Ze’ev Porat - Curriculum Vitae

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- **Personal details**

Date and place of birth: 22.7.1955, Tel-Aviv, Israel.

Work Address: Department of Chemistry, Nuclear Research Center-Negev (NRCN), P. O. Box 9001, Be’er-Sheva, Israel. Phone: 08-6567449.

Home address: 27 Sigalon Str, Omer 84965, Israel. Phone: 08-6467549. Mobile: 054-5598908.

- **Education**

B. Sc.: 1980, School of Chemistry, Tel-Aviv University.

M. Sc. : 1982, Faculty of Chemistry, The Weizmann Institute of Science, Rehovot, Israel.
Advisors: Prof. Ze’ev Luz and Dr. Alexander Weis.
Title of thesis: Dynamic NMR investigation of annular tautomerism in dihydropyrimidines.

Ph. D.: 1990, Department of Materials and Interfaces, The Weizmann Institute of Science, Rehovot, Israel.
Advisor: Prof. Israel Rubinstein.
Title of thesis: Nafion as a coating material for chemically-modifies electrodes and the behavior of new viologen derivatives in Nafion films and on bare electrodes.

- **Employment History**

Since 2019: Adjunct Professor at he unit of environmental Engineering, Ben-Gurion University of the Negev.

Since 2012: Guest researcher, Department of Chemistry, Bar-Ilan University, Ramat-Gan, Israel.

2011–2012: Sabbatical leave, Department of Chemistry, Bar-Ilan University, Ramat-Gan, Israel.

2007–2008: Sabbatical leave, Department of Materials and Interfaces, The Weizmann Institute of Science, Rehovot, Israel.

2005–2014: Guest researcher, Department of Biomedical engineering, Faculty of Engineering, Ben-Gurion University of the Negev, Be’er Sheva, Israel.

Since 2001: External lecturer, Unit of Environmental Engineering, Faculty of Engineering, Ben-Gurion University of the Negev, Be’er Sheva, Israel (see Educational activities).

Since 1994: Senior Researcher, Department of Chemistry, Nuclear Research Center-Negev.
1994 Rank B
2005 Rank A
2016 Rank A+

1990–1993: Post Doctorate, Department of Chemistry, University of North Carolina, Chapel-Hill, NC, USA (Laboratory of Prof. Royce W. Murray).

- **Professional Activities**

(a) NRCN: Positions in organizational administration

2001 – Head and member of several committees.

2002 – 2005 Head of analytical laboratory.

2005 – 2007 Deputy head of the department of analytical chemistry and director of research and development

2016 – Head of two organizational projects.

(b) <u>Ad-hoc reviewer</u>

Journals:

Journal of Analytical Chemistry
Journal of Electrochemical Society
Journal of Physical Chemistry
Journal of Thermal Analysis and Calorimetry
Journal of Nanotechnology
Int. J. of Innovative Res. in Sci, Eng. and Tech.
Reactive and Functional Polymers
Sensors and Actuators
Vacuum
Biochemistry and Biophysics Reports
Industrial & Engineering Chemistry Research
Journal of Electroanalytical Chemistry
Journal of Nanomaterials
Langmuir
Metal
Ultrasonics Sonochemistry
Nanomaterials
Optical Materials
Inorganica Chimica Acta
Applied Sciences
Water

Dissertations and research proposals:

Ben-Gurion University of the Negev
The Hebrew University, Jerusalem.
The Ministry of science
The National Science Fund (The Israeli Academy of Sciences).

- **Educational activities**

(a) <u>Courses taught</u>

Environmental Chemistry (course 376-2-6031) for the M. Sc. program in Environmental Engineering, Faculty of Engineering, Ben-Gurion university.

2001-2011: Elective course. 2 credit points.

Since 2012: Compulsory course, 3 credit points

(b) <u>Advisor to research students</u>

2 Ph.D. students.
3 M.Sc. students.
4 students - Final engineering research project.

(c) Academic course in preparation: Chapters in the History of Chemistry.

- **Synopsis of research**

  In the past ten years my research focused mainly on nine subjects, as described below. (The numbers in parentheses refer to the list of refereed articles.)

