UNIVERSITY OF CRETE
School of Science & Technology

Department of Materials Science & Technology
www.materials.uoc.gr

Academic Year 2010-2011

The Department of Materials Science & Technology prepares future professionals in the complex interdisciplinary field of materials. The undergraduate program combines the basics of physics, chemistry, biology and mathematics in the first year, and then focuses on the preparation, properties, use and applications of different classes of materials. In parallel, a competitive graduate program at the forefront of materials research, offers advanced degrees (Masters and PhD).

The department at a glance:

First year of operation:	2001
Undergraduate students:	500
Graduate students:	25
Administrative personnel:	4
Technical staff:	5
Faculty:	16 + 2 to be appointed
Visiting faculty (teaching):	15

Location: Heraklion academic campus (housed in 5 buildings)
Main secretarial office: Physics building (ground floor)

Research:

The following fields reflect current research interests of the faculty:

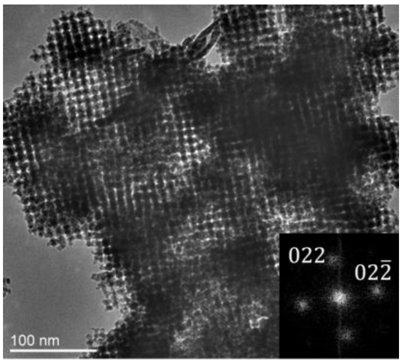
Biomaterials
Colloid and Polymer Science
Computational Materials Science
Magnetic materials
Optoelectronics
Materials Chemistry

In the following, short profiles of faculty are presented.

Gerasimos Armatas

Position: Assistant Professor
PhD: 2003, University of Ioannina, chemistry
Research interests: Nanostructured materials, Semiconductors, Mesoporous, Chalcogenides, Polyoxometalates, Catalysis
Major awards/appointments: EU Marie Curie IRG Fellow (2008-2012)
Teaching: Inorganic Chemistry, Materials Chemistry Laboratory, Transmission Electron Microscopy, Solid Materials
Research highlight:

Intending to fabricate advanced materials with desired emergent properties, we assemble multi-functional mesostructures using pre-organized nanocomposites or clusters, such as the metal-oxide compounds and polyoxometalates. As an example, we report the synthesis of highly ordered mesoporous frameworks consisted of nanocrystalline Co_3O_4 and Keggin-type 12-tungstophosphoric acid ($H_3PW_{12}O_{40}$, HPW) compounds using hard-templating method. These materials can incorporate different functionalities into the composite structure, such as mesoporosity and physicochemical characteristics of Co_3O_4 and HPW components. The resulting materials feature a Co_3O_4/HPW solid solution structure in three-dimensional cubic symmetry with large internal BET surface area (87-141 m^2g^{-1}) and narrow sized pores (*ca.* 4 nm). The Keggin structure of the incorporated $[PW_{12}O_{40}]^{3-}$ clusters within the mesoporous frameworks was confirmed with high-resolution TEM, diffused scattering and atomic pair distribution function (PDF) analysis, XPS, FT-IR and diffuse-reflectance UV/vis spectroscopy. Catalytic studies have indicated that these Co_3O_4/HPW composites can be effective catalysts, exhibiting remarkable catalytic activity on direct decomposition of N_2O into N_2 and O_2.



TEM and FFT image of mesoporous Co_3O_4/HPW (15 wt% in HPW) taken along the [100] direction of body-centered cubic structure. (Armatas et al., *Chem. Mater.*, 2010, **22**, 5739).

Selected publications:

1) G.S. Armatas, G. Bilis and M. Louloudi. “Highly Ordered Mesoporous Zirconia-Polyoxometalate Nanocomposite Materials for Catalytic Oxidation of Alkenes”, *J. Mater. Chem.*, **22**, 2997 (2011).

2) G.S. Armatas, A.P. Katsoulidis, D.E. Petrakis, P.J. Pomonis, M.G. Kanatzidis. “Nanocasting of Ordered Mesoporous Co_3O_4-based Polyoxometalate Composite Frameworks”, *Chem. Mater.*, **22**, 5739 (2010).

3) G.S. Armatas, A.P. Katsoulidis, D.E. Petrakis, P.J. Pomonis. “Synthesis and Acidic Catalytic Properties of Ordered Mesoporous Alumina-Tungstophosphoric acid Composites”, *J. Mater. Chem.*, **20**, 8631 (2010).

4) G.S. Armatas and M.G. Kanatzidis. “Size Dependence in Hexagonal Mesoporous Germanium: Pore Wall Thickness versus Energy gap and Photoluminescence”, *Nano Lett.* **10**, 3330 (2010).

5) N. Ding, G.S. Armatas and M.G. Kanatzidis. “Metal Inorganic Frameworks: Dynamic Flexible Architecture with Extended Pore Order Built from $[Se_3]^{2-}$ Linkers and $[Re_6Se_6Br_8]^{2-}$ Clusters”, *J. Am. Chem. Soc.*, **132**, 6728 (2010).

Maria Chatzinikolaidou

Position: Assistant Professor
PhD: 2004, Univ. of Essen, biochemistry
Research interests: Biological testing of biomaterials, osteogenesis, bone tissue engineering
Major awards/appointments: EU ENTER post-doctoral fellowship (2006-2008)
Teaching: Composite biomaterials, scaffolds and stem cells in tissue engineering, bone repair, cell adhesion
Research highlight:
Growth of bone marrow mesenchymal stem cells on novel composite biomaterials (in collaboration with Prof. M. Vamvakaki, Dr. M. Farsari, Prof. H. Papadaki)

