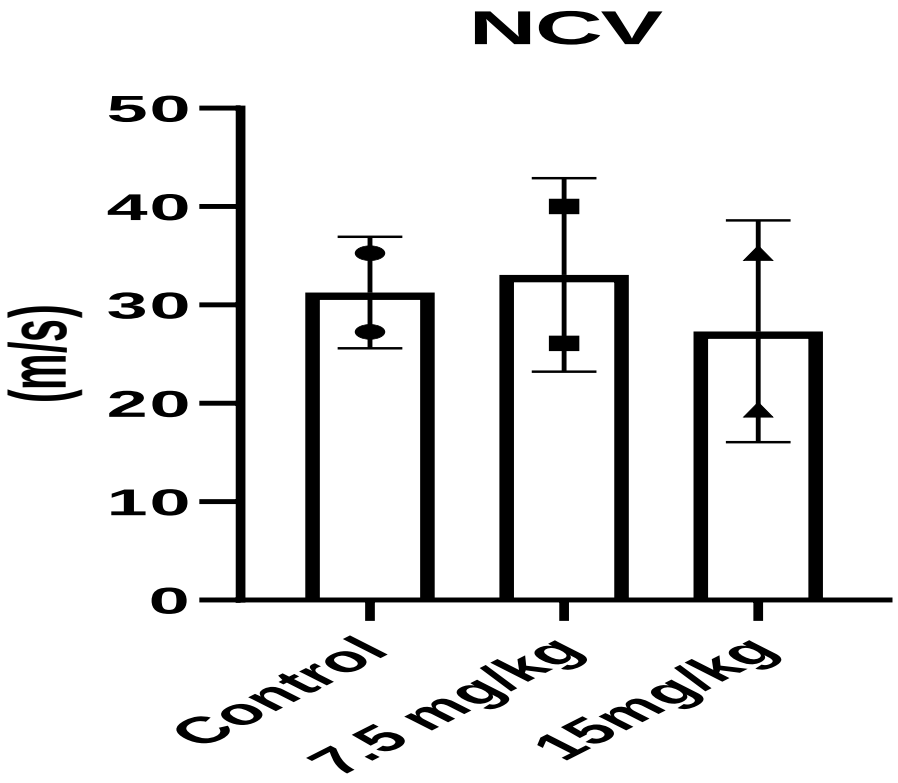
Blood work:



Level of white blood cells (WBC), red blood cells (RGB), total hemoglobin (HGB), and platelets (PLAT) in the mice treated $Pt(DECO)_2$ at different dosages (ip, once/weekly).

Control group mice were treated with a 5% dextrose solution (ip, once/weekly). The blood was collected from the mice after 7 weeks of weekly drug injections.

Nerve conductivity does not change!



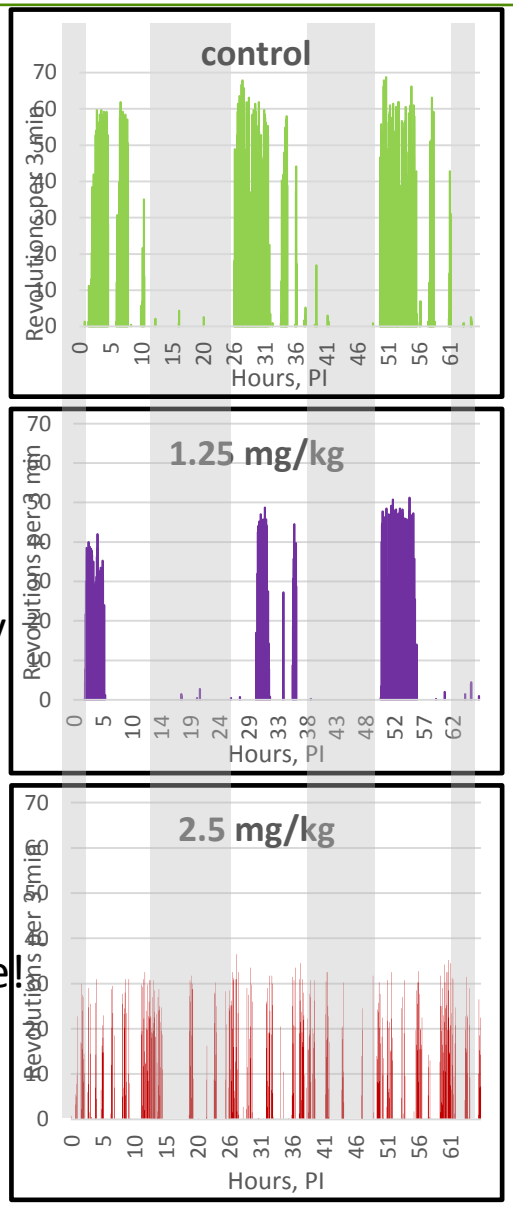
Nerve conduction velocity measured caudally in mice treated with $Pt(DECO)_2$ for 8 weeks.

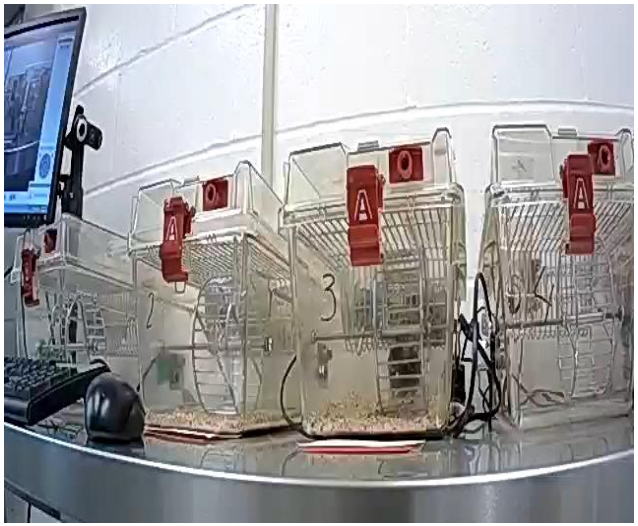
Behavioral changes in chemotherapy treated mice

Dextrose

Classic Chemotherapy

Increased dose!

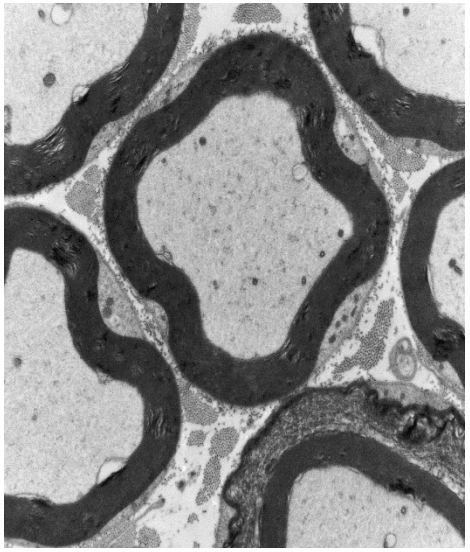




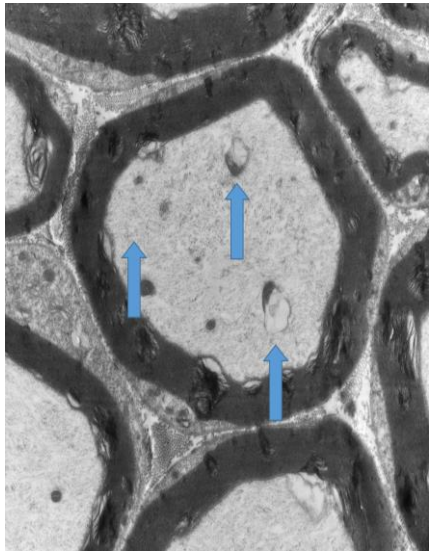
- Dose - dependent change in locomotor activity
- Overall lowering activity at higher doses
- Disruption of circadian rhythms (insomnia)

