

Laboratory of Inorganic Chemistry, NKUA & Laboratory of Sol-Gel, Institute of Nanoscience and  
Nanotechnology, NCSR D

**Project Leaders:** Dr.Eleni K. Efthimiadou and Dr. G. Mitrikas

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Dr. Eleni K. Efthimiadou completed her MSc and PhD at the University of Athens (Greece) in the domain of Chemistry in collaboration with NCSR "D" and dealt with the synthesis, characterization and biological evaluation of organic and inorganic compounds. Her phd funded by the NCSR "Demokritos". The synthetic compounds, organic or inorganic, had been biological evaluated as potential new drugs, MRI contrast agents and about their antimicrobials and anticancer activity. Her work was awarded in different conferences about pharmaceutical chemistry. She worked for 9 years as a postdoctoral fellow at the Sol-Gel Laboratory, Institute for Nanoscience and Nanotechnology of NCSR "Demokritos" at Athens, Greece, in the domain of Nanotechnology as potential Drug Delivery Systems (DDS) and other applications. In parallel, a second MSc was acquired in the domain of Chemistry, in the field of Catalysis and Environmental Chemistry, in The Open University of Greece, Patra, Greece. She successfully developed smart polymeric nanocontainers (NCs) based on their specific functionalization. The fabricated NCs exhibit different sensitivities such as pH, Thermo and Redox or combination of them. The NCs were modified with Magnetic Nanoparticles (MNPs) with target moieties, peptides and small molecules as well as coated with different biocompatible (polyethylene Glycol, PEG) and biodegradable polymers (Polylactic Acid, PLA). She also works on the polysaccharides as advanced coated material inducing specific pH, Thermo and Redox properties in this domain. She has experience in peptidic synthesis in solid and solution phase also. She also works in the domain of inorganic nanoparticles like gold, iron and other nps as potential theranostic systems. In this laboratory, she advanced her skills to characterize the fabricated NCs both, structural and morphological. For the NCs characterization, I learn to use and to estimate the result of the X-ray diffraction (XRD), Scanning and Transmission electron microscopy (SEM & TEM), thermogravimetric analysis (TGA) and others. She is an expert on in vitro and in vivo evaluation of materials. During this period, she has published 52 papers, in the majority of which she is the corresponding author. Her h-index is 19 and the published papers has 1250 citations. She co-authored three book chapters and co-supervised of 12 master and 6 Ph.D. candidates. She is a member of the cost action Radiomag TD-1402. Currency was elected as

Ass. Prof. In Inorganic Chemistry-bioinorganic chemistry, at Chemistry Department of University of Athens. Her work in the field of nanomedicine awarded by L 'Oreal-Unesco institution for Woman in Science

**Post Docs:** Dr. M. Krrokidis

**PhD Candidates:** M. Theodosiou, T. Koutsikou, E. Michailidi, D. Prokopiou, M. Kakou, . Bousis, A. Stavropoulou

**External Collaborators:** Dr. A. Laurenzana, Senior Researcher presso University of Florence, Florence, Italy

Dr E. Favvas, researcher A', INN, NCSR D

Dr. G. Mitrikas, Researcher B, NCSR D

Dr. Beata Kalska-Szostko, University of Bialystok · Institute of Chemistry

Dr. N. Boukos, Researcher A', INN, NCSR D

Dr. P. Bouziotis, Researcher A', INRASTES, NCSR D

Dr. D. Vourloumis, Researcher A', IRRP, NCSR D

Dr. Simo Spassov, Head of the Environmental Magnetism laboratory, Royal Meteorological Institute of Belgium - Chair of COST Action TD1402

Dr. Pr. Simona Miclaus, "Nicolae Balcescu" Land Forces Academy, Sibiu, Romania Technical Sciences

Dr. P. Neofytou, Researcher A', INRASTES, NCSR D

Dr. Oli Gobbo, Trinity University, Ireland

Pr. Triantafyllos Stylianopoulos, University of Cyprus, Department of Mechanical and Manufacturing Engineering

Dr. Nazende Günday Türeli, MJR PharmJet GmbH, Saarbrücken und Umgebung, Deutschl and Nanotechnologie