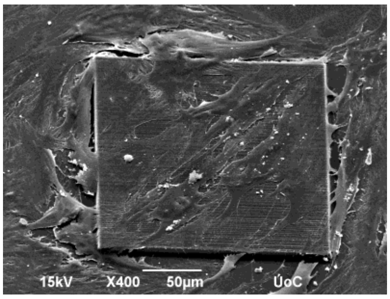


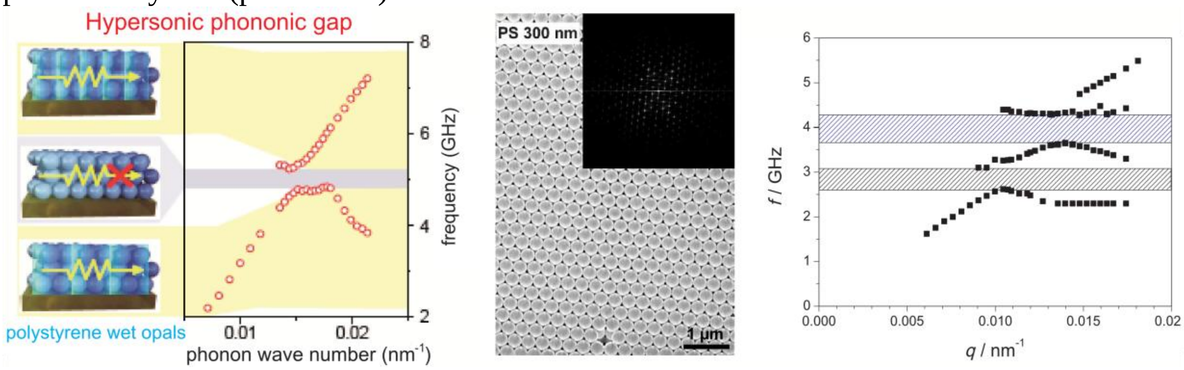
Figure: Growth and proliferation of bone marrow stem cells on an organic-inorganic material surface shown by scanning electron microscopy

Selected publications:

1) M. Chatzinikolaidou, T. K. Lichtinger, R.T. Müller, and H.P. Jennissen, "Peri-Implant Reactivity of Reversibly Immobilized rhBMP-2 on Titanium Carriers", *Acta Biomaterialia* **6**(11), 4405 (2010)
2) S. Zhang, G. Wang, X. Lin, M. Chatzinikolaidou, H.P. Jennissen, and H. Uludag, "Polyethylenimine-Coated Albumin Nanoparticles for BMP-2 Delivery", *Biotechnol. Prog.* **24**(4), 945 (2008)
3) M. Laub, M. Chatzinikolaidou and H.P. Jennissen, "Aspects of BMP-2 Binding to Receptors and Collagen: Influence of Cell Senescence on Receptor Binding and Absence of High-Affinity Stoichiometric Binding to Collagen", *Materialwiss. Werkstofftech.* **38**(12), 1019 (2007)
4) J. Becker, A. Kirsch, M. Schwarz, M. Chatzinikolaidou, D. Rothamel, V. Lekovic, and H.P. Jennissen, "Bone Apposition to Titanium Implants Biocoated with Recombinant Human Bone Morphogenetic Protein 2 (rhBMP-2). A Pilot Study in Dogs", *Clin. Oral. Invest.*, **10**(3), 217 (2006)
5) M. Chatzinikolaidou, T. Zumbrink, and H.P. Jennissen, "Stability of Surface enhanced Ultrahydrophilic Metals as a Basis for Bioactive rhBMP-2 Surfaces" *Materialwiss. Werkstofftech.,* **34**(12), 1106 (2003)

George Fytas

Position: Professor, Affiliated faculty FORTH-IESL, External Member of Max Planck Society (Institute for Polymer Research ,Mainz)
PhD: 1975, Technical University of Hannover, physical chemistry
Research interests: Dynamics and self-assembly (supramolecular polymers, colloids), instrumentation (light scattering and laser interactions), soft phononics.
Major awards/appointments: Humboldt Research Award (2002), APS Fellow (2004), Invited professor University of Lille (2009), Regional Editor of Colloid Polymer Science (1994-2006)
Teaching: Thermodynamics, Polymer physics (statics, dynamics)
Research highlight:
Manipulation of Phonons by Mesoscopic Engineering of Soft Matter: Colloid and polymer science offer methods to create novel materials that are characterized by periodic variations of density and elastic properties at mesoscopic length scales commensurate with the wavelength of hypersonic phonons. This allows for the design of materials with specified phonon dispersion relations based on theoretical modelling of wave propagation. We recently extended the decade-old field to hypersonic phononics realizing for the first time a Bragg-type band gap (2006) and a new band gap (2008) in colloidal glasses, coined hybridization-gap, for which order is not a precondition. Its association with vibration resonance modes of the building units led to the foundation of of particle vibration spectroscopy, a colloidal equivalent of molecular spectroscopy.Structures composed of periodically ordered and internally well-defined colloidal particles act as both hypersonic phononic and visible light photonic crystals (phoXonics).



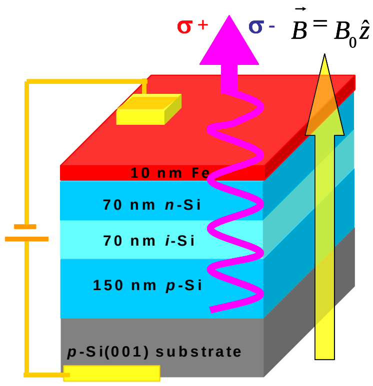
Deaf by design. *One phononic band gap (Bragg) in the dispersion diagram (frequency as a function of wave vector) of the periodic colloidal crystal (infiltrated with a fluid) and one hybridization gap (gray hatched area, right) due to the "music" of the polystyrene (PS) particle (with diameter 300nm, SEM image) (Nat. Mater.* 5,830 (2006),*PRL.* ***100****, 19430).*

Selected publications:
1) R. Sigel, G. Fytas, N. Vainos, S. Pispas and N. Hadjichristidis, Pattern Formation in Homogeneous Polymer Solutions Induced by a Continuous-Wave Visible Laser. *Science* **297**,67 (2002).
2) T. Gorishnyy, C.K. Ullal, M. Maldovan, G. Fytas and E.L. Thomas, Hypersonic phononic crystals. *Phys. Rev. Lett.* **94**,*115501 (*2005) [*Physics Web News* April 9, 2005]
3) W.Cheng, J.J. Wang, U. Jonas, G. Fytas, and N. Stefanou, Observation and tuning of hypersonic bandgaps in colloidal crystals. *Nat. Mater*. **5**,830 (2006) [Views & News Nature Mater.2006, 5,773]
4) T.M. Hermans, M.A.C. Broeren, N. Gomopoulos, P. van der Schoot, M.H. van Genderen, M. N.A. Sommerdijk, G. Fytas and E.W. Meijer, Self-assembly of soft nanoparticles with tunable patchiness. *Nat. Nanotechnol*. **4**,721 (2009)
5) T. Still, M. Mattarelli, D. Kiefer, M. Montagna and G. Fytas, Eigenvibrations of Submicron Colloidal Spheres. *J. Phys. Chem. Lett.* **1**, *2440* (2010).

