***CURRICULUM VITAE* AND LIST OF PUBLICATIONS**

Dr. Yael Albo

September, 2018

PERSONAL DETAILS

Name: Yael Albo

Date and place of birth: July 16, 1976, Beer Sheva, Israel.

Regular military service: August 15, 1994 – May 9, 1996

Address and telephone number at work: Chemical Engineering Department, Ariel University, Kiriyat Hamada 3, Ariel, Israel. 972-74-7296786

Address and telephone number at home: Vangruver 5/20 Petach Tikva, Israel. 972-39193276, 972-506378588

LIST OF CITATIONS

https://scholar.google.com/citations?user=23K0VBgAAAAJ&hl=en&authuser=1

EDUCATION

B.Sc.: 1996-2000, Ben-Gurion University, Israel, Chemical Engineering Department (Graduated *Cum Laude*).

M.Sc.: 2000-2002, Ben-Gurion University, Israel, Chemistry Department (Graduated *Cum Laude*).

Supervisor: Prof. Meyerstein Dan.

Title of thesis: "Design and synthesis of ligands for high valent transition metal cations".

Ph.D.: 2002-2007, Ben-Gurion University, Israel, Chemistry Department.

Supervisor: Prof. Meyerstein Dan.

Title of thesis: "Design and synthesis of ligands for high valent transition metal cations".

EMPLOYMENT HISTORY

2009 to present: Lecturer, Chemical Engineering Departmaent, Ariel University, Israel.

2008-2009: Instructor, Chemical Engineering Departmaent, Ariel University, Israel.

2004-2007: Teaching assistant, Chemical Engineering Department, SCE - Shamoon College of Engineering, Israel.

2000-2007: Teaching assistant, Chemistry Department, Ben-Gurion University of the Negev, Israel.

PROFESSIONAL ACADEMIC ACTIVITIES

2010 to present: Academic consultant for second year B.Sc. students at Ariel University.

2009 to present: Member of the library committee, Ariel University.

EDUCATIONAL ACTIVITIES

(a) Teaching activities

2008 to present at Ariel University:

Undergraduate courses: "Chemical Engineering 1- Fluid Mechanics", "Chemical Engineering 2- Heat Transfer", "Introduction to Chemical Engineering", "Analytical Methods for Chemical Engineering".

Graduate course: "Kinetics and Catalysis"

Laboratory supervisor: "Instrumentation in the chemical engineering and the biotechnology industry", "Separation laboratory", "Chemical engineering and processes control laboratory".

(b) Supervising research students

2018-Neelam Singh Ph.D. thesis, Ariel University (Jointly supervised, Prof. Dan Meyerstein)

2017- Michael Meistelman M.Sc. thesis, Ariel University (Jointly supervised with Prof. Dan Meyerstein)

2017- Reem Nassar M.Sc. thesis, Ariel University.

2015 – Yulia Katzman M.Sc. thesis, Ariel University (Jointly supervised with Prof. Dan Meyerstein).

2014 – Lior Hayoun M.Sc. thesis, Ariel University.

2011 – Stephanie Gottesman M.Sc. thesis, Bar-Ilan University (jointly supervised with Prof. Haim Cohen and Prof. Moshe Lalush)

2009 to present: Supervised 33 B.Sc. students final projects.