Electron Microscopy:
neurons dysfunction after classic chemotherapy

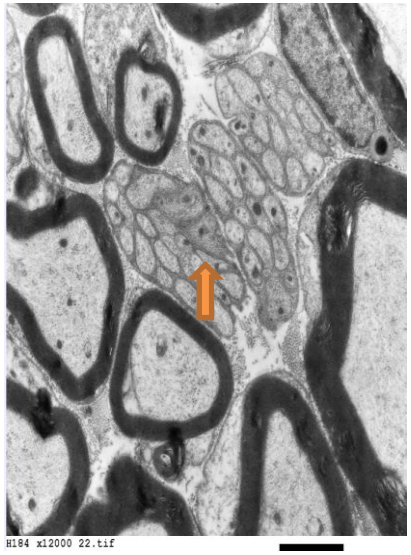
control



1.25 mg/kg

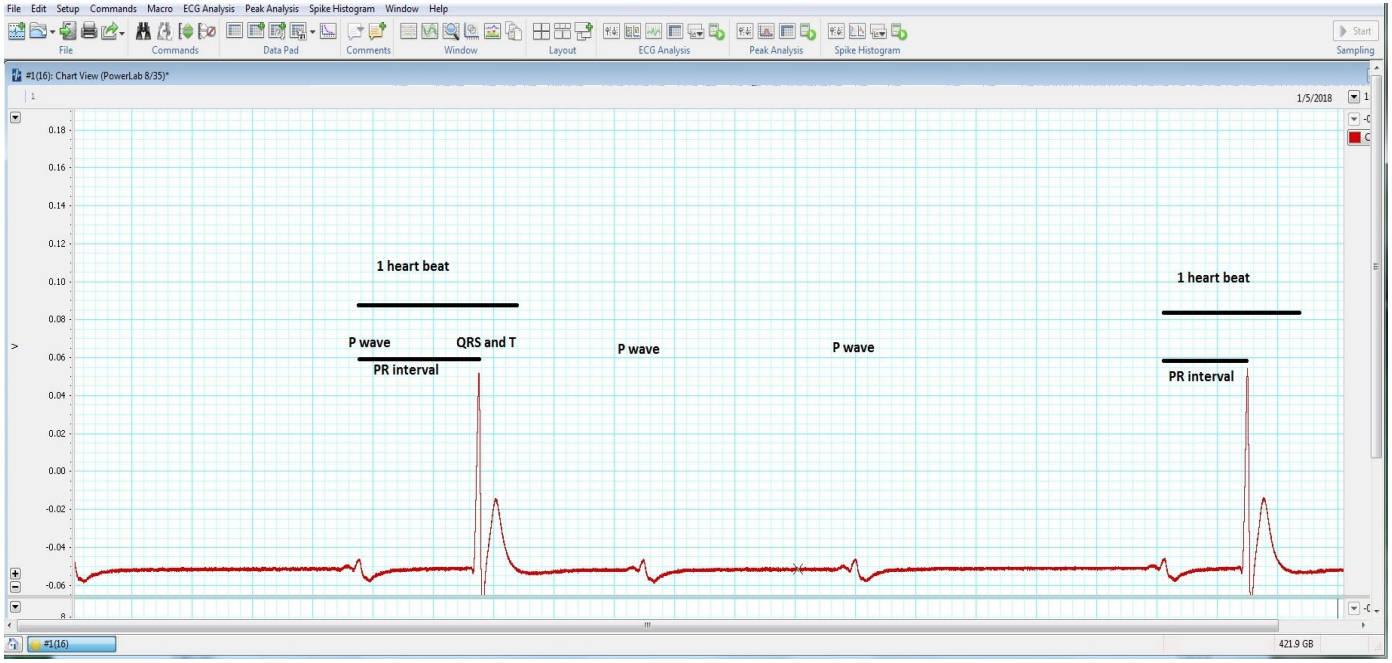


6 times that



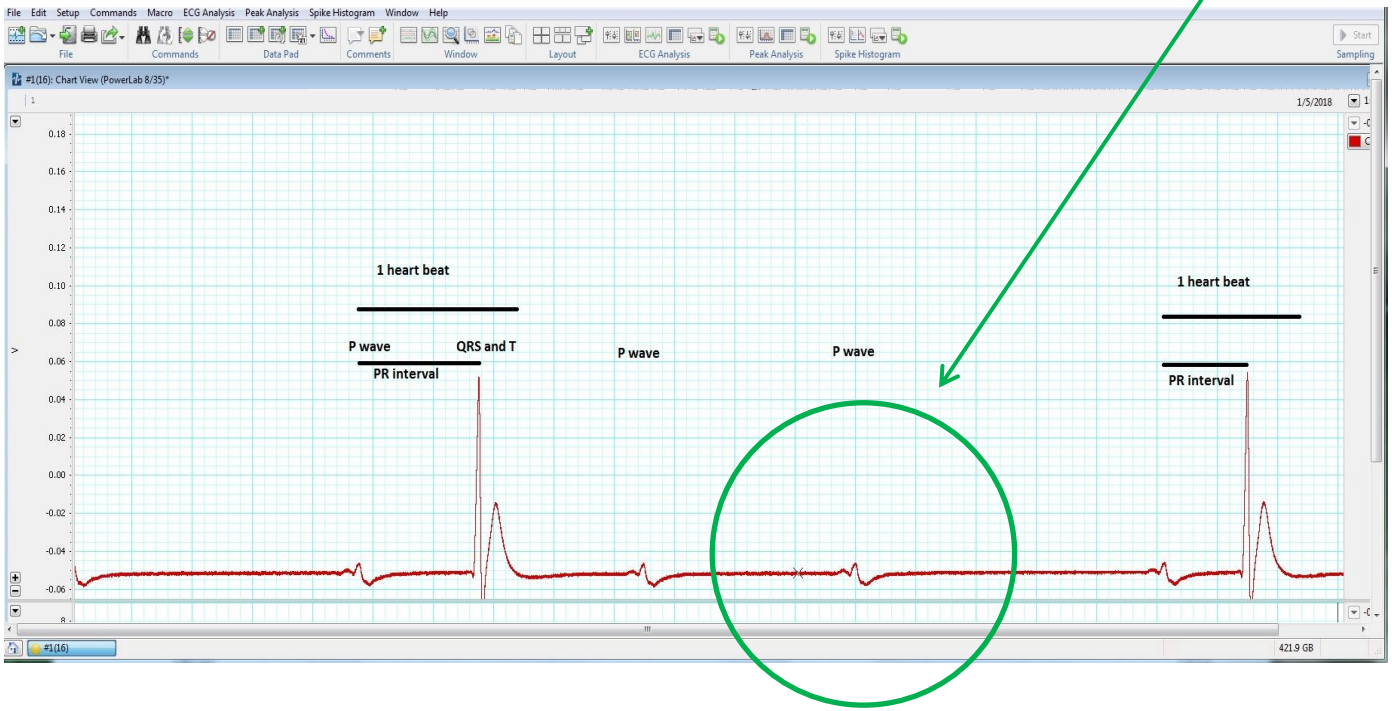
Microscopy reveals changes in nerves induced by conventional chemotherapy drugs

EKG


File Edit Setup Commands Macro ECG Analysis Peak Analysis Spike Histogram Window Help
#1(16): Chart View (PowerLab 8/35)*
1/5/2018
1 heart beat
P wave
QRS and T
PR interval
P wave
P wave
1 heart beat
PR interval

EKG

missing heart beat ☹



My “platinum students”:

Daniel Eddings

Leon Goeden

Michael Hilton

Carl Cheadle

Jessica Ratcliff

Daniel Klaus

My pride: my Masters!

Daniel B. Eddings, 2003

"The synthesis, Characterization and Biological Activity Studies of Pt(II) and Pd(II) Disubstituted Arylcyanoximes"

Tiffany R. Maher, 2004

"Synthesis, Characterization and Anti-cancer Properties of Organotin(IV) Cyanoximates"

Leon J. Goeden, 2005

"The synthesis, Characterization and Biological Activity Studies of Pt(II) and Pd(II) Disubstituted Arylcyanoximes"

Daniel Robertson, 2006

"Thallium(I) Coordination Polymers Based on Monosubstituted Arylcyanoximes"

Carl Cheadle, 2008

"Synthesis and Studies of N^1,N^2-Piperazine-*bis*-(2-oximino-2-cyano)-acetamide and its Several Metal Complexes"

Daniela Marcano, 2007

"Pyridylcyanoximes and Their Metal Complexes"

Jennifer Snyder, 2007

"Synthesis and Investigation of Several Dibutyltin(IV) Cyanoximates"

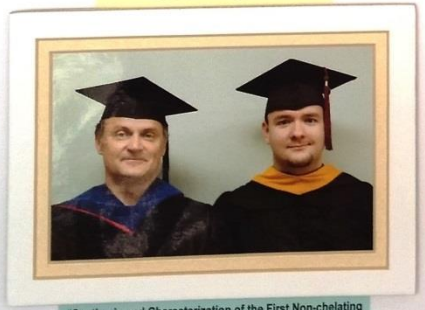
Jessica Ratcliff, 2007

"Further Investigations of Cytotoxic Metallocyanoximates"

Jeff Morton, 2010

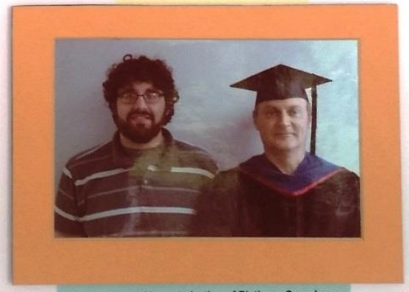
"Further Investigations of Silver(I) Cyanoximates"

Scott Curtis, 2013



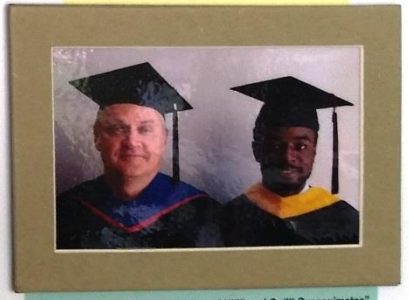
"Synthesis and Characterization of the First Non-chelating Bis-cyanoximes and Their Metal Complexes"

Michael Hilton, 2013



"Synthesis and Characterization of Platinum Complexes with Oximes-based Ligands"

Adademola Abraham Opalade, 2016



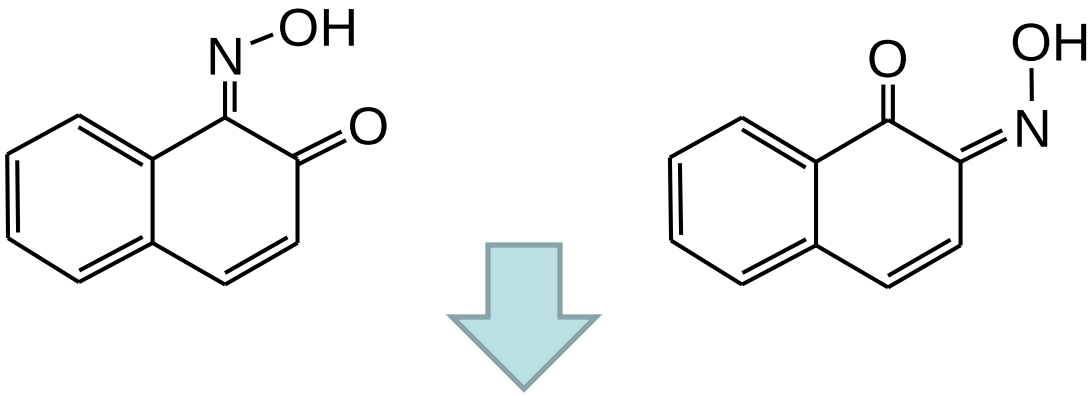
"The Synthesis and Characterization of Ni(II) and Cu(II) Cyanoximates"

My other interests and activities?