George Kioseoglou

Position: Associate Professor
PhD: 1999, State University of New York at Buffalo, physics
Research interests: Physics and applications of semiconductor nanostructures, Semiconductor Spintronics, Spin dynamics and transport, Magnetic semiconductors
Major awards/appointments: NRC Fellowship (2004-2006), NRL Alan Berman Research Publication Award (2000,2002,2007)for outstanding work on efficient spin injection in GaAs and Si spin-LEDs
Teaching: Differential Equations I, Magnetic Materials, Spintronics, Solid Materials
Research highlight:

Spin-polarized electrons have been injected from an Fe film through an Al_2O_3 tunnel barrier into silicon, producing a large electron spin polarization in the silicon. The circular polarization of the electroluminescence resulting from radiative recombination in Si tracks the Fe magnetization confirming that these electrons originate from the magnetic contact. The polarization reflects the Fe majority spin. We determine an electron spin polarization of 27% at 5K, with significant polarization extending to at least 125K.



This demonstration is a key enabling step for developing devices which rely on electron spin rather than electron charge, a field known as semiconductor spintronics, and is expected to provide higher performance with lower power consumption and heat dissipation. The complete findings of this study titled, “Electrical spin injection into silicon from a ferromagnetic metal/tunnel barrier contact” are published in the August 2007 issue of Nature Physics.

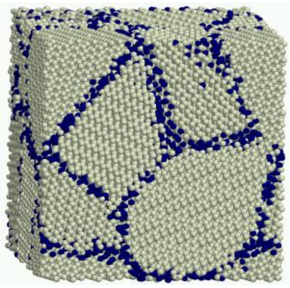
Our research team includes George Kioseoglou, Aubrey Hanbicki, Connie Li, Phillip Thompson, and Berend Jonker. This research is supported by funding from NRL core programs and the Office of Naval Research.

Selected publications:

1) G. Kioseoglou, A.T. Hanbicki, R. Goswami, O.M.J. van’t Erve, C.H. Li, G. Spanos, P.E. Thompson, and B.T. Jonker, “Electrical Spin Injection into Si: a comparison between Fe/Si Schottky and Fe/Al_2O_3 tunnel contacts”, *Appl. Phys. Lett.* **94**, 122106 (2009)
2) G. Kioseoglou, M. Yasar, C.H. Li, M. Korkusinski, M. Diaz-Avila, A.T. Hanbicki, P. Hawrylak, A. Petrou, and B.T. Jonker, “Inteshell exchange and sequential electrically injected spin populations of InAs quantum dot shell states”, *Phys. Rev. Lett.* **101,** 227203 (2008)
3) B.T. Jonker, G. Kioseoglou, A.T. Hanbicki, C.H. Li, and P.E. Thompson, “Electrical Spin Injection into Silicon”, *Nature Physics* **3,** 542 (2007)
4) G. Kioseoglou, A.T. Hanbicki, J.M. Sullivan, O.M.J. van ‘t Erve, C.H. Li, S.C. Erwin, B.T. Jonker, R. Mallory, M. Yasar and A. Petrou, “Electrical Spin Injection from an n-type Ferromagnetic Semiconductor into a III-V Device Heterostruture”, *Nature Materials* **3**, 799 (2004)
5) A.T. Hanbicki, B.T. Jonker, G. Itskos, G. Kioseoglou, and A. Petrou, "Efficient electrical spin injection from a magnetic metal/tunnel barrier contact into a semiconductor", *Appl. Phys. Lett.* **80**, 1240 (2002)

Georgios Kopidakis

Position: Assistant Professor (tenured)
PhD: 1995, Iowa State University, condensed matter physics
Research interests: atomistic simulations for the structural, mechanical, electronic, optical properties of amorphous and nanostructured materials, fundamentals and applications of localization and transfer of nonlinear excitations.
Major awards/appointments: Individual Marie-Curie post-doctoral fellowship (1996-1998).
Teaching: Introduction to Computer Science, Computer Programming, Numerical Analysis, Solid State Physics II: Electronic and Magnetic Properties, Computational Materials Science I and II (Electronic structure), Materials Theory
Research highlight:
Dependence of Mechanical Properties of Nanocrystalline Materials on Grain Size:



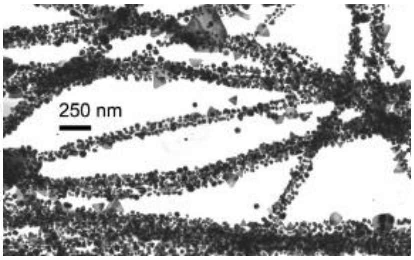
Understanding and controlling nanoscale phenomena is fundamentally interesting and technologically important for the design of materials with tailored properties. The dependence of the mechanical properties of polycrystalline materials on the grain size, when this size is reduced to a few nanometers, is of great interest in this context. We perform atomistic simulations for the structure and elastic properties of several nanocrystalline materials. We observe softening at small grain sizes, in analogy with the reverse Hall-Petch effect for plastic deformations in nanocrystalline metals. The decrease of elastic constants is explained by the increase of the fraction of grain boundary atoms for smaller grains. By decomposing the binding energy into contributions from atoms in the bulk of grains and at interfaces, we derive simple scaling relations for various properties as a function of the average grain size. These theoretical predictions fit very well the simulation data. Our results are for different materials that range from nanocrystalline metals to nanocrystalline diamond suggesting that softening at small grain sizes is a general nanoscale effect (*Status Solidi C*, **7**, 1372, 2010, *Acta Mater.*, **56**, 5340, 2008).

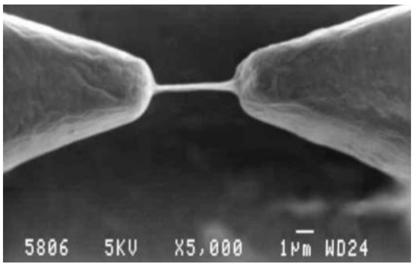
Selected publications:

1) G. Kopidakis, S. Komineas, S. Flach, and S. Aubry, "Absence of Wave Packet Diffusion in Disordered Nonlinear Systems", *Phys. Rev. Lett.*, **100**, 084103 (2008).
2) S. Aubry and G. Kopidakis, "A Nonadiabatic Theory for Ultrafast Catalytic Electron Transfer: A Model for the Photosynthetic Reaction Center", *J. Biol. Phys.*, **31**, 375 (2005).
3) C. Mathioudakis, G. Kopidakis, P.C. Kelires, C.Z. Wang, and K.M. Ho, "Physical Trends in Amorphous Carbon: A Tight-Binding Molecular Dynamics Study", *Phys. Rev. B*, **70**, 125202 (2004).
4) G. Kopidakis, S. Aubry, and G.P. Tsironis, "Targeted Energy Transfer through Discrete Breathers in Nonlinear Systems", *Phys. Rev. Lett.*, **87**, 165501 (2001).
5) G. Kopidakis and S. Aubry, "Discrete Breathers and Delocalization in Nonlinear Disordered Systems", *Phys. Rev. Lett.*, **84**, 3236 (2000).