AWARDS

Teaching excellence award, Ariel University, 2015

SCIENTIFIC PUBLICATIONS

BOOK CHAPTERS

1. Tomer Zidki, Ronen Bar-Ziv, Ariela Burg, Yael Albo, Dan Meyerstein, (**2016**) "Radical Reactions at Surfaces". In book: The Optimization of Composition, Structure and Properties of Metals, Oxides, Composites, Nano and Amorphous Materials. Publisher: Russian Academy of Sciences, Ekaterinburg, Editors: M. Zinigrad and E. Pastukhuv, Ural Branch Russian Academy of Sciences, 180-185.
2. Yael Albo, Michael Meistelman, Ariela Burg, Dror Shamir, (**2016**) "Entrapment of Ag^0 and Au^o nanoparticles in sol-gel matrices for catalytic applications". In book: The Optimization of Composition, Structure and Properties of Metals, Oxides, Composites, Nano and Amorphous Materials. Publisher: Russian Academy of Sciences, Ekaterinburg, Editors: M. Zinigrad and L. Pastukhuv, Ural Branch Russian Academy of Sciences, 4-9.
3. Ariela Burg, Yael Albo, Dror Shamir, Yair Lavi, Michael Meistelman, Neelam Singh, Dan Meyerstein (**2015**), "Transition metal complexes and nano-particles entrapped in sol-gel matrices as electron exchange columns and as redox catalysts". In book: The optimization of Composition, Structure and Properties of Metals, Oxides, Composites, Nano and Amorphous Materials, Publisher: Russian Academy of Sciences, Ekaterinburg, Editors: M. Zinigrad and L. Pastukhuv, Ural Branch Russian Academy of Sciences, 59-70.

ARTICLES PUBLISHED IN PEER-REVIEWED JOURNALS

1. Neelam, Dan Meyerstein Ariela Burg, Dror Shamir, Yael Albo (corresponding author), **(2018)**, "Polyoxometalates entrapped in sol-gel matrices as an electron exchange column and as catalyst for the reductive de-halogenation of halo-organic acids in water". Accepted for publication in "Journal of Coordination Chemistry".
2. Dror Shamir, Eric Maimon, Israel Zilbermann, Ariela Burg, Yael Albo, Alexander I Shames, Radion Vainer, Eitan J.C. Borojovich, Guy Yardeni, Haya Kornweitz, Dan Meyerstein, **(2018)**, "Copper catalyze the reduction of perchlorate by both formaldehyde and by dihydrogen in aqueous solutions". Accepted for publication in "Journal of Coordination Chemistry".
3. Jaydeep Adhikary, Dan Meyersteina, Vered Marks, Michael Meistelman, Gregory Gershinsky, Ariela Burg, Dror Shamir, Haya Kornweitz, Yael Albo (corresponding author), **(2018),** "Sol-gel entrapped Au^0 - and Ag^0 -nanoparticles catalyze reductive dehalogenation of halo-organic compounds by BH_4^-". Applied Catalysis B: Environmental, 239, 450-469.
4. Neelam, Yael Albo (corresponding author), Ariela Burg, Dror Shamir, Dan Meyerstein, **(2017)**, "Bromate reduction by an electron exchange column". Chemical Engineering Journal, 330, 419-422.
5. Yael Albo (corresponding author), Lior Hayoun, Elizabeta Shandalov, Israel Zilbermann, Eric Maimon and Dan Meyerstein, **(2017)**, "Homogeneous and Heterogeneous Electrocatalytic Reduction of Halo-organic Compounds by ($Ni^{II}L_i$) (L_i = tetraaz-macrocyclic ligand) in aqueous solutions". Inorganica Chimica Acta, 466, 502-509.
6. Ariela Burg, Yaniv Wolfer, Dror Shamir, Haya Kornweitz, Yael Albo, Eric Maimon, Dan Meyerstein, **(2017)**, "The Role of Carbonate in Electro-catalytic water oxidation by $Ni(Cyclam)^{2+}$". Dalton Transactions, 46, 10774-10779.
7. Michael Meistelman, Jaydeep Adhikary, Ariela Burg, Dror Shamir, Gregory Gershinsky, Dan Meyerstein, Yael Albo (corresponding author), **(2017)** "Ag^0 and Au^0 Nanoparticles Encapsulated in Sol-Gel Matrices as Catalysts in Reductive De-halogenation Reactions". Chim. Oggi Chem. Tod. Catalysis and Biocatalysis, 35 (5), 16-19.
8. Jaydeep Adhikary, Michael Meistelman, Ariela Burg, Dror Shamir, Dan Meyerstein, and Yael Albo (corresponding author), **(2017)**, "The Reductive De-halogenations of Mono and

Tribromo Acetic Acids by $NaBH_4$ Catalyzed by Gold Nanoparticles Entrapped in Sol-Gel Matrices Follow Different Pathways". European Journal of Inorganic Chemistry, 2017 (11), 1510-1515.