… studies of other oximes and their metal complexes

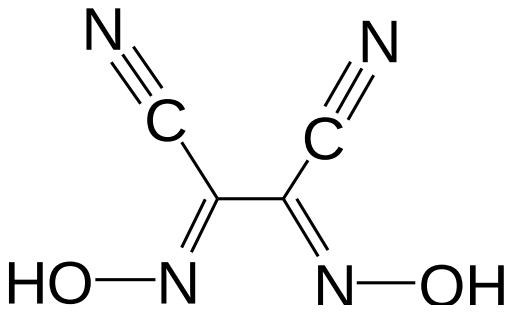
Service work to others!

isomeric nitrosonaphtols



Oximes!
6 complexes were studied using the XRD

And a new bis-cyanoxime:

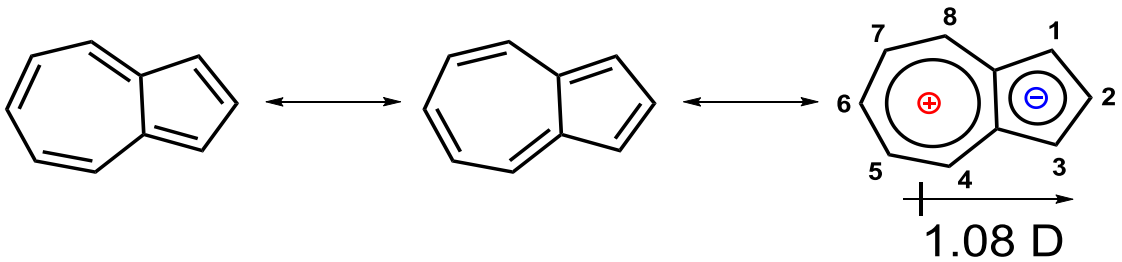


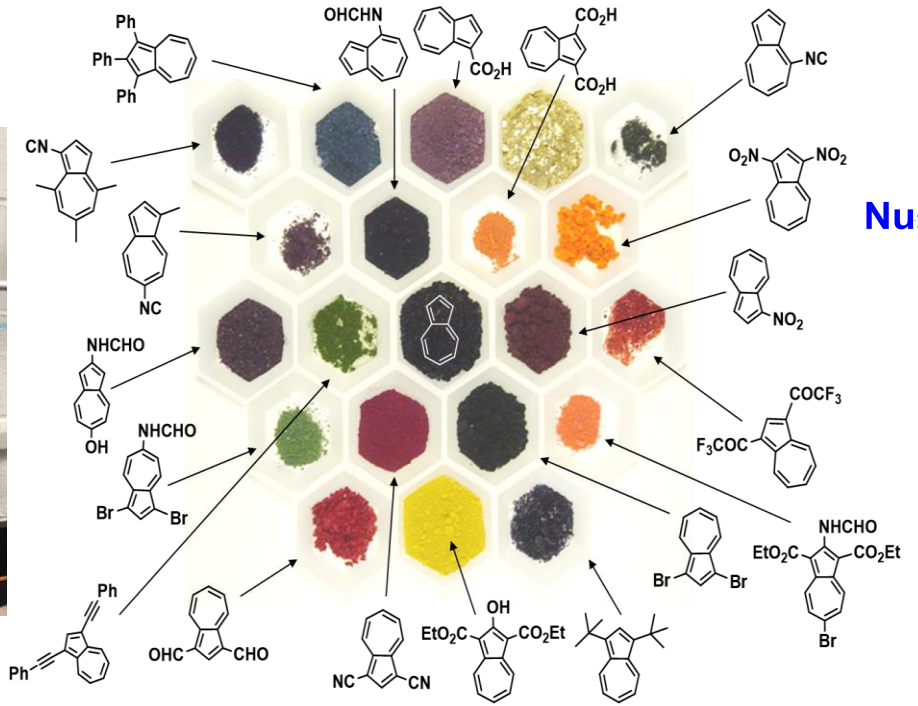
NG-group

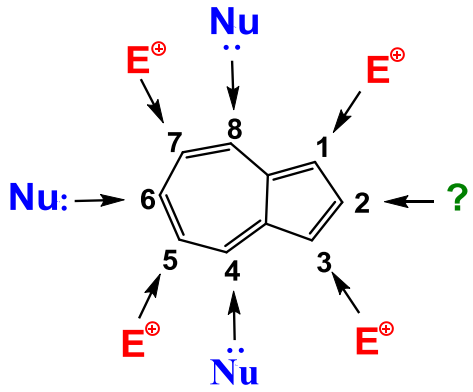
My service work includes:

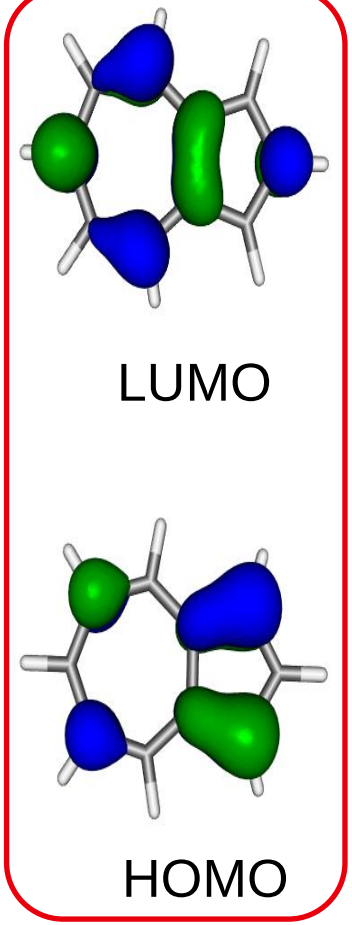
- X-ray crystallography
- thermal analysis
- variable temperature UV-visible spectroscopy
- CD spectroscopy

Azulene: A Molecular Diode



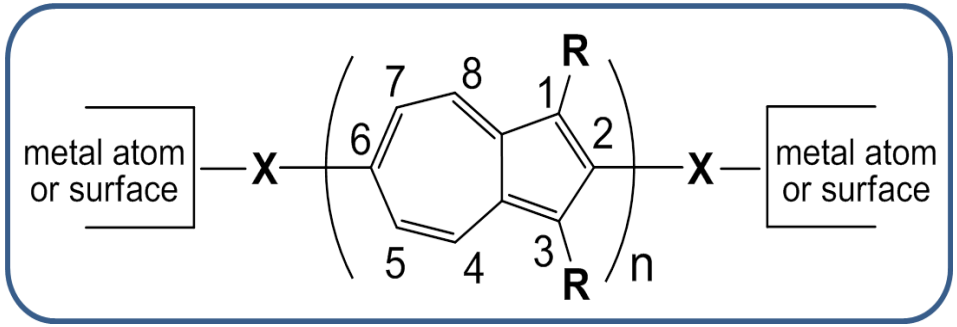




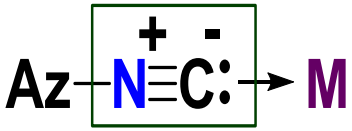


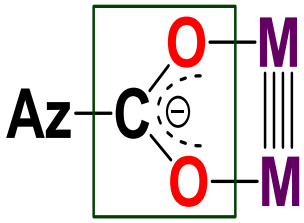
- Frontier MO's are not mirror-related ⇒ separation of e^- and hole charge transport regimes

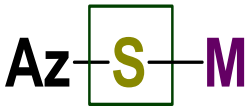
The linear 2,6-azulenic motif



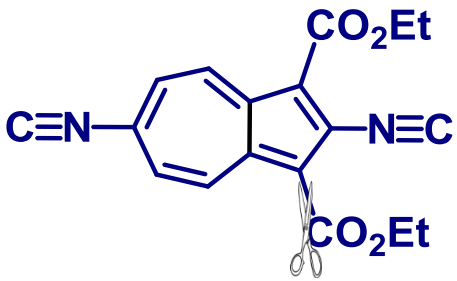
Barybin *et al. JACS* **2006**, *128*, 2300

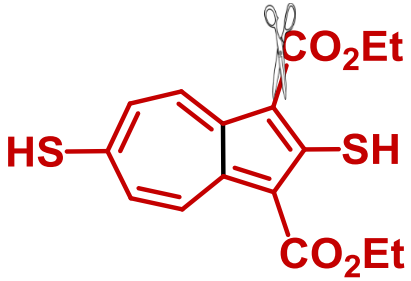


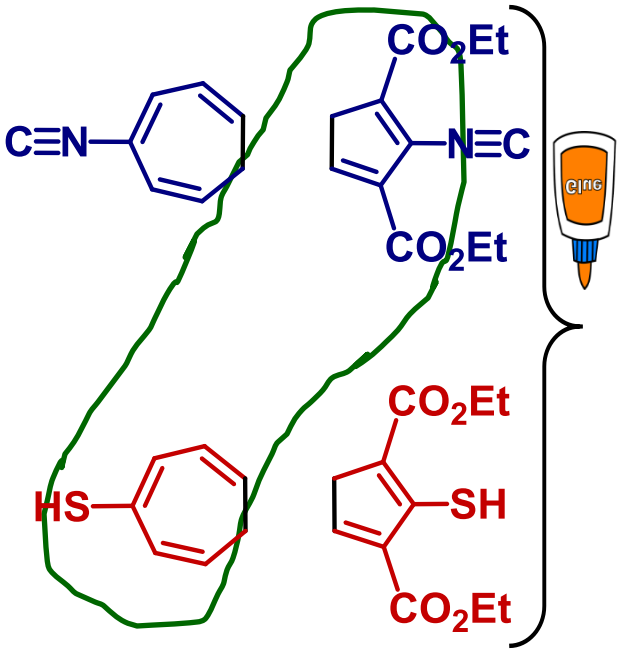


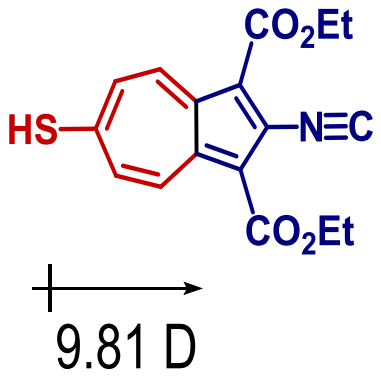


- Mercapto and isocyano anchoring groups in the **same** molecule !