**Sol-Gel Lab deals** with synthesis, characterization and *in vitro* and *in vivo* biological evaluation of nanostructured materials. The main aim of our laboratories is to evaluate the fabricated materials about their biocompatibility, efficacy and targetability. For this reason we produced different *in vitro* and *in vivo* protocols. Sol-gel lab activities include:

1. Synthesis and characterization of polymeric materials for biological, environmental and pharmaceutical applications.
2. Synthesis and characterization of inorganic materials as diagnostics and biosensors.
3. Evaluation of materials' toxicity *in vitro* and *in vivo*
4. Antimicrobial behavior of nanocomposites, small molecules and composites

**Techniques:**

1. Structural Characterization: Raman, FT-IR (For materials, liquids, surfaces), GPC and BET.
2. Thermal properties: Study of hydrodynamic diameter in relation to temperature, LCST determination
3. Optical properties: UV-vis
4. Heavy metals and determination of purity (ICP). Evaluation of COD and BOD.
5. Dynamic light scattering (DLS): Evaluation of hydrodynamic diameter  $D_h$  and Surface zeta potential vs pH, temperature and other conditions. Determination of aggregation point and stability.
6. Hyperthermia system by using alternate magnetic field
7. Toxicity studies: 1. Colorimetric assay in Healthy and diseased cells (assays: MTT, XTT, HDL), 2. Wound healing assay and materials entrapment in cells. 3. Oxygen radicals determination vis Eliza.
8. Antimicrobial studies in different microorganisms (gram positive and gram negative): MIC,  $OD_{600}$ , Disc diffusion assay, colorimetric techniques.
9. Fluorescent microscopy : In vitro and in vivo staining studies of different tissues.
10. In vivo toxicology studies in healthy and diseased mice.

#### **Awards**

- Best Women in Science by L' Oreal-Unesco institution, 2016.
- First award in the International conference: from nanoparticles and nanomaterials to nanodevices and nanosystems. Smart Nanoparticles as new Drug Delivery Systems: Bioapplications, was selected as the Crete, Greece, 26-29 June, IC4N 2011 receiving 1000 \$.
- Award as the most cited paper in the 2006-2009 period of the Journal of Bioorganic and Medicinal Chemistry Letters. "Crystal structure, spectroscopic, and biological study of the copper(II) complex with third-generation quinolone antibiotic sparfloxacin".
- Second place Award for better poster presented at "The 9th Conference of Medicinal Chemistry: Drug Discovery and Design". March 26-28, 2008. University of Patras, Patras, Greece. «New Contrast Agents for Magnetic Resonance Imaging Targeting Cancer Cells».
- Scholarship from the Institute of Physical Chemistry of the NCSR "Demokritos" for postgraduate studies (PhD thesis). 2004-2006.

#### **Projects**

- 3/04 to 6/04: Research in Paramagnetic Organometallic Compounds of Rare Earth Elements and study of these compounds in health, Program Frame: "E-1094".
- 2007 -2009: Research in MRI Contrast Agents, Program Frame: «PEP Attikis, 1.2, Action 1.2.1».
- 2007-2009: Research in Drug Delivery Systems, "Nanoscale Functionalities for Targeted Delivery of Biopharmaceutics", 'NMP' INTEGRATED PROJECT, Contract No. NMP4-CT-2006-026723. European Union Program Frame.
- 2009-2013: Research in Nanobiopharmaceutics, "IDEAS –NANOTHERAPY". A novel nano-container drug carrier for targeted treatment of prostate cancer.
- 2013-2015: ERC PoC: A Novel Nanocontainer drug carrier for targeted treatment of cancer

- 2014-2016: Marine Paint: Collaboration 2011 Novel Self-Healing Eco-friendly Coatings with Antifouling and Anticorrosion Properties for Maritime Applications
- 2014-2016: Colonovrec Greek-China 2012 “Linear-focus concentrating solar collector based on a novel receiver -Development and demonstration”.
- 01/07/2014-18. Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy (RADIOMAG)-TD1402, [http://www.cost.eu/COST\\_Actions/TDP/Actions/TD1402](http://www.cost.eu/COST_Actions/TDP/Actions/TD1402).
- 2014-2016: PABET 2013: Interior wall protection technology development for water heaters with Sol-Gel method
- 2016-2017: Establishing a multidisciplinary and effective innovation and entrepreneurship hub.
- 2016-2017: Laboratory of physicochemical analysis, sol-gel lab, NCSR D.
- 2017-2020: Treat “Development of animal models for the diagnosis and treatment of the atheromatic plaque”, GRST, Greece.