9. Stephanie Gottesman, Haim Cohen, Yael Albo (corresponding author), (**2017**), "Removal of toxic trace elements from aqueous solutions using a SiO_2-sol-gel/2, 2'-(imidazolidine-1,3-diylbis(methylene))bis(3,5-di-*tert*-butylphenol) matrix. Glass Physics and Chemistry, 43 (5) 429-435.
10. Neelam, Yael Albo (corresponding author), Ariela Burg, Dror Shamir, Subramanian Palaniappan, Gil Goobes, Dan Meyerstein, (**2016**), "Polyoxometalate entrapped in sol-gel matrices for reducing electron exchange columns applications". J. of Coordination Chemistry, 69 (23), 3449-3457.
11. Ariela Burg, Dror Shamir, Lina Apelbaum, Yael Albo, Eric Maimon, Dan Meyerstein, (**2016**), "Electrocatalytic Oxidation of Amines by Ni-(1,4,8,11-tetraazacyclotetradecane)$^{2+}$ Entrapped in Sol–Gel Electrodes". European Journal of Inorganic Chemistry, 2016 (4) 459-463.
12. Yael Albo (corresponding author), Nina Buzaglo, Eric Maimon, Israel Zilbermann, Dan Meyerstein, (**2015**), "Design of a ligand suitable for sensitive uranyl analysis in aqueous solutions". Journal of Coordination chemistry, 68 (17-18), 3079-3089.
13. Yael Albo (corresponding author), Eric Maimon, Israel Zilbermann, Magal Saphier and Dan Meyerstein, (**2009**), "A New Chelate Ligand Designed for the Uranyl Ion", Coordination Chemistry Reviews, 253, 15, 2049-2055.
14. Yael Albo, Eric Maimon, Israel Zilbermann, Magal Saphier, Haim Cohen, Dan Meyerstein, (**2005**), "The Redox Chemistry of (N1- [3-(2-aminoethylimino)-1,1 – dimethylbutyl]ethane-1,2-diamine)nickel(II) Perchlorate, Ni(II)$L^1(ClO_4)_2$, in Aqueous Solutions – A Pulse Radiolytic and an Electrochemical Study". European Journal of Inorganic Chemistry, 2005 (21), 4335-4340.

LECTURES AND PRESENTATIONS AT MEETINGS AND INVITED SEMINARS NOT FOLLOWED BY PUBLISHED PROCEEDINGS

1. Alina Sermiagin, Ronen Bar-Ziv, Jaydeep Adhikary, Vered Marks, Ariela Burg, Dror Shamir, Haya Kornweitz, Tomer Zidki, Yael Albo, Dan Meyerstein, "M°-nanoparticles catalyze the reductive de-halogenation of halo-organic compounds by $BH4^-$ in aqueous

media: What determines the nature of hydrogen atoms on M° surfaces". ECIRM 3, European Colloquium Inorganic Reaction Mechanism, Barcelona, Spain, July 2018.