1. Analytical chemistry

   My activity in this field included development of analytical procedures for special purpose and validation of unique analytical methods, as well as academic research. The principles and guidelines of validation were summarized in an internal book entitled: "A Guide for validation of analytical methods and accreditation of analytical laboratories". This topic is also included in my course "Environmental analytical chemistry" at the Ben-Gurion University. My academic research in analytical chemistry included electrochemical detection of uranyl in aqueous solutions (13), precipitation of ammonium from industrial wastewater (14) and measuring the water content in freshly-deposited fingermarks (48).

2. Interaction of ultrasonic energy with molten metals

   Metals of low melting point (below 400 ºC) can be heated and melted in silicone oil and thus form two immiscible liquid phases. Irradiation of the system with ultrasonic energy forms acoustic cavitation in the oil that disperse the liquid metal into micrometric and nanometric spheres. The development of this novel method enabled the formation of such particles of Pb, Sn, Bi, In, Ga, Hg as well as the binary alloys Au-Ge Au-Si. Crystalline nanoparticles of gold were also formed (15, 17).

3. Physical and chemical properties of metallic particles formed by sonication

   Micro- and nanospheres of metals that were form by acoustic cavitation exhibit interesting properties. First, they crystalize instantaneously and form solids, even when the surrounding temperature of the medium is still higher than the melting point of these metals. DSC measurements of various size-groups of gallium particles gave experimental verification to the melting-point depression theory (23). Sonication of molten bismuth together with one other metal gives various kinds of products: metal matrix composite with tin or zinc, intermetallic compound with indium and an alloy with gallium (27). The surface of the BiIn particles were covered with tiny spikes that were identified to be solely In_2O_3 (31), while the sonication product of Bi-Sn showed multiple phases (26).

4. Formation of gallium particles by ultrasonic irradiation

   Gallium has a very low melting point (29.7ºC) and thus can be melted and sonicated in warm water or organic liquids at t>50ºC, to form micrometric and nanometric spheres. In water, the spheres were covered with rectangle crystallites that were identified as GaO(OH). Prolonged sonication renders all the particles into GaO(OH), which can be oxidized to Ga_2O_3. Thus, sonication of Ga in water provides a facile synthetic route for these compounds (24). Sonication of gallium in hexane or dodecane yielded bare particles without crystallites (18). There are several evidences that the gallium spheres or part of them are hollow. The unfavorable formation of gallium carbide by the sonochemical interaction between molten gallium and the hydrocarbon medium was also examines (40).

5. Interaction of molten gallium with solutes in water under ultrasonic irradiation

   Gallium can be melted and sonicated not just in water but also in aqueous solutions of various materials. Sonication of molten gallium in solutions of Au, Ag or Cu salts formed first micro- and nanoparticles of gallium, which reduced rapidly the metallic ions, forming particles of these metals and also the bimetallic compounds $AuGa_2$, Ag_2Ga and $CuGa_2$ (21). Sonication of gallium in solutions of organic compounds leads to their entrapment in the gallium particles, followed by slow leaching when the particles are separated and transferred to pure water (19). AFM measurements of the stiffness of gallium particles showed that it considerably increased upon the entrapment of various organic substances, which affects the dimensions of the crystallographic unit cell (39).

6. <u>Porous silicon: formation, characterization and chemical interactions</u>

Porous silicon (PSi) is formed by anodic etching of silicone wafer in HF/ethanolic solution. The average pore-size and the total porosity are governed by the current density and the HF concentration. Two methods for measuring the porosity were described in the literature: gravimetric and N_2 adsorption. We developed a new method for calculating the porosity by processing SEM images of the surface, assuming that the ratio between the area of the pore-openings to the total area of the sample represents the ratio between the total volume of the pores to that of the entire layer. Our results shows excellent agreement with those obtained by the other two methods (30).

An interesting property of porous silicon is its ability to reduce metallic ions having positive reduction potential with respect to H_2. Thus, these metals can be deposited on the surface of the PSi when it is soaked in their aqueous solutions (immersion plating). However the challenge was to introduce the metals into the pores and thus fill them with the reduced metals. Using a combination of working conditions and solution composition we succeeded to reduce gold and silver inside the pores (29). Deposition of silver nanoparticles on PSi created surface enhanced Raman scattering active substrate, on which extremely low concentrations of two organic compounds could be detected (16).