Anna Mitraki

Position: Associate Professor, Affiliated faculty FORTH-IESL.
PhD: 1986, Université Paris-Sud, Orsay, biochemistry/enzymology
Research interests: The proteins as biomaterials; engineering and design of fibrous biomaterials; self-assembling peptides; protein folding, engineering and production
Major awards/appointments: Academic Editor, PLoS ONE (www.plosone.org, since 2009)
Teaching: Biochemistry and Molecular Biology, Natural Biomaterials, Biomimetic Materials Design (Post-graduate lectures), Biomaterials Laboratory course
Research highlight:
Design and development of bioinspired fibrous materials: Our research focuses on natural biological fibers as models for the design of new materials. We have been involved for a number of years in the rational design, synthesis and characterization of self-assembling proteins and peptides following identification of building blocks in natural fibrous proteins. Of particular interest is the possibility of using these peptide nanofibers and nanotubes as templates for the growth of inorganic materials (metals, semiconductors, silica, etc), templates for biomineralization and tissue engineering, and scaffolds for the production of overexpressed proteins in cell factories. Besides our collaboration with the Laser group at the Institute of Electronic Structure and Laser (IESL) at FORTH, we are also currently engaged in other collaborations with colleagues that develop techniques to manipulate, assemble and position these materials in a controlled manner, in view of their eventual integration in future generations of nanoscale devices.





Left: Peptide fibrils covered with gold nanoparticles (ref.2). Right: peptide fibrils positioned on a polymeric matrix using laser technologies (ref.3).

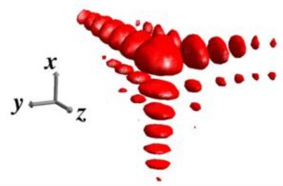
Selected publications:

1) A. Mitraki, "Protein aggregation: from inclusion bodies to amyloid and biomaterials" *Advances in Protein Chemistry and Structural Biology*, **79**, 89 (2010)
2) E. Kasotakis, E. Mossou, L. Adler-Abramovich, V.T. Forsyth, E.P. Mitchell, E. Gazit, and A. Mitraki, "Design of metal-binding sites onto self-assembled peptide fibrils". *Biopolymers –Peptide Science* **92**, 164 (2009).
3) V. Dinca, E. Kasotakis, J. Catherine, A. Mourka, A. Ranella, A. Ovsianikov, B. Chichkov, M. Farsari, A. Mitraki, and C. Fotakis, "Directed three-dimensional patterning of self-assembled peptide fibrils". *Nanoletters*, **8**, 538 (2008).
4) M.J. van Raaij, A. Mitraki, G. Lavigne, and S. Cusack, "A triple beta-spiral in the adenovirus fibre shaft reveals a new structural motif for a fibrous protein". *Nature* **401,** 935 (1999).
5) A. Mitraki, B. Fane, C. Haase-Pettingell, J. Sturtevant, J. King, "Global suppression of protein folding defects and inclusion body formation". *Science*, **253,** 54 (1991).

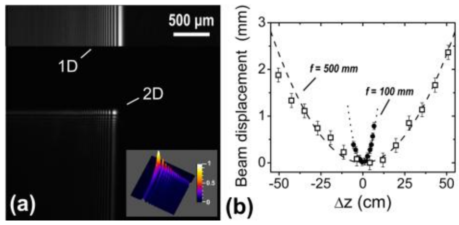
Dimitris Papazoglou

Position: Assistant Professor, Affiliated faculty FORTH-IESL
PhD: 1998, Aristotle University of Thessaloniki, physics
Research interests: nonlinear interactions of ultra-short laser pulses with transparent media, exotic optical waves and light bullets, wavefront sensing and manipulation
Teaching: Introduction to materials Science, Optics and waves, Optics I, Optics II

Research highlight:
Spatio-temporal Airy light bullets in the linear and nonlinear regimes:



Intensity iso-surface of the experimentally realized Airy^3 light bullet (to assist visualization, the *z* axis, time, is stretched by 5 times)



Experimental results for Airy beam generation using the coma aberration

By combining a spatial Airy beam with an Airy pulse in time we have demonstrated the realization of intense Airy-Airy-Airy (Airy^3) light bullets. The Airy^3 light bullets belong to a family of linear spatiotemporal wave packets that do not require any specific tuning of the material optical properties for their formation and withstand both diffraction and dispersion during their propagation. Furthermore, we have show that the Airy^3 light bullets are robust up to the high intensity regime since they are capable of healing the nonlinearly induced distortions of their spatiotemporal profile
D. Abdollahpour, et al., Phys. Rev. Lett. **105**, 253901 (2010),
Papazoglou et al. Phys. Rev. A, **81,** 061807(R) (2010)

Selected publications:

1) G. Stegeman, D. G. Papazoglou, R. Boyd and S. Tzortzakis, *"Nonlinear birefringence due to non-resonant, higher-order Kerr effect in isotropic media."*, Opt. Express **19**, 6387 (2011).
2) D. Abdollahpour, S. Suntsov, D. G. Papazoglou and S. Tzortzakis, *"Spatiotemporal Airy Light Bullets in the Linear and Nonlinear Regimes"*, Phys. Rev. Lett. **105**, 253901 (2010)
3) D. G. Papazoglou, S. Suntsov, D. Abdollahpour, and S. Tzortzakis, *"Tunable intense Airy beams and tailored femtosecond laser filaments"*, Physical Review A, **81,** 061807(R) (2010)
4) D. G. Papazoglou, and S. Tzortzakis, *"In-line holography for the characterization of ultrafast laser filamentation in transparent media"*, Appl. Phys. Lett. **93**, 041120 (2008)
5) D. G. Papazoglou, I. Zergioti , S. Tzortzakis, *"Plasma strings from ultraviolet laser filaments drive permanent structural modifications in fused silica"*, Opt. Lett. **32** (14): 2055 (2007).