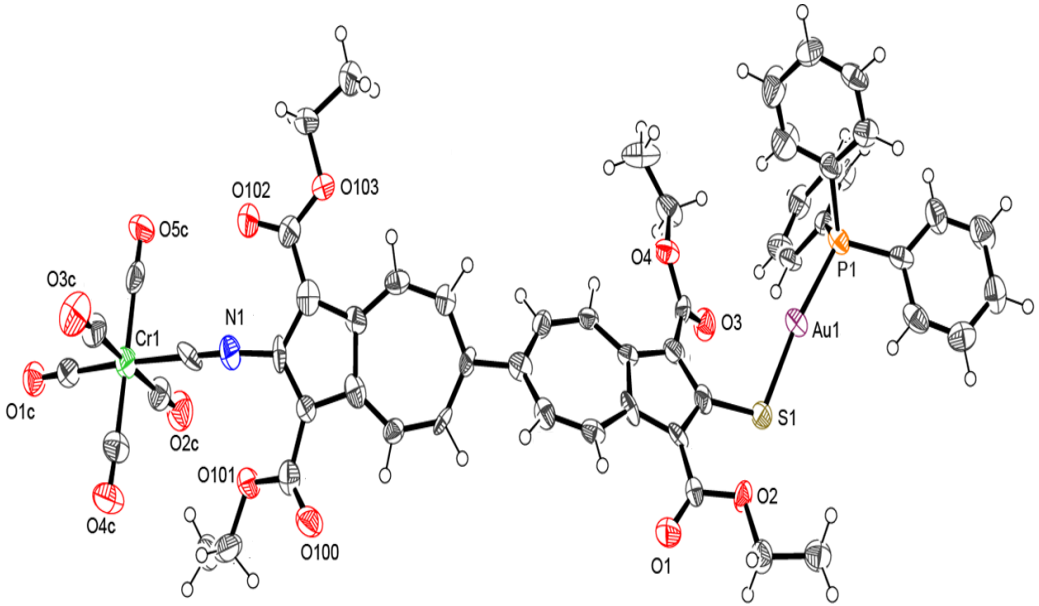


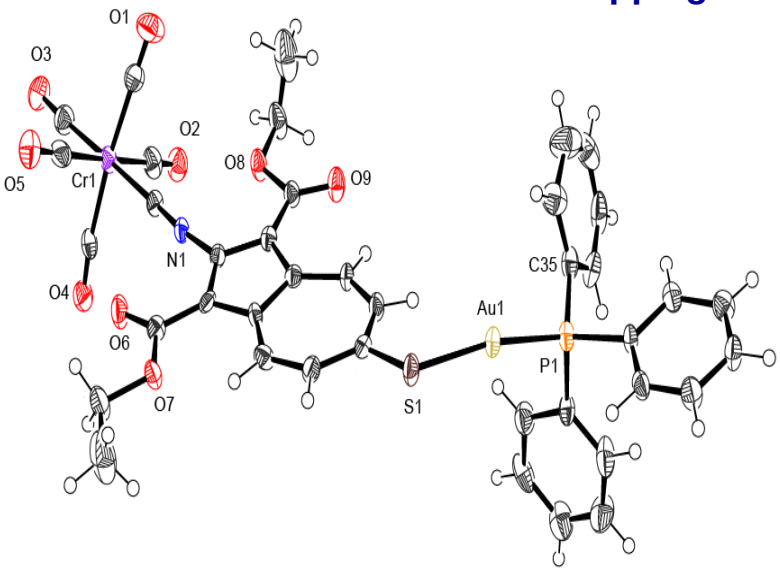
Barybin *et al. Chem. Sci.* **2013**, *4*, 4267

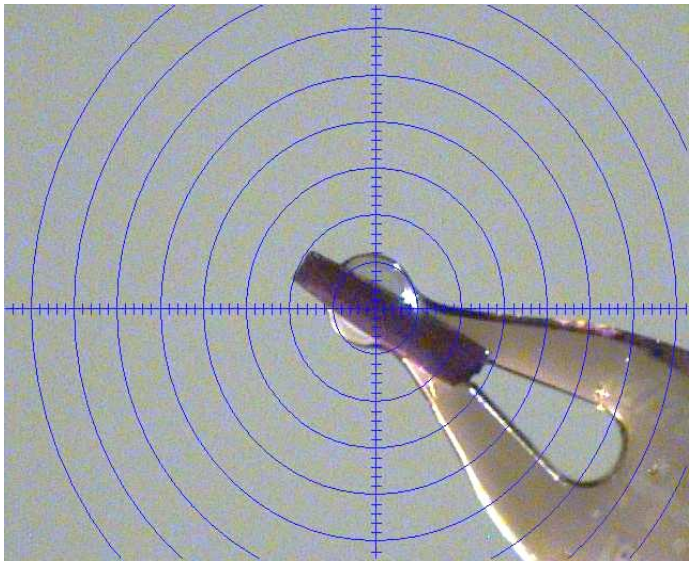
Barybin *et al. Chem. Sci.* **2016**, *7*, 1422

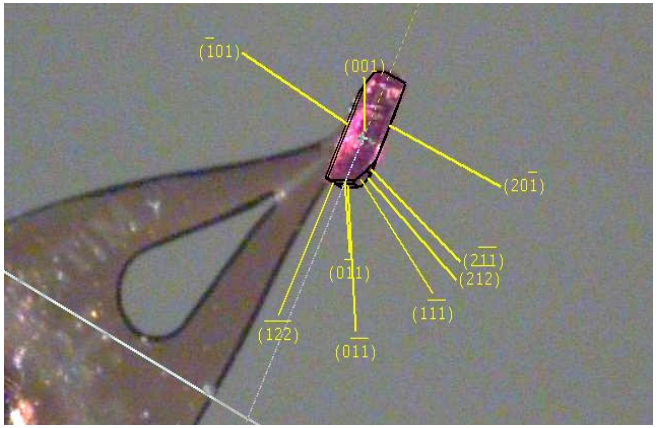
Anchoring to Cr^0 & Au^I via isocyanide and thiolate junctions

Jason Applegate









Applegate, J. C.; Okeowo, M. K.; Erickson, N. R.; Neal, B. M.; Berrie, C. L.; Gerasimchuk, N. N.; Barybin, M.V. *Chem. Sci.* **2016**, *7*, 1422–1429

Publication practices:

My total list of publications consists of 118 items including two book chapters.

Since my arrival to MSU in 2001 I have **61** publications in peer-reviewed journals with international circulation:

Co-authorship (from the company I worked for!) **7**

My own design + studies + writing = publication 34

Service work = helping other with:
XRD, spectrometry (UV-visible, CD/MCD) thermal analysis **20**

Breakdown of publications with my name on them.

You replied to this message on 26.07.2013 8:28.

From: Igor Nikolaenko <Nikolaenko@ukzn.ac.za>
To: Gerasimchuk, Nikolay N
Cc:
Subject: L1 crystals

Dear Kolia,

The first batch of crystals is on the way to you. Please let me know when you receive them.

Best,
Igor

Igor Nikolayenko,
Associate Professor of Physical Chemistry

School of Chemistry & Physics (Pietermaritzburg)
University of KwaZulu-Natal

Office 15, Chemistry Building
Street address: Chemistry Close, Golf Road, Scottsville, Pietermaritzburg
Postal address: Private bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Tel: +27033 2605658
Fax: +27033 2605009

You replied to this message on 12.04.2013 11:37.

From: Haukka Matti <matti.o.haukka@jyu.fi>
To: Gerasimchuk, Nikolay N
Cc:
Subject: Conductivity of Rh cahins
Sent:

Message | Samples.pdf (1 MB)