2. Yanna Gurianov, Faina Nakonechny, Yael Albo and Marina Nisnevitch, "Metal-polymer composites for water disinfection". The 53rd Annual Meeting of the Israel Institute of Chemical Engineers, Tel Aviv, Israel, June 2018.
3. Yael Albo, "Ag^0 and Au^0 nanoparticles encapsulated in sol-gel matrices as catalysts in reductive de-halogenation reactions", 8th Annual Global Congress of Catalysis, Shanghai, China, October 2017. Invited Lecture
4. Yael Albo, Michael Meistelman, Jaydeep Adhikary, Ariela Burg, Dror Shamir, "Ag^0 and Au^0 nanoparticles encapsulated in sol-gel matrices as catalysts in reductive de-halogenation reactions". The 8th Eastern Mediterranean Chemical Engineering Conference, Haifa, Israel, February-March 2017.
5. Liraz Kuztashi, Yael Albo, "Dye degradation by using M^0 nanoparticles incorporated in SiO_2 matrices". 20th International Conference on Advanced Nanotechnology, Amsterdam, Netherlands, September 2017.
6. Neelam Singh, Yael Albo, Ariela Burg, Dror Shamir, Dan Meyerstein, "Electron exchange columns for contaminated water treatment". The 82th Meeting of the Israel chemical society, Tel Aviv, Israel, February 2017.
7. Tomer Zidki, Ronen Bar-Ziv, Ariela Burg, Yael Albo, Dan Meyerstein, "Radical reactions at surfaces", 3rd European Colloquium on Inorganic Reaction Mechanisms, Krakow, Poland 2016.
8. Neelam Singh, Yael Albo, Ariela Burg, Dror Shamir, Dan Meyerstein, "Polyoxometalates entrapped in sol-gel matrices for reducing electron exchange column applications". The ICCC-42, Brest, France, July 2016.
9. Yael Albo, Michael Meistelman, Ariela Burg, Dror Shamir, "Entrapment of Ag^0 and Au^o nanoparticles in sol-gel matrices for catalytic applications". The 15th Israeli-Russian Bi-National workshop, Ekaterinburg, Russia, Septembers 2016.
10. Ariela Burg, Inbar Elias, Dror Shamir, Lina Apelbaum, Yael Albo, Dan Meyerstein, "Entrapment of the Complex Cu-(2,5,8,11-tetramethyl-2,5,8,11-tetraazadodecane) in Sol-gel electrodes for Electrocatalysis". The 51th Annual Meeting of the Israel Institute of Chemical Engineers, June 2016.
11. Michael Meistelman, Yael Albo, Ariela Burg, Dror Shamir, Dan Meyerstein "Reductive dehalogenation of haloacetic acids catalyzed by Ag^0-NPs incorporated in sol-gel

matrices". The 81th Meeting of the Israel Chemical Society, Tel Aviv, Israel, February 2016.

12. Neelam Singh, Yael Albo, Ariela Burg, Dror Shamir, Dan Meyerstein, "Polyoxometalates entrapped in sol-gel matrices for reducing electron exchange column applications". The 81th Meeting of the Israel Chemical Society, Tel Aviv, Israel, February 2016.
13. Ariela Burg, Inbar Elias, Dror Shamir, Lina Apelbaum, Yael Albo, Dan Meyerstein, "Electrocatalysis by entrapped Cu(II)(2,5,8,11-tetramethyl-2,5,8,11-tetraaza-dodecane)$^{2+}$ in sol-gel electrodes", Israel Electrochemistry Annual Meeting, Beer Sheva, 2015.
14. Yulia Katzman, Yael Albo, Dan Meyerstein, "Entrapment of Ag^0 and Au^0 NPs in SiO_2 matrices prepared via the sol-gel process and their catalytic role in the reduction of 4-nitrophenol". The 2nd EuCheMS Inorganic Chemistry Conference, Jerusalem, Israel, July 2013.
15. Yulia Katzman, Yael Albo, Dan Meyerstein, "Immobilization of noble metal nanoparticles in SiO_2 matrices and investigation of their chemical and catalytic properties". The 78th Meeting of the Israel Chemical Society, Tel Aviv, Israel, February 2013.
16. Stephanie Gottesman, Haim Cohen, Yael Albo, "Removal of polluting metal cations from water using a SiO_2 matrix entrapped ligand - N,N' di(2-hydroxy-4,6 di-tertbutyl-benzyl) imidazolidine". The 4th EuCheMs Chemistry Congress Prague, Czech Republic, August 2012.
17. Stephanie Gottesman, Haim Cohen, Yael Albo, "Fixation of the ligand N, N' di(2-hydroxy-4,6 di-terbutyl-benzyl)imidazolidine in SiO_2 via the sol-gel matrix mediated synthesis for the purification of water from toxic trace elements". The 47th IIChE Annual meeting, Tel Aviv, Israel, June 2011.
18. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "Design and synthesis of a new chelate for the uranyl ion". ICCC 38, Jerusalem, Israel, 2008.
19. Yael. Albo, Israel Zilbermann, Eric. Maimon, Haim Cohen and Dan Meyerstein "Mechanisms of oxidation of NiL^{2+} by inorganic radicals in aqueous solutions. A pulse radiolysis study". EYIC, Radiation Chemistry Meeting, Slubice, Poland, 2007.
20. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "Design and synthesis of a new chelate for the uranyl Ion". The 1st European Chemistry Congress, Budapest, Hungary, August 2006.

21. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "The Redox Chemistry of (N^1- [3-(2-aminoethylimino)-1,1 –dimethylbutyl]ethane-1,2-diamine)nickel(II) Perchlorate, $Ni^{II}L^1(ClO_4)_2$, in Aqueous Solutions – A Pulse Radiolytic and an Electrochemical Study". The Inorganic Reaction Mechanism Meeting, Athens, Greece, January 2004.
22. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "The Redox Chemistry of (N^1- [3-(2-aminoethylimino)-1,1–dimethylbutyl]ethane-1,2-diamine)nickel(II) Perchlorate, $Ni^{II}L^1(ClO_4)_2$, in Aqueous Solutions – A Pulse Radiolytic and an Electrochemical Study". The 69th Meeting of the Israel Chemical Society, Tel Aviv, Israel, February 2004.
23. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "A novel cyclam type ligand with pendant N- Hydroxo xylene moieties and its transition metal complexes". The ICCC-35, Heidelberg, Germany, July 2002.
24. Yael Albo, Magal Saphier, Israel Zilbermann, Eric Maimon, Dan Meyerstein, "A novel cyclam type ligand with pendant N-Hydroxo xylene moieties and its transition metal complexes". The 67th Meeting of the Israel Chemical Society, Jerusalem, Israel, February 2002.

RESEARCH GRANTS

2018 Ariel University internal grant

Subject: "Ag@ORMOSIL Catalyst for Environmental, Biocidal, and Synthetic Applications".

2018 Ariel Scientific Innovations LTD internal grant: Joint research with Prof. Dan Meyerstein.

Subject: "Development of catalytic degradation system for industrial organic waste"

2015 Pazi foundation: Joint research with Dr. A. Burg (SCE) and Dr. D. Shamir (NRCN).

Subject: "Sol-gel matrices as ion and electron exchange columns and as redox catalysts"

RESEARCH STUDENTS SUPERVISOR

2017 to present: Keren Trabelsi, M.Sc. thesis, "Ag@ORMOSIL catalyst for environmental, biocidal, and synthetic applications" (the research is in collaboration with Dr. Mario Pagliaro CNR Italy)

2017 to present: Yana Guryanov Ph.D. thesis "Fixation of antibacterial species in porous matrices" (Jointly supervised, Prof. Marina Nisnevitch and Dr. Faina Nakonechny)

2017 to present: Aswin Vijay, Ph.D. thesis, "Hydrogen spillover from M^0 nanoparticles encapsulated in sol-gel matrices", Ariel University (Jointly supervised, Prof. Haim Cohen)

2016 to present: Post-doctoral fellow: Dr. Jaydeep Adhikary

2015 to present: Liraz Kuztashi M.Sc. thesis "M^o nanoparticles incorporated in sol-gel matrices as catalysts in dyes degradation processes"

PRESENT ACADEMIC ACTIVITIES

Research in progress:

1. "Immobilization of Iron NPs in SiO_2 matrices via sol-gel technology and their environmental applications"
2. "Immobilization of noble metal nanoparticles in porous solid frameworks and investigation of their chemical and catalytic properties"
3. "Development of Inorganic electron exchange columns"
4. "Entrapment of complexes in sol-gel matrices for practical applications"
5. "Incorporation antibacterial species into sol-gel matrices"
6. "Influences of silica nanoparticles size and content on blended cement properties"

SYNOPSIS OF RESEARCH

My research can be divided to three main topics: applicative sol-gel matrices, modified electrodes and the design and synthesis of ligands for stabilizing high valent transition metal cations.