Nikos Pelekanos

Position: Professor, Affiliated faculty FORTH-IESL
PhD: 1991, Brown University, physics
Research interests: Third generation solar cells based on semiconductor nanostructures. Efficient light emitting devices, including polariton and hybrid LEDs and lasers. Single photon emitters based on piezoelectric quantum dots.
Major awards/appointments: Solar Innovation 2010 Award (CEA, France).
Teaching: Electromagnetism, Semiconductor Physics, Optoelectronic Devices

Research highlight:
Polarization-resolved single dot spectroscopy performed on piezoelectric (211)B InAs/GaAs quantum dots reveals that the fine structure splitting of the excitonic levels in these dots is much lower compared to the usual (100)-grown InAs dots. Time-resolved measurements confirm the high oscillator strength of these dots, and thus their good quantum efficiency at 4 K, comparable with that of (100) InAs/GaAs dots. Last, photon correlation measurements demonstrate single photon emission out of the excitonic optical transition of these dots. All these features make this novel dot system very promising for implementing solid-state entangled photon sources.

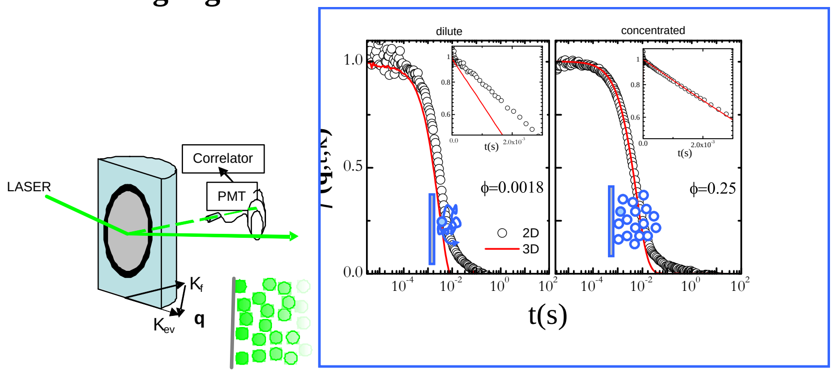
Selected publications:

1) G. E. Dialynas, S. Kalliakos, C. Xenogianni, M. Androulidaki, T. Kehagias, P. Komninou, P. G. Savvidis, Z. Hatzopoulos, N. T. Pelekanos, "Piezoelectric InAs (211)B quantum dots grown by molecular beam epitaxy: structural and optical properties", *J. Appl. Phys.* **108**, 103525 (2010).
2) S. Tsintzos, P. G. Savvidis, G. Deligeorgis, Z. Hatzopoulos, N. T. Pelekanos, "Room temperature GaAs exciton-polariton light emitting diode", *Appl. Phys. Lett.* **94**, 071109 (2009).
3) G. E. Dialynas, G. Deligeorgis, M. Zervos, N. T. Pelekanos, "Internal field effects on the lasing characteristics of InGaN/GaN quantum well lasers", *J. Appl. Phys.* **104**, 113101 (2008).
4) S. Tsintzos, N. T. Pelekanos, G. Konstantinidis, Z. Hatzopoulos, P. G. Savvidis, "A GaAs polariton light-emitting diode operating near room temperature", *Nature* **453**, 372 (2008).
5) J. Simon, N.T. Pelekanos, C. Adelmann, E. Martinez-Guerrero, R. André, B. Daudin, Le Si Dang, H. Mariette, "Direct comparison of recombination dynamics in cubic and hexagonal GaN/AlN quantum dots", *Phys. Rev. B* **68**, 035312 (2003).

George Petekidis

Position: Assistant Professor (tenured), Affiliated faculty FORTH-IESL
PhD: 1997, University of Crete, Department of Physics
Research interests: Soft Condensed Matter with emphasis on Colloids: Dynamics and rheology of suspensions, glasses and gels. Instrumentation combining scattering and rheology.
Major awards/appointments: Individual Marie-Curie post-doctoral fellowship (1999-2001, return type 2002-2003).
Teaching: Materials II: Polymers & Colloids, Introduction to Colloidal Dispersions

Research highlight:



Set-up and evanescent-wave dynamic light scattering of Hard sphere colloidal particles near a wall (*Phys. Rev. Lett.* **102**, 068302, 2009)

We investigate the Brownian motion of hard-sphere colloidal particles near a solid, planar surface, utilizing Evanescent Wave Dynamic Light Scattering (EWDLS). We carried out measurements for various volume fractions of sterically stabilized PMMA hard-sphere suspensions over a range of scattering wave vectors, q, and analyzed the results extracting the short-time diffusivity from evanescent wave scattering data. While in the dilute regime particle diffusion near the wall is significantly slowed down due to particle-wall hydrodynamic interactions as the volume fraction is increased the wall effect on the short--time diffusion is progressively diminished at all q's, below and above the peak of the structure factor. We present a new analysis for the EWDLS short-time self- and collective diffusivities applicable to all volume fractions and a simple model for the self-diffusion which, describing the interplay between the particle-wall and particle-particle hydrodynamic interactions, captures the basic physical mechanism responsible for such behavior. Moreover, a quantitative prediction of the weaker decay of the near-wall self-diffusion coefficient with volume fraction is offered by Stokesian dynamics simulations.

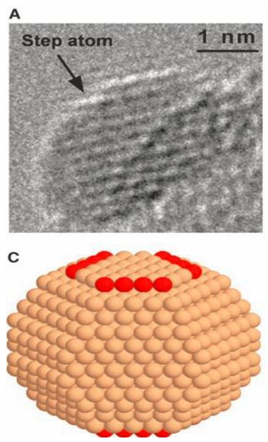
Selected publications:

1) N. Koumakis, A.B. Schofield and G. Petekidis "Effects of shear induced crystallization on the rheology of Hard sphere colloids" *Soft Matter* **4**, 2008 (2008)
2) P. Ballesta, R. Besseling, L. Isa, G. Petekidis and W.C.K Poon "Slip and flow of glassy hard sphere colloidal suspensions" *Phys. Rev. Lett.* **101,** 258301 (2008)
3) G. Brambilla, D. El Masri, M. Pierno, L. Berthier, L. Cipelletti, G. Petekidis, A. B. Schofield "Probing the Equilibrium Dynamics of Colloidal Hard Spheres above the Mode-Coupling Glass Transition" *Phys. Rev. Lett.* **102,** 085703 (2009)
4) R. Besseling, L. Isa, P. Ballesta, G. Petekidis, M. E. Cates and W. C. K. Poon "Shear banding and flow-concentration coupling in colloidal glasses" *Phys. Rev. Lett.*, **105**, 268301, (2010)
5) N. Koumakis and G. Petekidis "Two step yielding in attractive colloids: Transition from gels to attractive glasses" *Soft Matter*, **7**, 2456, (2011)

Ioannis N. Remediakis

Position: Assistant Professor
PhD: 2002, Univ. of Crete, physics.
Research interests: Surface chemistry and catalysis, nanoscience, mechanical properties.
Major awards/appointments: Visiting professor, University of Southern California, USA (7-8/2009); University of Jyväskylä, Finland (6-7/2010).
Teaching: Solid-state physics, Surfaces and nanomaterials, Theoretical Materials Science, Symmetry in materials science, Electronic structure lab.