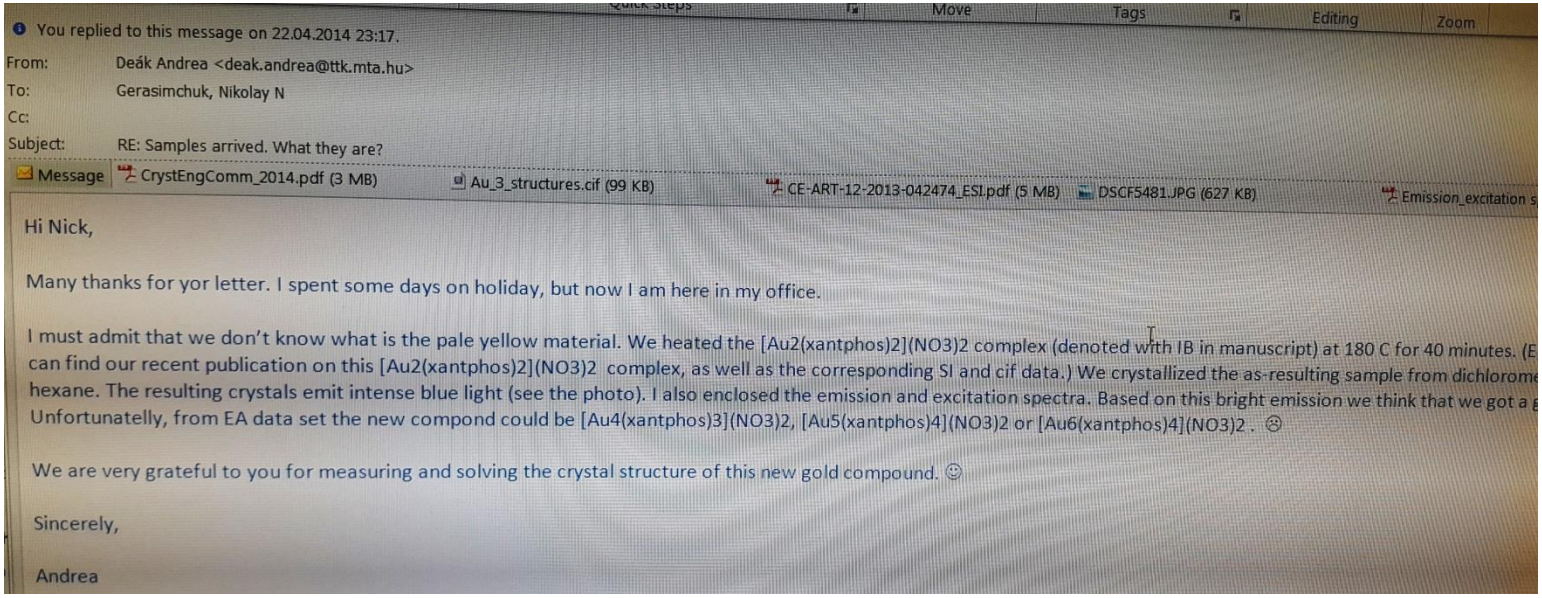
Hi Nikolay,

I don't know if you still remember me. We met briefly last summer in Valencia (ICCC40) and discussed about the possibilities to analyze conductivity of some Rh chain samples. I just moved from University of Eastern Finland to University of Jyväskylä last fall and it has taken me a while to reorganize my work. Now finally been able to start working with our Rh chains again and we have reproduced some of the material I showed in Valencia. So, I was wondering if you still interested in to take a look at these materials and try if conductivity can be determined?

I could send you some material (see the attachment) at anytime. Some of the samples we have at the moment are not so nice looking single-crystals but maybe possible to do at least some preliminary testing with them. We are currently trying to grow more regular crystals for more accurate analysis.

I attach a description of what we have available at the moment.

Please let me know if you are still interested in running these conductivity tests.



You replied to this message on 22.04.2014 23:17.

From: Deák Andrea <deak.andrea@ttk.mta.hu>
To: Gerasimchuk, Nikolay N
Cc:
Subject: RE: Samples arrived. What they are?

Message | CrystEngComm_2014.pdf (3 MB) | Au_3_structures.cif (99 KB) | CE-ART-12-2013-042474_ESI.pdf (5 MB) | DSCF5481.JPG (627 KB) | Emission_excitation s

Hi Nick,

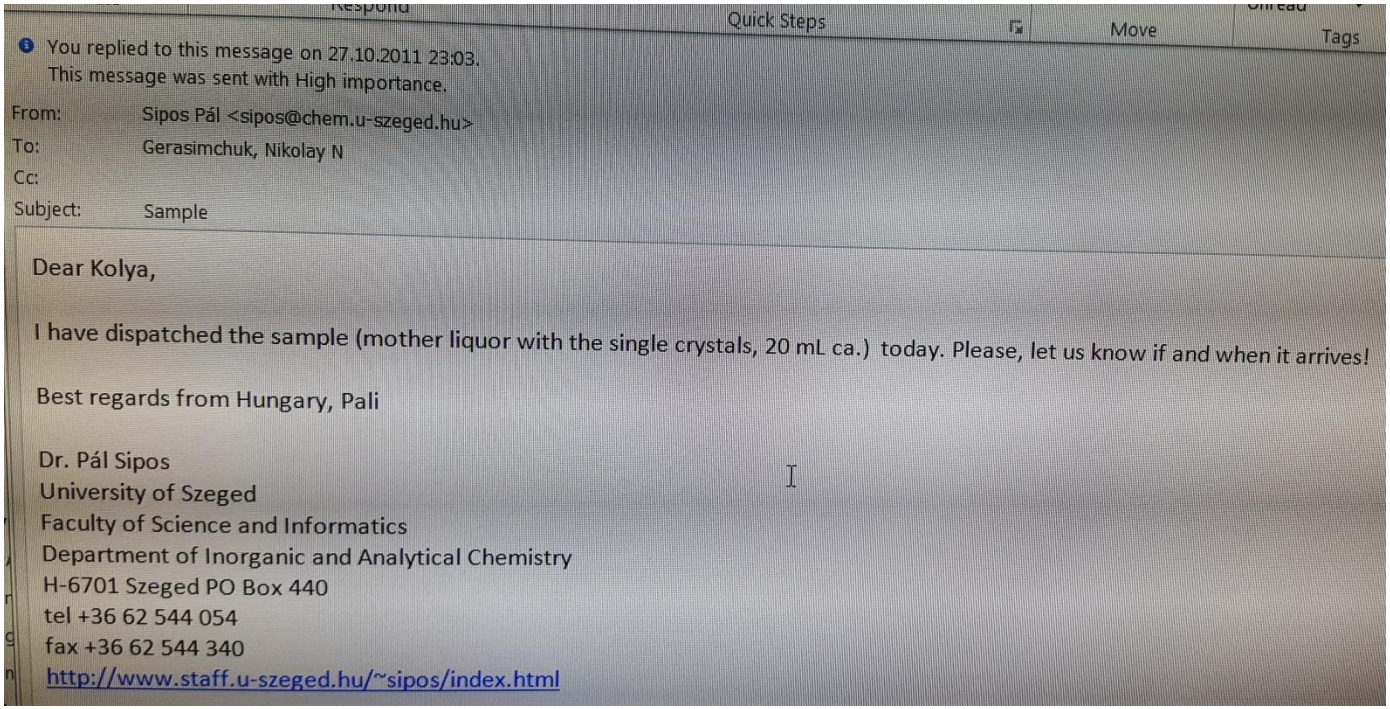
Many thanks for yor letter. I spent some days on holiday, but now I am here in my office.

I must admit that we don't know what is the pale yellow material. We heated the [Au2(xantphos)2](NO3)2 complex (denoted with IB in manuscript) at 180 C for 40 minutes. (E
can find our recent publication on this [Au2(xantphos)2](NO3)2 complex, as well as the corresponding SI and cif data.) We crystallized the as-resulting sample from dichlorome
hexane. The resulting crystals emit intense blue light (see the photo). I also enclosed the emission and excitation spectra. Based on this bright emission we think that we got a g
Unfortunatelly, from EA data set the new compond could be [Au4(xantphos)3](NO3)2, [Au5(xantphos)4](NO3)2 or [Au6(xantphos)4](NO3)2 . ☹

We are very grateful to you for measuring and solving the crystal structure of this new gold compound. ☺

Sincerely,

Andrea



You replied to this message on 27.10.2011 23:03.
This message was sent with High importance.

From: Sipos Pál <sipos@chem.u-szeged.hu>
To: Gerasimchuk, Nikolay N
Cc:
Subject: Sample

Dear Kolya,

I have dispatched the sample (mother liquor with the single crystals, 20 mL ca.) today. Please, let us know if and when it arrives!

Best regards from Hungary, Pali

Dr. Pál Sipos
University of Szeged
Faculty of Science and Informatics
Department of Inorganic and Analytical Chemistry
H-6701 Szeged PO Box 440
tel +36 62 544 054
fax +36 62 544 340
http://www.staff.u-szeged.hu/~sipos/index.html

Samples origin:

NG-group

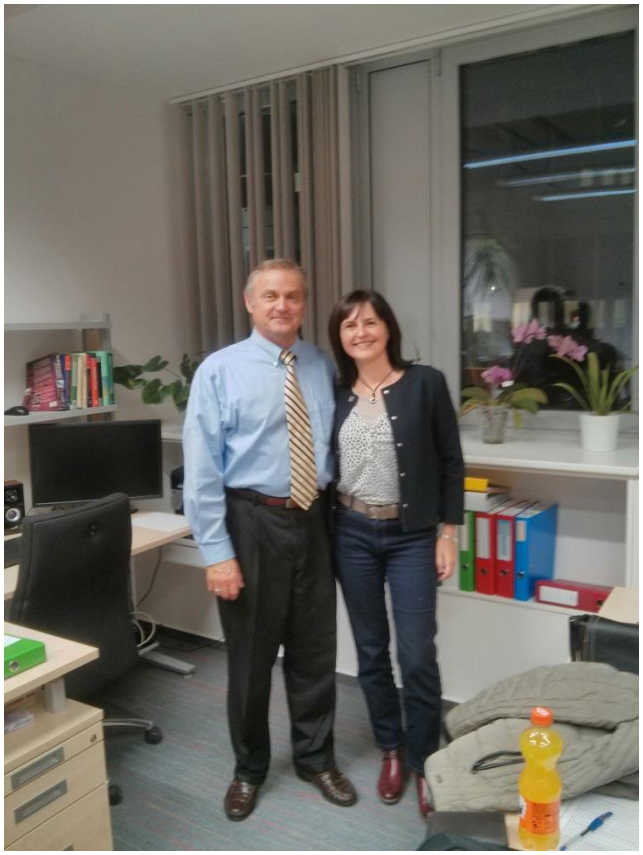
International collaboration and service:

Ukraine:	14 samples, XRD	1 published
	2 samples, TG/DSC, magnetism	1published
Alger:	6 samples	0 published
Spain:	2 samples	0 published
South Africa:	9 samples from Pietermaritzburg	0 published
	5 samples from Bloemfontein	0 published
Kazakhstan:	2	0 published
Israel:	1	1 published
Finland:	6	0 published
Hungary:	6	0 published

53 samples

Hungary: visited two universities in Budapest and in Szeged with lectures in 2016 during my sabbatical.