#### **Participation in Conference committees**

- Organizer of 5th Hellenic Forum For Science, Technology and Innovation, Nanomedicine: The present and future in personalized therapy, Athens 5-07-2017, Greece.
- Organizer of Radiomag Training School, about “Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy”, TD-1402, Athens 21-24 November, 2017, Greece.
- Member of the Scientific Committee of 13th PAINTS SYMPOSIUM, 15-16 March 2018, Athens, Greece.

#### **Referee/Editor/editorial board in international journals**

##### **Referee**

- Journal of Nanoparticle research, European journal of Medicinal Chemistry, Materials Science and Engineering C, Journal of Surfaces and Interfaces B: Biointerfaces, Journal of materials science and engineering C, Inorganica Chimica Acta, Polyhedron, Colloids and interface sciences, Energy Conversion & Management

##### **Textbooks and special volumes Editor**

- Self-Healing Coatings for Corrosion Protection of Metals-The Sol-Gel Handbook - Synthesis, Characterization, and Applications: Synthesis, Characterization and Applications, 3-Volume Set, George Kordas and Eleni K. Efthimiadou, 2015, doi:10.1002/9783527670819.ch44.
- Polysaccharides: Bioactivity and Biotechnology, Modified polysaccharides for drug delivery (Book Chapter) Efthimiadou, E.K., Metaxa, A.F., Kordas, G.K., 2015, pp. 1805-1835.
- Handbook of Small Animal Imaging: Preclinical Imaging, Therapy, and Applications Hardcover –September, 2015, ISBN-13: 978-1466555686 ISBN-10: 1466555688. Efthimiadou E.K., Kordas G., Book Chapter 17, Molecular targets and optical probes.

- Stimuli Responsive Polymeric Nanocarriers for Drug Delivery Applications: Types and triggers, Chapter 20: Responsive biopolymer carriers for drug delivery applications, 2017, Elsevier.

### Selected Papers

1. "Synthesis of novel quaternary silica hybrid bioactive". A., Angelopoulou, **E.K. Efthimiadou\***, G., Kordas, J. Biomed. Mater. Res. B Appl. Biomater., 106(1), (**2018**), 112-120.
2. "Purine 5',8-cyclo-2'-deoxynucleoside lesions: formation by radical stress and repair in human breast epithelial cancer cells" M.G., Krokidis, M.A., Terzidis, E.K.Efthimiadou, D., Kletsas, C. Chatgililoglu, Free Rad. Res., 51(5), (**2017**), 470-482.
3. "Versatile quarto stimuli nanostructure based on Trojan Horse approach for cancer therapy: Synthesis, characterization, in vitro and in vivo studies", **E.K.Efthimiadou\***, E., Fragogeorgi, L., Palamaris, T., Karampelas, P., Lelovas, G., Loudos, C., Tamvakopoulos, N., Kostomitsopoulos, G., Kordas, Mater. Sci. Eng. C., 79, (**2017**), 605-612.
4. "Sustained release profile of quatro stimuli nanocontainers as a multi sensitive vehicle exploiting cancer characteristics". C., Tapeinos, **E.K. Efthimiadou\***, N., Boukos, G. Kordas. Colloids. Surf. B Biointerfaces, 148, (**2016**), 95-103.
5. "Microspheres as therapeutic delivery agents: Synthesis and Biological evaluation of pH responsiveness". C., Tapeinos, **E.K., Efthimiadou\***, N., Boukos, A., Koklioti, C., Charitidis, G., Kordas\*. J. of Mat. Chem. B. 1 (2), (**2013**), 194-203.
6. "Synthesis and characterization of novel natural product-Gd(III) MRI contrast agent conjugates". **E.K. Efthimiadou**, M. E. Katsarou, M. Fardis, C. Zikos, E.N. Pitsinos, A. Kazantzis, L. Leondiadis, M. Sagnou, D. Vourloumis. Bioorg. Med. Chem. Lett. 18 (23), (**2008**), 6058-6061.
7. "Structure and biological properties of the copper(II) complex with the quinolone antibacterial drug N-propyl-norfloxacin and 2,2'-bipyridine" E.K., Efthimiadou, H. Thomadaki, Y. Sanakis, C.P. Raptopoulou, N. Katsaros, A. Scorilas, A. Karaliota, G.L. Psomas. J. Inorg. Biochem. 101, (**2007**), 64-73.
8. "A Novel Copper(II) Complex of N-propyl-norfloxacin and 1,10-phenanthroline with enhanced Antileukemic and DNA nuclease activities". M. E. Katsarou, **E.K., Efthimiadou**, G. Psomas and D. Vourloumis\*. J. of Med. Chem. 51(3), (**2008**), 470-478.