Research highlight:
In 2005, INR participated in a large collaboration between theorists (led by by J. K. Nørskov of the Technical University of Denmark- DTU, now at Stanford) and R&D people from catalyst manufacturer Haldor Topsoe AS. The project resulted in the first *ab initio* calculation of the ammonia synthesis rate for a commercial catalyst (Honkala et al., *Science* **307**, 558 (2005); *Surf. Sci.*, **600**, 4264 (2006); *Surf. Sci.*, **603**, 1731 (2009)). INR calculated the equilibrium shape of Ru nanoparticles, in good agreement with TEM observations (see figure). The project gained great publicity, and the image of the Ru nanoparticle has been used for nanoscience conference fliers and network logos. The method has been employed since then for various nanomaterials, including Si quantum dots in SiO_2, and is currently the subject of an on-going doctoral thesis.



Selected publications:
1) K. Honkala, A. Hellman, I. N. Remediakis, A. Logadottir, A. Carlsson, S. Dahl, C.H. Christensen and J. K. Nørskov, "Ammonia synthesis from first-principles calculations", *Science*, **307** 558 (2005).

2) I. N. Remediakis, N. Lopez and J. K. Nørskov, "CO oxidation on rutile-supported Au nanoparticles", *Angew. Chem. Int. Ed.* **44**, 1824 (2005).

3) M.G. Fyta, I.N. Remediakis, P.C. Kelires and D.A. Papaconstantopoulos, "Insights into the fracture mechanisms and strength of amorphous and nanocomposite carbon", *Phys. Rev. Lett*, **96**, 185503 (2006).

4) I. N. Remediakis, G. Kopidakis and P. C. Kelires, "Softening of ultra-nanocrystalline diamond at low grain sizes", *Acta Materialia* **56**, 5340 (2008)

5) N. V. Galanis, I. N. Remediakis and G. Kopidakis, "Mechanical Response of Nanocrystalline Materials from Atomistic Simulations", *Physica status solidi c* **7**, 1372 (2010) (+ Journal cover image).

Pavlos Savvidis

Position: Assistant Professor (tenured), Affiliated faculty FORTH-IESL
PhD: 2001, University of Southampton, physics
Research interests: Novel polariton based optoelectronic devices. Ultrafast non-linear interactions in semiconductor and organic microcavities and Bragg structures
Major awards/appointments: Marie-Currie Senior Research Fellow (Univ. of Southampton) 2011. Member of Mediterranean Institute of Fundamental Physics
Teaching: Automation Lab, Materials III -Introduction to Semiconductor Physics, Physics of Semiconductors.

Research highlight:

Publication in Nature Journal, where for the first time we demonstrate polariton LED device that operates up to room temperature. It was independently highlighted in News & Views section of the Nature by one of the leaders in the field Prof. Benoît Deveaud-Plédran of EPFL, as well as in Physics World, Laser Focus World, Chemical & Engineering News, και Ελευθεροτυπία.

Selected publications:

1) A. Askitopoulos, L. Mouchliadis, I. Iorsh, G. Christmann, J.J. Baumberg, M.A. Kaliteevski, Z. Hatzopoulos, P.G. Savvidis, «Bragg polaritons: Strong coupling and amplificationin an unfolded microcavity», Phys. Rev. Lett. 106, 076401 (2011)
2) G. Christmann, A. Askitopoulos , G. Deligeorgis , Z. Hatzopoulos, S. I. Tsintzos , P.G. Savvidis, Oriented polaritons in strongly-coupled asymmetric double quantum well microcavities, J. J. Baumberg, Appl. Phys. Lett. **98**, 081111 (2011)
3) E. Trichas, M. Kayambaki, E. Iliopoulos, N.T. Pelekanos, P.G. Savvidis, Resonantly enhanced selective photochemical etching of GaN, Appl. Phys. Lett. 94, 173505 (2009)
4) S. I. Tsintzos, N. T. Pelekanos, G. Konstantinidis, Z. Hatzopoulos, P. G. Savvidis, A GaAs polariton light-emitting diode operating near room temperature, Nature 453, 372 (2008)
5) P.G. Savvidis, J.J. Baumberg, R.M. Stevenson, M.S. Skolnick, D.M. Whittaker, J.S. Roberts, Angle-resonant stimulated polariton amplifier, Phys. Rev. Lett. 84, 1547 (2000)

Costas M. Soukoulis

Position: Professor (part time), Affiliated faculty FORTH-IESL, Distinguished Professor Iowa State University (Dept. of physics & astronomy)
PhD: 1978, Univ. of Chicago, physics
Research interests: Theoretical modeling of properties of disordered systems, photonic crystals, metamaterials, left-handed materials, random lasers, random magnetic systems, nonlinear systems, and amorphous semiconductors. Complementary experiments on metamaterials and photonic crystals.
Major awards/appointments: Humboldt Research Award (2002), EU Descartes Prize for Research (2005), Fellow APS, OSA, AAAS
Teaching: Modern Physics, Optoelectronics and Photonic Materials

Research highlight:
Tunable Metamaterials in the Terahertz (THz) regime: The principle driving motivation behind metamaterials research is the ability to create materials with highly customized electromagnetic (EM) responses, especially in the THz regime. THz technology has become a hopeful alternative for sensing, imaging, and applications, such as amplifiers, modulators and switches. In this manuscript, for the first time we experimentally demonstrated an optically implemented, by pho-excitation, blue shift tunable metamaterial in the THz regime. This work paves the way for future bi-directional (simultaneously red- and blue-shift) and multi band switchable devices, which especially benefits various important applications in filling the so-called "THz gap." From natural materials, THz response is somewhat rare and one of the advantages of the metamaterials for THz applications is their resonance EM response, which significantly enhances their interaction with THz radiation. In addition, THz radiation has many advantages, such as its non-ionizing property, excellent transmission through optically-opaque materials for imagining applications and ability to detect biochemical molecules and illegal drugs. Thus, electronic devices are pushing their boundaries to the THz regime, where many potential applications exist in different disciplines. (In collaboration with Maria Kafesaki and Stelios Tzortzakis. These results were published in *Phys. Rev. Lett* **106**, 037403 (2011)).