Studied **6** crystal samples - 0 published

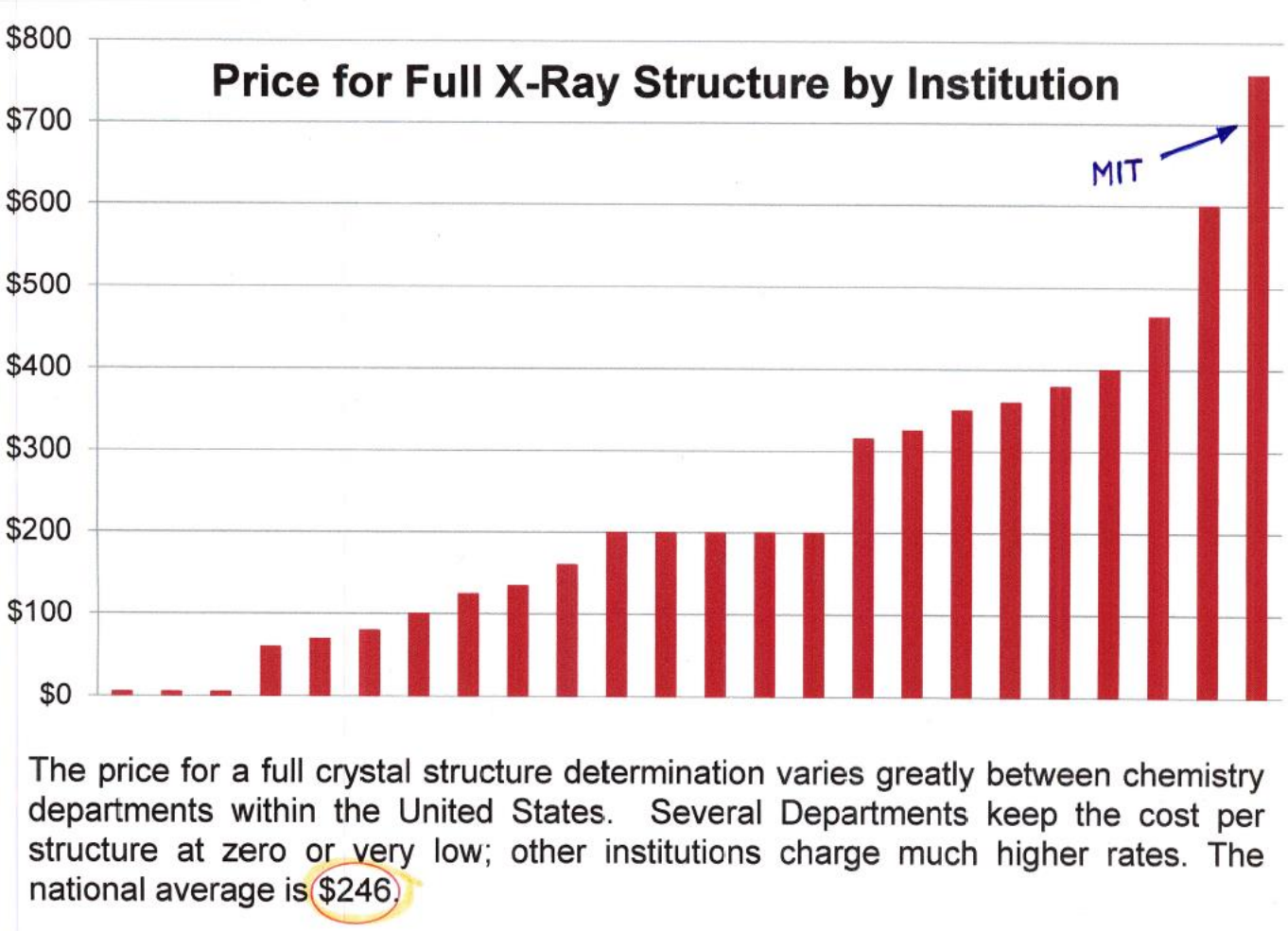


With Prof. Andrea Deak,
Institute of Organic Chemistry

With and Erno Kuzmann and his wife, Laboratory Nuclear Chemistry

Our departmental recruitment booth:

- Brochures with list of facilities and equipment
- Demos of student' work
- Slide show about our campus, labs and research infrastructure

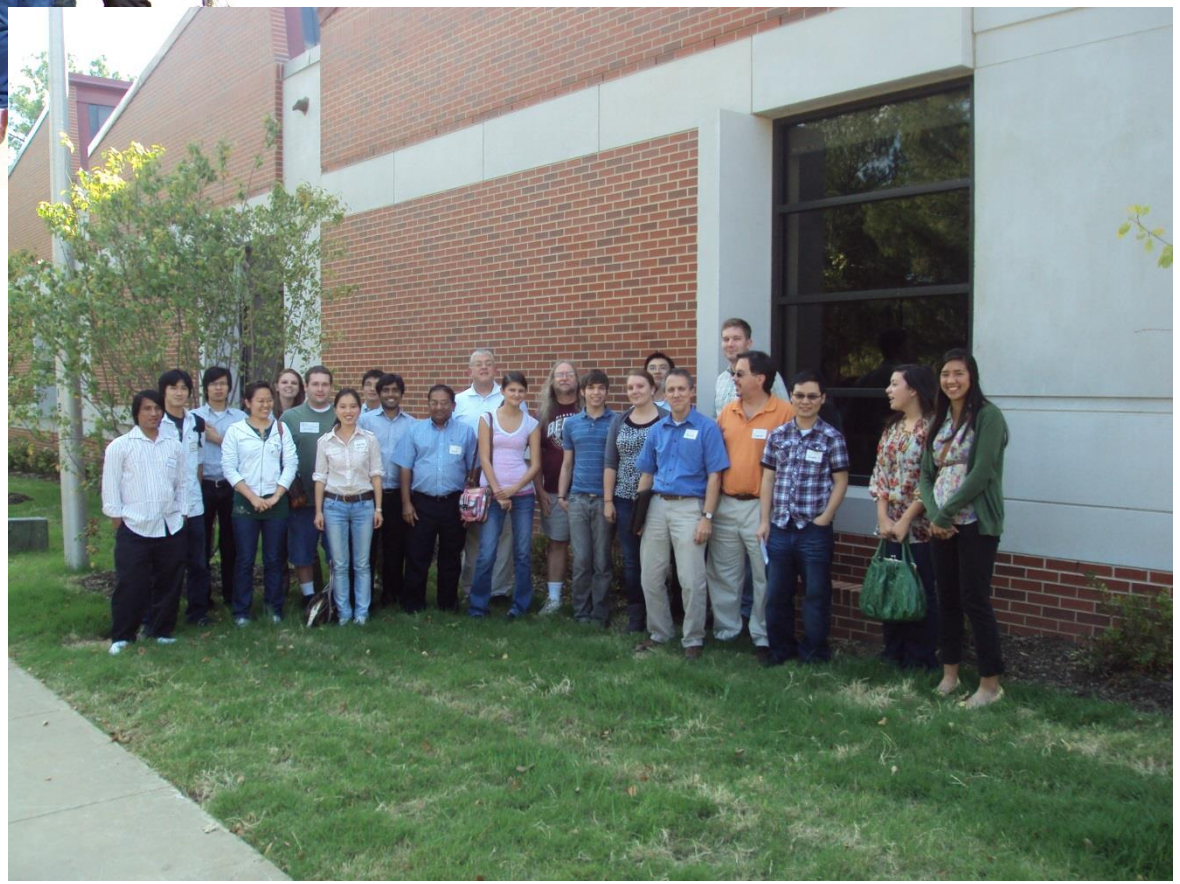


Many colleges and universities don't have funds for this…

Domestic collaboration and service:

U Minnesota - Duluth:	2 samples, XRD	2 published in 2 papers
Arkansas:		
U Arkansas – Fayetteville	2 samples, XRD	all published in 1 paper
U Arkansas – Little Rock	6 samples, XRD	
Arkansas Technical University	6 samples, XRD, TG/DSC, NMR	
University of Central Arkansas:		
Prof. Pat Desrochers	6 samples, XRD, TG/DSC	
	UV-visible variable T	0 published
Prof. Ley Yang	8 samples, TG/DSC	all published in 1 paper
Lyon College		
Prof. Floyd Beckford		
Prof. Burt Holansworth	4 samples, XRD	0 published
Kansas:		
Prof. Misha Barybin	18 samples, XRD	1 published in 1 paper
Prof. Mikhail Rubin	2 samples, XRD	published in 1 paper
New York:		
SUNY Albany	2 samples, fluorimetry	all published in 1 paper

2016, at MSU



2011

2016, at MSU

People indicated with arrows interested in collaborative service work with me

2011

2017

2019

2017

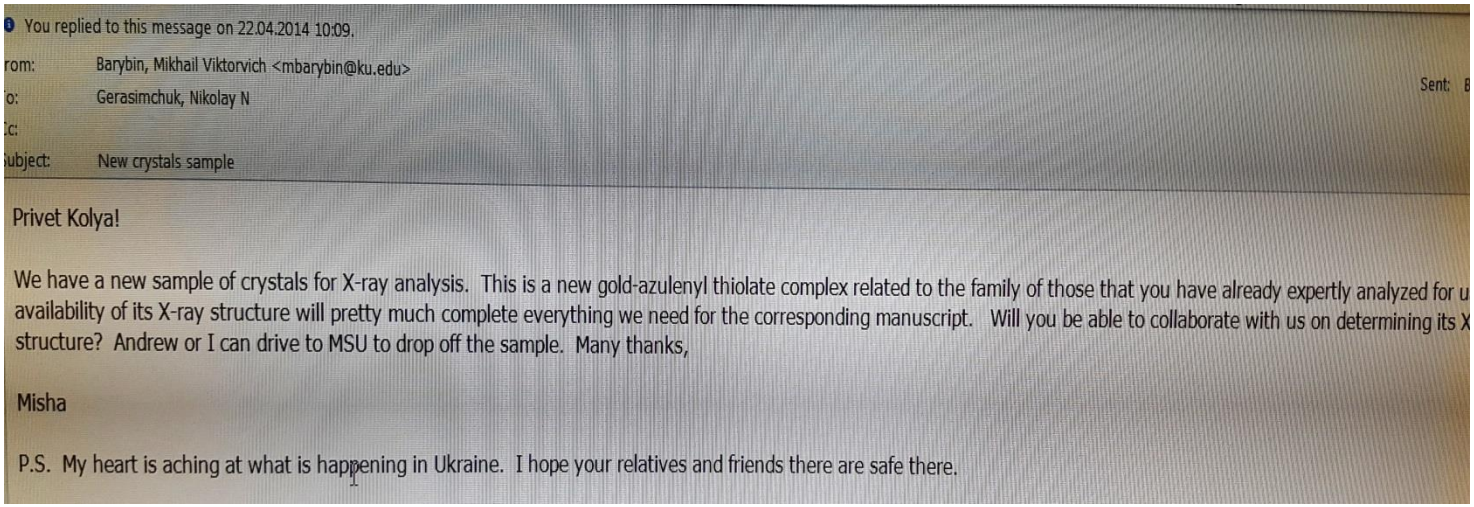
People indicated with arrows interested
in collaborative service work with me