1. Applicative Sol-Gel Matrices

Matrices prepared via the sol-gel synthesis route have been shown to entrap different compounds. The matrices can be prepared from a variety of precursors *e.g.* $(R'O)_3Si$-$R/(Si(OR')_4)$ and other metal–alkoxides such as titanium, and anhydrous metal halides. The large diversity of species that can be incorporated into the matrices by sol-gel synthesis enables us to tailor their properties to the desired application. Our studies involve the entrapment of desired catalysts and electro-catalysts in sol-gel matrices, the development of electron-exchange columns, ion exchange columns and their application in processes of environmental and industrial importance.

These studies are being done in collaboration with Dr. Ariela Burg at the Sami Shamoon College of Engineering and Dr. Dror Shamir at the Nuclear Research Centre Negev and prof Dan Meyerstein at Ariel University.

1.1. Design, Preparation and Characterization of Inorganic Electron Exchange Columns

Electron exchange columns are analogous to ion exchange columns, however, while ion exchange columns have been extensively studied, the research concerning electron exchange columns is still preliminary. These columns are comprised of an entrapped strong redox agent that performs oxidation/reduction cycles and a substrate that passes through the column. Such columns are reversible in nature and are advantageous as the redox reagents do not contaminate the products and are expected to have various applications, in pharmaceutical and in fine chemical industrial processes that involve redox reactions, and in water treatment processes.

The matrix in which the redox reagent is entrapped has to be stable to redox processes, therefore sol-gel matrices are expected to be applicable for this purpose. This research involves the entrapment of different oxidizing/reducing inorganic redox reagents *e.g.* polyoxometalates, metal complexes with inorganic ligands and nanoparticles in different sol-gel matrices for the development of electron-exchange columns.

1.2 Entrapment of noble M°- and M°/M'°-NPs in sol-gel matrices for catalytic applications

Sol-gel matrices can be efficiently utilized in heterogeneous catalysis. The incorporation of a homogeneous catalyst into the matrix combines the specificity and reproducibility of the homogeneous catalyst with the advantages of heterogeneous catalysts.

In this studies the catalytic ability of metal nanoparticles embedded in SiO_2 matrices prepared by using the sol-gel synthesis route in order to prevent their agglomeration, is investigated.

Ag^o and Au^0 entrapped in SiO_2 matrices have been shown to have good catalytic activity in the reduction of 4-nitrophenol. Matrices incorporated with Ag^0 and Au^0 and Fe^0 nanoparticles have been shown to catalyze the reduction of polluting halo-organic compounds and of polluting dyestuff with sodium borohydride. These catalysts can be easily separated from the reaction products and reused.

1.3 Entrapment of Zero-Valent–Iron NPs in Sol-Gel Matrices

Conventional biological processes applied for remediation of industrial waste streams have significant disadvantages including the inhibition of microorganisms by certain pollutants, the unfeasibility of treating high concentrations of organic compounds and the production of sludge, which is a source of pollution. Advanced oxidation processes (AOP) offer promising end line solutions for the treatment of high strength wastewater containing non-bio-degradable organic pollutants. These processes include; Fenton like processes based on oxidation of pollutants by hydrogen peroxide; ozonation that is based on the strong oxidant properties of ozone; photo-catalysis based on photonic activation of the catalysts; catalytic wet oxidation; sonolysis; and electro-chemical oxidation. Among these technologies the Fenton method, in which hydroxyl radicals with high oxidation potential are generated, is the most promising because the reagent components, ferrous and hydrogen peroxide are easy to handle and environmentally benign.

The main drawback of the traditional Fenton reagent, which is a homogenous catalytic process, is the high quantity of ferrous iron salts needed, which must be separated from the treated effluent. Thus, in recent years an alternative Fenton like system has been studied involving the oxidation of nano scale zero-valent iron (nZVI) under acidic conditions, generating Fe^{2+}. The heterogeneous zero-valent iron/H_2O_2 Fenton-like system has shown good results in the oxidation of several toxic pollutants such as 4-chlorophenol, 4-chloro-3-methylphenol and phenol.