Selected publications:

1) N. H. Shen, M. Massaouti, M. Gokkavas, J. M. Manceau, E. Ozbay, S. Tzortzakis, M. Kafesaki, and C. M. Soukoulis, "Optical implemented broadband blue-shift switch in the terahertz regime," *Phys. Rev. Lett.* **106**, 037403 (2011).
2) C. M. Soukoulis & M. Wegener, "Optical metamaterials: More bulky & less lossy," *Science* 330, 1633 (2010).
3) R. S. Penciu, M. Kafesaki, Th. Koschny, E. N. Economou and C. M. Soukoulis, "Magnetic response of nanoscale left-handed metamaterials," *Phys. Rev. B* **81**, 235111 (2010).
4) J. Zhou, J. Dong, B. Wang, Th. Koschny, M. Kafesaki and C. M. Soukoulis, "Negative refractive index due to chirality," *Phys. Rev. B.* **79**, 121104(R) (2009).
5) J.-M. Manceau, N.-H. Shen, M. Kafesaki, C. M. Soukoulis, and S. Tzortzakis, "Dynamic response of metamaterials in the terahertz regime: Blue shift tunability and broadband phase modulation," *Appl. Phys. Lett.* **96**, 021111 (2010).

Kostas Tokatlidis

Position: Associate Professor, Affiliated faculty FORTH-IESL
PhD: 1993, Univ. of Delaware, chemical engineering
Research interests: cellular biochemistry, mitochondria biogenesis, oxidative protein folding, protein targeting, multiprotein complex assembly, peptide-based mitochondrial targeting
Major awards/appointments: Fulbright fellow (1988), MRC (UK) Career establishment award (2001), Lister (UK) Award and Fellow (2001), Lister Institute Member (2005)
Teaching: Molecular Cellular Biochemistry, Protein Kinesis and Molecular Machines, Proteins in the intracellular environment

Research highlight:

Discovery and molecular characterisation of a *novel oxidative folding* and import pathway in mitochondria biogenesis: Proposal of key concept, discovery of crucial components and new type of import signal, mechanistic analysis of molecular recognition and protein-protein interactions .

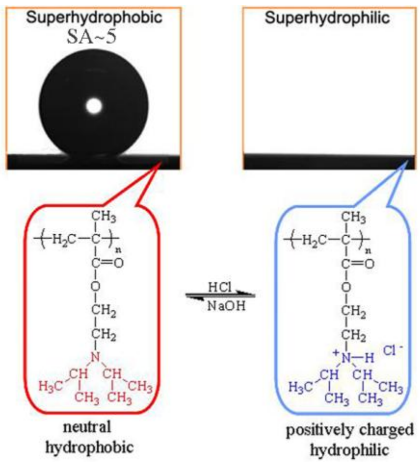
Selected publications:

1) Tokatlidis, K., Junne, T., Moes, S., Schatz, G., Glick, B.S. and Kronidou, N. Translocation arrest of an intramitochondrial sorting signal next to Tim11p, a novel protein of the inner membrane import site. *Nature* **384**, 585-588 (1996)
2) Banci L., Bertini I., Cefaro C., Ciofi-Baffoni S., Gallo A., Martinelli M., Sideris DP, Katrakili N. and Tokatlidis K***** MIA40 is an oxidoreductase catalyzing oxidative protein folding in mitochondria, *Nature Structural and Molecular Biology* **16**, 198-206 (2009)
3) Banci L*., Bertini I*., Calderone, V., Cefaro C., Ciofi-Baffoni S., Gallo A., Kallergi, E., Lionaki, E., Pozidis, C. and Tokatlidis K*. Molecular recognition and substrate mimicry drive the electron transfer process between MIA40 and ALR. *Proc Natl Acad. Sci USA* **108**, 4811-6 (2011)
4) Banci L*., Bertini I*., Cefaro C., Cenacchi, L., Ciofi-Baffoni S., Felli, I.C., Gallo A., Gonnelli, L., Luchinat, E., Sideris D.P. and Tokatlidis K*. A molecular chaperone function of Mia40 triggers consecutive induced folding steps of the substrate in mitochondrial protein import *Proc Natl Acad. Sci USA* **107**, 20190-20195 (2010)
5) Sideris, D.P., Petrakis, N., Katrakili, N., Mikropoulou, D., Gallo, A., Ciofi-Baffoni, S., Banci, L., Bertini, I., and Tokatlidis, K**.*** A novel targeting signal primes precursors for correct cysteine docking onto Mia40 in the mitochondrial intermembrane space *J. Cell Biol.* **187**, 1007-1022 (2009)

Maria Vamvakaki

Position: Assistant Professor (tenured, promoted to Associate level), Affiliated faculty FORTH-IESL
PhD: 1998, Univ. of Sussex, polymer science
Research interests: Materials Chemistry. 'Smart' polymers, surfaces and microgels/hydrogels. Supramolecular assemblies. Biomimetic polymers. Organic-inorganic materials.
Major awards/appointments: "2^{nd} Best Innovation by an Individual Researcher" Award, SPIE Photonics Europe 2010. Treasurer of the Hellenic Polymer Society
Teaching: General Chemistry Laboratory, Soft Matter Laboratory, Materials Chemistry Laboratory, Polymer Synthesis, Soft Matter

Research highlight:
pH-responsive surfaces, reversibly switching between superhydrophilicity and superhydro-phobicity/water repellency have been developed by "grafting from" a pH-sensitive polymer onto a hierarchically micro/nano-structured substrate. The water repellency of the surfaces was qunatified by investigating the restitution coefficient of water droplets bouncing off the surfaces. The water repellent state requires appropriate hydrophobicity of the functionalizing polymer as well as very low values of contact angle hysteresis (*Chem. Comm.* **2010,** *46*, 4136 - 4138). Moreover, the ability of the surfaces to react with biologically active compounds can make them useful in drug delivery, bio-separation, biosensors, enzyme immobilization, etc. Such surfaces could be utilized in micro-lab-on-a-chip devices to separate DNA molecules. Current work involves the development of surfaces that respond to other stimuli like light, temperature, humidity and so on which could open new opportunities regarding their potential applications.

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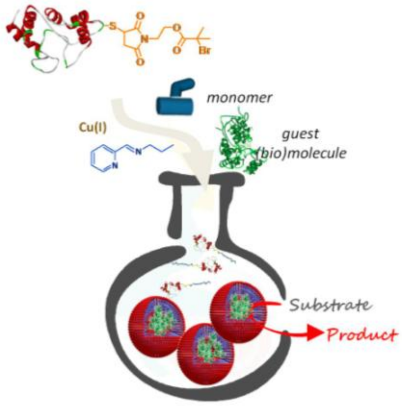
Chemical science news from across RSC Publishing.
Switchable superhydrophobic surfaces
15 June 2010
A surface that can switch between superhydrophobic and superhydrophilic could have important medical implications, claim scientists in Greece.