2019

MO Inorganic-Day 2011, at MSU

People indicated with arrows interested
in collaborative service work with me

34th Spring MICA meeting in Springfield, MO, 2020



You replied to this message on 22.04.2014 10:09.

rom: Barybin, Mikhail Viktorvich <mbarybin@ku.edu>

o: Gerasimchuk, Nikolay N

c:

ubject: New crystals sample

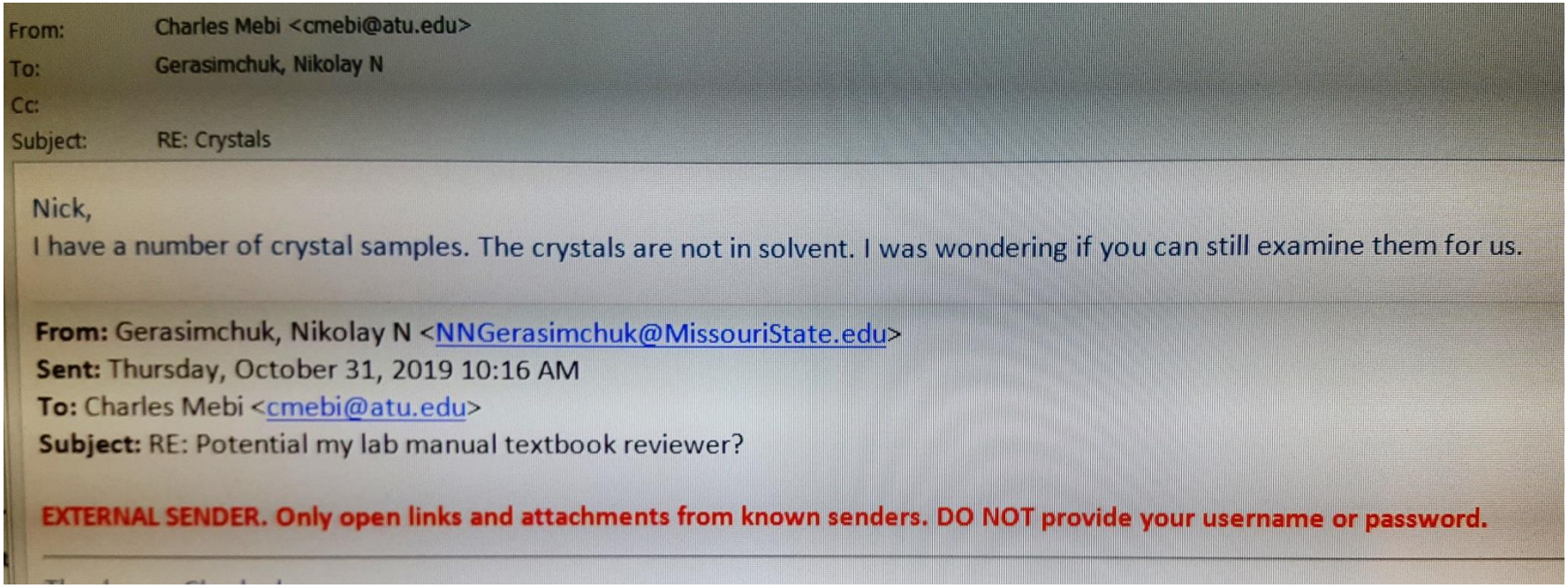
Sent:

Privet Kolya!

We have a new sample of crystals for X-ray analysis. This is a new gold-azulenyl thiolate complex related to the family of those that you have already expertly analyzed for u availability of its X-ray structure will pretty much complete everything we need for the corresponding manuscript. Will you be able to collaborate with us on determining its X structure? Andrew or I can drive to MSU to drop off the sample. Many thanks,

Misha

P.S. My heart is aching at what is happening in Ukraine. I hope your relatives and friends there are safe there.



From: Charles Mebi <cmebi@atu.edu>

To: Gerasimchuk, Nikolay N

Cc:

Subject: RE: Crystals

Nick,

I have a number of crystal samples. The crystals are not in solvent. I was wondering if you can still examine them for us.

From: Gerasimchuk, Nikolay N <NNGerasimchuk@MissouriState.edu>

Sent: Thursday, October 31, 2019 10:16 AM

To: Charles Mebi <cmebi@atu.edu>

Subject: RE: Potential my lab manual textbook reviewer?

EXTERNAL SENDER. Only open links and attachments from known senders. DO NOT provide your username or password.

You made changes to another copy of this item. This is the most recent version. Click here to see the other versions.

From: Burt Hollandsworth <burt.hollandsworth@lyon.edu> Sent:
To: Gerasimchuk, Nikolay N
Cc:
Subject: Crystals on the way

Hey Nick,

I'm mailing some nice crystals to you. I checked spectral data and they look like the right compound.

The starting materials are both liquids so the crystals can't be starting material.

It will be great to see you at MICA if you are planning to be there. :)

Burt

Carl B. "Burt" Hollandsworth, Ph.D.
Sent from a mobile device.

You replied to this message on 17.09.2018 17:05.

From: Carl Hollandsworth <drburth@gmail.com>
To: Gerasimchuk, Nikolay N
Cc:
Subject: Crystals
Sent: Пн 27.08.201

Hey Nick,

I have some crystals to send your way. I think it's a ligand that I made but I'm not sure based on the NMR. It's possible that it's an impurity.

What's the best address to send to?

Thanks!

Burt

Local, in the state, collaboration and service:

Missouri:

UM Rolla		
Prof. Amitava Choudhuri	XRD, TG/DSC, UV-visible variable T	
Prof. Thomas Shuman	TG/DSC	no publication offered Paid $
UMKC	5 samples, CD spectra	all published in 1 paper + paid $
Prof. Zhonghua Peng		
UMSL		
Prof. Janet Wilking	UV-visible variable T TG/DSC	no publication offered
College of the Ozarks		
Prof. Jerry Easdon	5 samples, XRD	0 published
MU-Columbia		
Prof. Paul Sharp	2 samples, fluorimetry	no publication offered

5 structures, 0 pubs

9 structures, 0 pubs

9 structures, 0 pubs

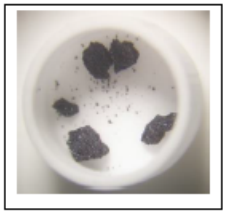
KU

17 structures for Barybin, 1 only in 1 pub

3 structures for Rubin, 1 only in 1 pub

NG-group

If interested in service people can provide payments – I send them a bill.



Missouri State University

Department of Chemistry
Instrumentation Laboratory
Temple Hall 457

TG / DSC analysis
TA Q-600

Date: January 6 – 10 , 2017

Samples from: Professor Tom Schuman, Missouri University of Science & Technology

Number of samples: 4

Type of work: Recording thermograms and heat flow traces for four submitted compounds. Conditions: air, from r.t. to +800°C, with 20°C / min speed of heating. The job took ~4 hours.

The instrument conditioning/calibration/preparation took 1 hour

Data procession:

preliminary plotting	interpretation	collecting and sending to inquirer
YES	no	YES

Data sent: YES NO

Samples sent back YES NO, discarded NO, kept for future use

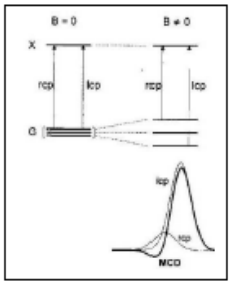
Time spent: 5

Recharge rate: $ 50 / hour **Total:** $ 250

Nick Gerasimchuk

Operator: Prof. Nick Gerasimchuk

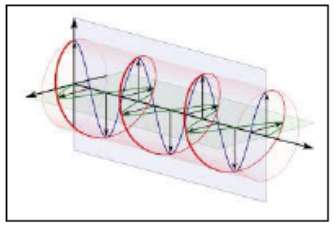
NG-group



Missouri State University

Department of Chemistry
Instrumentation Laboratory
Temple Hall 457

CD / MCD spectrophotometry
JASCO-815



Date: January 26, 2015

Samples from: Professor Zhonghua Peng, University of Missouri-Kansas City; Department of Chemistry

Number of samples: **15** (12 samples x 3 averaged scans + 3 samples – single scan)

Type of work: recording circular dichroism spectra of polymers in mixed water/THF solutions

Time spent: 9.5 hrs

Recharge rate: $50 / hour for Dr. Gerasimchuk (1 hour) and $25 / hour for trained outside users/customer (8.5 hrs)