### Invited presentations to peer-reviewed, internationally established conferences

- *Paramagnetism in Drug Delivery Systems: Bioapplications*. 4th North America-Greece-Cyprus Workshop on Paramagnetic Materials, 14-18 June **2011**, Patras, Greece. (15 min)
- Smart Nanoparticles as new Drug Delivery Systems: Bioapplications, IC4N, 26-29 June, **2011**, Crete, Greece.
- *Multi responsive targeting microcontainers as drug delivery systems: Release and cytotoxicity studies*. Nano 2012 XI International Conference on Nanostructured Materials, 26-31 August **2012**, Rhodes, Greece.

- In-vitro release study and dynamic in-vivo imaging of pH- and Magnetic field sensitive hybrid microspheres. Eleni Efthimiadou, NCSR Demokritos, Greece. International Conference on Nanotheranostics (ICoN 2013), 27-29 September, **2013**, Cyprus.
- *Quattro Stimuli Microspheres as a Versatile Drug Delivery System: Release Properties, In-vivo and In-vitro Study*. 6th North America-Greece-Cyprus Workshop on Paramagnetic Materials, 3-6 June **2015**, Athens, Greece. (15 min)
- *Quattro targeted Stimuli Nanocontainers: In-vitro and in vivo study*, Efthimiadou Eleni, Eleni Efthimiadou, NCSR Demokritos, Greece. International Conference on Nanotheranostics (ICoN 2015), 29-1 November, **2015**, Cyprus.
- In vitro and in vivo application of hyperthermia against glioblastoma by using modified iron NPS. 1st Workshop on Synthesis and functionalisation of magnetic nanoparticles for hyperthermia and radio-therapy UCL, London, 21st and 22nd April, **2016**, (15 min).
- E. Efthimiadou, Trinity College, Dublin: St. James Hospital, November 2017. (A. Prima Mello);
- E. Efthimiadou, School of Pharmacy & Pharmaceutical Sciences (O. Gobbo), November 2017.
- E. Efthimiadou, Department of Biomedical and Clinical Science "Mario Serio", University of Florence, Italy (A. Laurenzana), March 2018.

**Cost Actions Invited presentations to peer-reviewed, internationally established conferences**

1. Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy (RADIOMAG)-TD1402, **2014-18.**, [http://www.cost.eu/COST\\_Actions/TDP/Actions/TD1402](http://www.cost.eu/COST_Actions/TDP/Actions/TD1402)
2. Multi-Functional Nano-Carbon Composite Materials Network (MultiComp), **2015-2019**, <http://www.multicomp-ca15107.eu>
3. Cancer nanomedicine - from the bench to the bedside, CA COST Action CA17140, **2018-2022**, Nano2clinic.

**Patents**

1. George Kordas, Eleni Efthimiadou, Multi-responsive targeting drug delivery systems for controlled-release pharmaceutical formulation WO 2015074762 A1. WIPO Patent Application WO/2015/074762.
2. Λειτουργικά αποκρινόμενα σε πολλαπλά ερεθίσματα πολυμερικά νανοδοχεία-μικροδοχεία ως συστήματα μεταφοράς φαρμάκων.  
Αρ. διπλώματος Ευρεσιτεχνίας: 1007882
3. Επιφανειακώς τροποποιημένα πολλαπλώς αποκρινόμενα σε ερεθίσματα νανο/μικρο-δοχεία ως φορείς φαρμάκων για στοχευμένη θεραπεία διαφόρων μορφών καρκίνου. Αρ. διπλώματος Ευρεσιτεχνίας: 100654

## Lab Photo

### Characterization equipment



### In vitro evaluation equipment