7. <u>Carbon-dots: formation, doping and applications</u>

Carbon dots (C-dots), or fluorescent quantum dots, are the latest discovered form of carbon nanostructures which exhibit superior optical properties and biocompatibility. Therefore they were widely investigated for applications in various fields. Among several routes of preparation, we focused mainly on the sonochemical formation of plain or doped C-dots in liquids such as PEG 400 (33) or aqueous BSA (37). Thus, Ga- and Sn-doped (Ga@C-dots and Sn@C-dots) were prepared by one-step sonochemical procedure (22). Plain and doped C-dots were examined as electrode materials (36, 49), anticacterial agents (42) and polymerization catalyst (45). Composites of doped C-dots were also prepared: Sn@C-dots/TiO_2 was examined as an improved photocatalyst (43), and the interactions of Ga-doped C-dots on Ga nanoparticles (Ga@C-dots@Ga NPs) (44) and of N-doped C-dots on γ-Fe_2O_3 particles (NCDs/γ-Fe_2O_3) (46) with neural cells were studied.

8. <u>Chiral separation by microsphere</u>

Two approaches of chiral separation with sonochmically-formed particles were investigated: a) Formation of gallium particles in aqueous solution of one enantiomer of a chiral compound, creating templates of that enantiomer on the surface of the particles. Separation of these particles and soaking them in a racemic solution created an excess of the other enantiomer in the solution (25). b) Microspheres of proteins, such as bovine serum albumin (BSA) or avidine, exhibit various rates of chiral separation of amino acids. Enantiomeric excess of 59% for cysteine and 41 % for phenylalanine. were measured using BSA and avidine particles, respectively (41).

9. Miscellaneous synthetic works

9.1. Green synthesis of gold nanoparticles u

Gold nanoparticles (GNPs) were prepared using four different plant extracts as reducing and stabilizing agents. The GNPs showed good biocompatibility and stability for over 3 weeks. Therefore, they can be used for imaging and drug-delivery in the human body. The active ingredients in the plant extract that might be involved in the formation of GNPs were proposed, based on experiments with pure antioxidants that are known to exist in that plant (20).

9.2. Synthesis and characterization of new ternary yttrium-rare earth sesquioxided

Several groups, each of three compounds which include yttrium and two lanthanide elements in different compositions (such as Y_2EuErO_6, YEu_2ErO_6 and $YEuEr_2O_6$) were prepared by the sol-gel method. The products were in the hydroxide forms and were oxidized while heated at 900ºC and 1500 ºC. X-ray diffraction patterns of the crystals were analyzed by the Rietveld's method and showed that the cell parameters and the peak intensities changed with the composition and the temperature (28).

9.3. Formation of silver and copper particles and their oxides.

Ultrasonic irradiation of suspensions of Ag and Cu salts, suspended in Si oil, led to the formation of the metals and the oxide forms Ag_2O and Cu_2O. Local heating, caused by the acoustic cavitation, enhanced the thermal decomposition of the salts and the formation of metallic particles. It was also found that the presence of silver particles enhances the formation of metallic copper (47).

9.4. Sonochemical synthesis of $CH_3NH_3PbI_2$ perovskite nanocrystallites

This compound is considered as a very clean and cheap component in solar cells, which is usually obtained in the form of thin films. In our work, sonicating together solutions of the two components, CH_3NH_3I and PbI_2, in isopropanol yielded fine powder of the product, composed of 10-40 nm polygonal crystallites. These can be deposited on cathodes for use in solar cells (35).

- **Present academic activities**

(a) Research in progress

Determination of the porosity of porous materials by SEM-image processing.
Properties and applications of metal-filled porous silicon.
Ultrasonically formation of C-dots.
Chemical analysis of latent fingermarks.
Synthesis and characterization of new ternary yttrium and rare-earth oxides.
Composition and characterizatioin of fingermarks
Development and validation of analytical methods.