Total: ***$262.50***

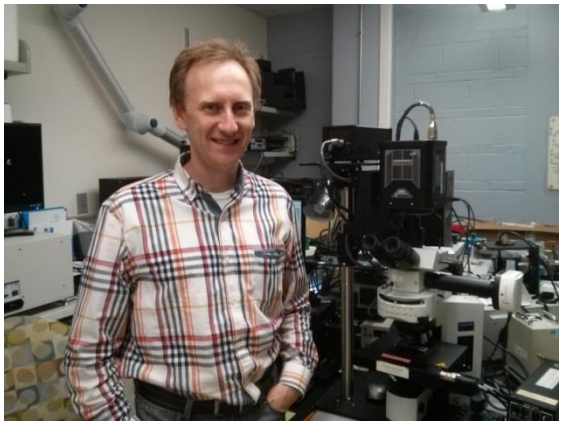
Operator: Prof. N. Gerasimchuk

Nick Gerasimchuk

NG-group

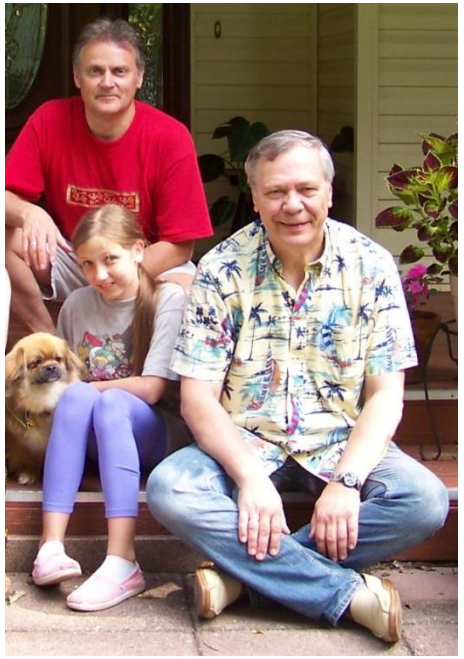
Who I reach for collaboration:

Prof. Mikhail Berezin, Washington University Medical School, radiology department (NIR emission studies, *in vivo* studies).

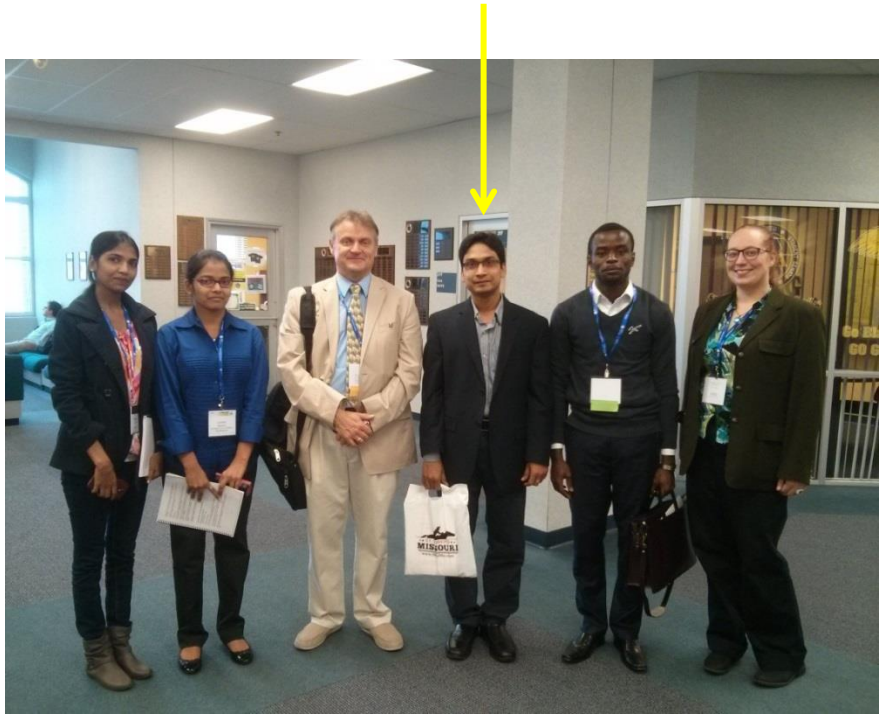


Prof. Marianna Patrauchan, Oklahoma State University microbiology department (biofilm studies)

Prof. Santimukul Santra, Pittsburg State University (molecular biology, *in vitro* studies)



Dr. Sergey Lindeman, Marquette University (powder XRD studies)



Prof. Santimukul Santra,
Pittsburg State University
(molecular biology, *in vitro* studies)

2014 samples sent
2019 – paper published!

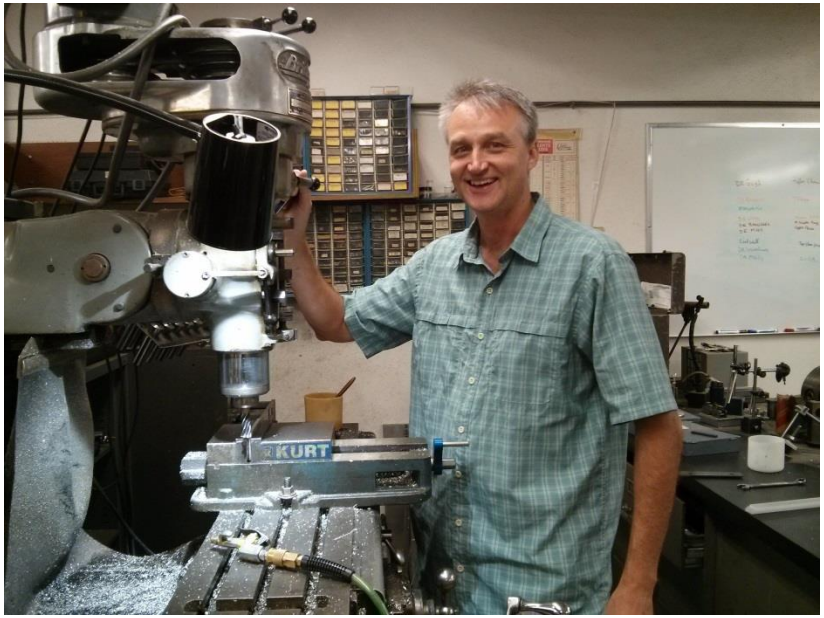
2008 - current

Prof. Victor Nemykin
University of Manitoba, Canada
mass-spectrometry, electrochemistry

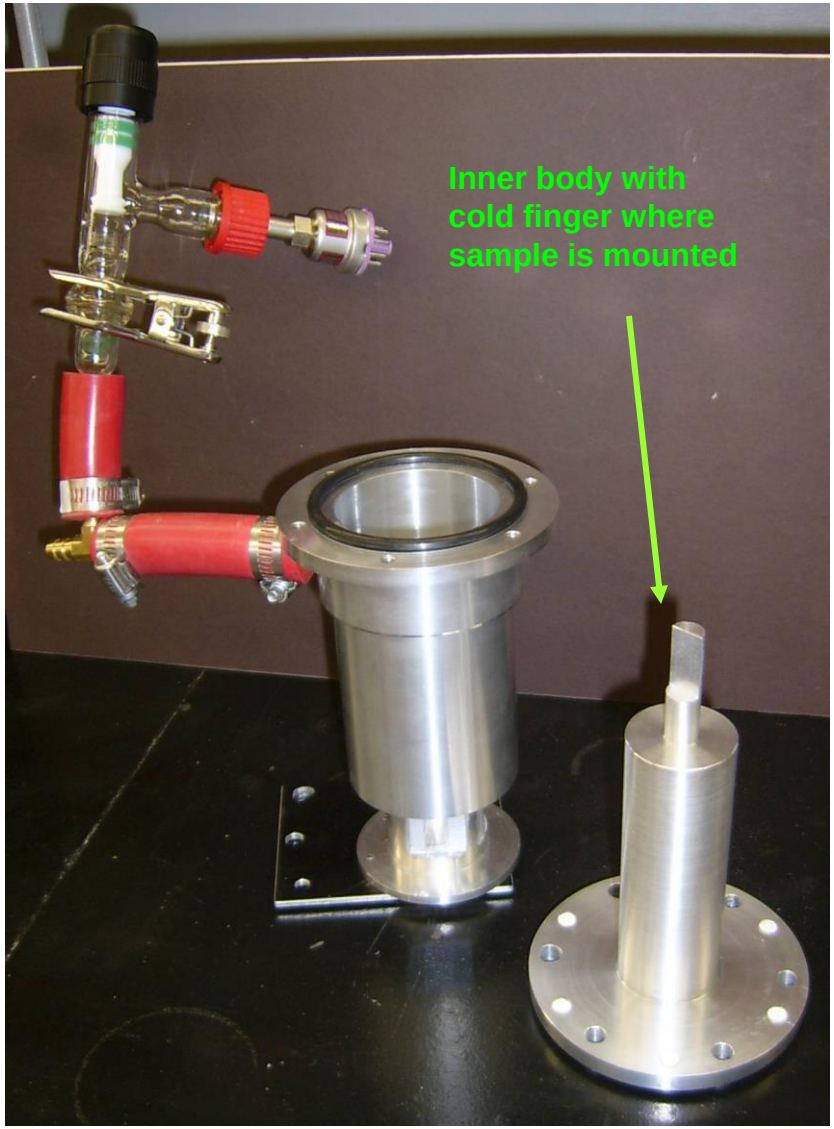
Profs. Jeannette Krause and **Allen Oliver**
(XRD, Berkeley Synchrotron; USA)

2011 - current

Special acknowledgment:



Mr. **Brian Grindstuff**, a machinist
(custom manufacturing of cryostats,
cuvettes, sample holders, etc.)



Acknowledgment and support:

1) **Department of Chemistry MSU for financial support:**
- Faculty Research Grants (2002, 2004, 2006, 2008, 2010, 2013, 2017)
- Summer Faculty Research Fellowships (2002, 2008, 2011, 2015, 2018)

2) **ACS PRF grant # 39079-B3** (2003-2006)

3) **NIH Area R15 grant** (2012-2016)

4) **US Research Corporation Award** CC6598 (2006-2008)

5) **MSU Graduate College** (partial support to graduate students)

6) **X-ray data collection for very small crystals: Dr. A. Oliver, Dr. J. Krause** (at UC Berkeley, CA)

7) **mass-spectra of Pt-polymers Prof. Victor Nemykin** (UM-Duluth)

Thank you for listening!