Due to the tendency of these particles to coalesce into aggregates, immobilization of these particles in sol-gel matrices prepared via the hydrolytic synthesis offers further improvement of this technology, as it not only avoids the agglomeration of these particles but also prevents

the release of iron into wastewater, due to the precipitation and possible interaction between the Fe^{III} formed in the Fenton reaction with the residual hydroxyl surface groups present in the matrices. These Fe^{III} precipitates can be recycled by a reducing agent or be re-used as initiators of the Fenton like reaction.

In this research sol-gels immobilized with nZVI are prepared and their catalytic ability in the oxidation of various organic pollutants by the Fenton like reaction using H_2O_2 as an oxidant is studied to optimize the reaction conditions.

1.4 Development of novel sol-gel based methods for the recycling of heavy metal ions and radioactive waste

Rampant industrial development in parallel with the ever-growing world population has led to increasing pollution of water sources with heavy metals. In addition, significant effort is being invested in the search for alternative energy sources. Principal among these is nuclear energy, for which radioactive elements are needed, also constituting a source of highly toxic pollutants. Because heavy metals are rare, the optimal treatment method for reducing their incidence in the environment should entail a method for their extraction so that they can be reused. This is especially the case for radioactive elements, which are needed as an energy source. The inherent toxicity of radioactive elements, however, dictates that the recycling process be easy, and that it includes strict safety protocols to prevent any radiation from escaping during their recovery. In recent years, intensive research efforts have been devoted to solving these problems. The sol-gel process can be exploited in the easy fabrication of columns, such as ion exchange columns, which can be used to separate and/or concentrate heavy metal cations. The chemical and morphological characteristics of the matrices can be adjusted to bind different heavy metals via designed modification of the matrix by incorporation of specially designed ligands, where binding affinity may be controlled exploiting the HSAB principle.

In this research novel sol-gel based methods are being developed for the recycling of heavy metal ions and radioactive waste.

2. Modified Electrodes

Electrocatalytic reduction of halo-organic compounds using transition metal complexes of Ni^{II} incorporated in modified electrodes

Halogenated pollutants have low solubility, are toxic, tend to accumulate in food chains and are the most often found contaminates in subsurface environments. As such, their remediation has been extensively studied with the aim of finding economical treatment methods for the degradation of these compounds to environmentally safe products.

With respect to the treatment of drinking water from halo-acetic acids and other halogenated disinfection byproducts that are formed upon addition of chlorine to water for disinfection purposes, electro-chemical methods for reductive dehalogenation are advantageous as a degradation process that does not produce toxic byproducts, since there is no risk of creating new pollutants as in the case with bio-degradation or treatment with metal nanoparticles. The electro-catalytic reduction can be carried out either by direct reduction of the halo-organic substrates on the electrode surface or by the addition of an electro-catalyst. In the latter case, the electro-catalytic reduction has been studied either in homogeneous systems or in heterogeneous systems by using mediator –modified electrodes.

This research explores the possibility of developing an electro-catalytic method for the degradation of halo-organic compounds by using macrocyclic complexes of Ni(II) that will act as electron mediators in the reduction process. The first part of the research was dedicated to homogeneous electro-catalysis in which the complexes are dissolved in the aqueous solution of the halo-organic substrate. In the second part of the research, in order to develop an applicative method, two types of electrode modification methods with the macrocyclic complexes were used; modification of carbon paste electrodes and modification of glassy carbon electrode by using nafion. A combined study of the homogenous and heterogeneous catalysis enables better understanding of the factors that control the electro-catalytic reduction of these compounds, which is essential for any future scale up of the method towards its full implementation.

3. Design and Synthesis of Ligands for Stabilizing High Valent Transition Metal Cations

In this study a number of ligands were designed and synthesized in order to stabilize high valent transition metal cations. The complexes formed with UO_2^{2+}, Ni^{III} and Cu^{III} were characterized. In the ligand design, the expected applications and the electronic properties of the metal cations were considered. As an example, for the uranyl ion, the linear dioxo cation of six valent uranium (UO_2^{2+}, U(VI)) were used, di-aminie polydentate ligands substituted with arms containing oxygen atoms which are known as optimal donors for the hard acid

uranyl cation. The ability of the ligands to coordinate to the uranyl cation was examined with the aim of developing new reagents for the extraction and analytical determination of the cation.