Selected publications:

1) S. Biggs, K. Sakai, T. Addison, A. Schmid, S. P. Armes, M. Vamvakaki, V. Butun and G. Webber, "Layer-by-Layer Formation of Smart Particle Coatings using Oppositely Charged Block Copolymer Micelles", *Adv. Mater.* **19,** 247 (2007).
2) A. Mateescu, J. Ye, R. Narain and M. Vamvakaki, "Synthesis and Characterization of Novel Glycosurfaces by ATRP", *Soft Matter* **5,** 1621 (2009).
3) D. S. Achilleos and M. Vamvakaki, "Multi-responsive Spiropyran-based Copolymers Synthesized by Atom Transfer Radical Polymerization", *Macromolecules* **43,** 7073 (2010).
4) G. Pasparakis and M. Vamvakaki (invited review), "Multiresponsive polymers: nano-sized assemblies, stimuli-sensitive gels and smart surfaces", *Polym. Chem.* in press (2011).
5) G. Pasparakis, Th. Manouras, A. Selimis, M. Vamvakaki, and P. Argitis, "Laser induced cell detachment and patterning using photodegradable polymer substrates", *Angew. Chem. Int. Ed.* **50,** 1 (2011).

Kelly Velonia

Position: Assistant Professor (tenured).
PhD: 1999, University of Crete, chemistry
Research interests: Biohybrids, Bioconjugation, Polymer Chemistry, Catalysis, Nanotechnology, Supramolecular/Hierarchical Assembly, Single Molecule Catalysis.
Major awards/appointments: Outstanding Emerging Investigator in Materials Chemistry (RSC, 2007). Assistant Professor, Department of Organic Chemistry, University of Geneva (2004-2007). EU Marie-Curie post-doctoral fellowship (2002-2004). Europa Medal and Prize, SET for EUROPE/Chemistry (2002).
Teaching: General Chemistry, Organic Chemistry, Bioorganic Nanostructures, Biomaterials.



Research highlight:

The first ATRP-mediated *in situ* preparation of giant amphiphiles was recently accomplished (*Scheme*, *Angew. Chem., Int. Ed*., 47, 6263 (2008)). The *in situ* creation of such chimeric systems allowed the one-pot hierarchical incorporation of other species and the formation of superstructures that are permeable and can be used as nanoreactors. Our current efforts are focused on the full exploitation of the, *grafting from*, ATRP technique for the preparation of functional bioconjugates and multienzyme nanoreactors (2 papers submitted) and on the development of a new -green- *grafting from* synthetic approach aimed at biocompatible and biodegradable giant amphiphiles (1 paper in preparation).

Selected publications:

1) K. Velonia,* O. Flomenbom, D. Loos, S. Masuo, M. Cotlet, Y. Engelborghs, J. Hofkens,* A.E. Rowan,* J. Klafter, R.J.M. Nolte and F.C. de Schryver, "Single-enzyme kinetics of CALB-catalyzed hydrolysis", *Angew. Chem., Int. Ed.*, **44**, 560, (2005) *[front cover]*.

2) G. Mantovani, F. Lecolley, L. Tao, D.M. Haddleton, J. Clerx, J.J.L.M. Cornelissen and K. Velonia, "Design and synthesis of N-maleimido-functionalized hydrophilic polymers via copper-mediated living radical polymerization: A suitable alternative to PEGylation chemistry", *J. Am. Chem. Soc.*, **127**, 2966 (2005).

3) B. Le Droumaguet, Mantovani, G., Haddleton, D.M. and K. Velonia,* "Formation of giant amphiphiles by post-functionalization of hydrophilic protein-polymer conjugates", *J. Mater. Chem.*, 17, 1916 (2007). *[Outstanding Emerging Investigator in Materials Chemistry Issue]*

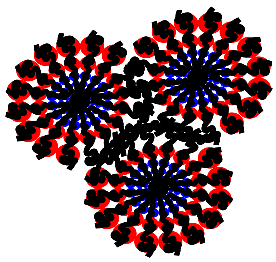
4) B. Le Droumaguet, K. Velonia,* "In situ ATRP mediated hierarchical formation of nanoreactors", *Angew. Chem., Int. Ed*., 47, 6263 (2008).

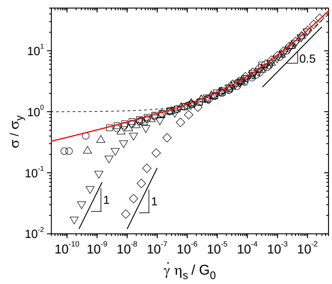
5) K. Velonia, "Protein-polymer amphiphilic chimeras: Recent advances and future applications", Polymer Chemistry, 1, 944 (2010). *[Invited Review]*

Dimitris Vlassopoulos

Position: Professor, Affiliated faculty FORTH-IESL
PhD: 1990, Princeton University, chemical engineering
Research interests: Molecular rheology, rheo-physics, branched polymers, soft colloids, interfacial rheology, dynamic arrest, nonlinear shear / extension.
Major awards/appointments: Co-editor Rheologica Acta (2006-). Michelin Visiting Professor ESPCI 2009.
Teaching: Polymer physics (statics, dynamics), transport phenomena in materials science, thermodynamics

Research highlight:
Multiarm star polymers are representative of a large class of soft hairy colloids, which interpolate between polymers and colloids. By selecting the number and size of arms, it is possible to tune their interaction potential from hard-sphere-like (many small arms) to polymer-like (few long arms). This has implications on their structure and macroscopic properties, which encompass both polymeric and colloidal features. As such, they exhibit an extremely rich, and often unique behaviour. What sets them apart from other colloidal particles such as hard spheres or microgels is the inter-penetrability of their arms at high volume fractions (left cartoon). Further, in the dense state they react to osmotic forces by deforming/squeezing like microgels, unlike hard spheres. The right figure depicts the response of a dense star suspension to steady shear, plotted a shear stress against shear rate (normalized quantities). Symbols refer to different concentrations, increasing from lower values at low rates (slope of 1 indicates liquid). Highest concentrations collapse onto the red curve in the glassy state, which for these stars is very different from the conventional colloidal one in this representation (dashed line, the so-called yield-stress region). At high rates all data exhibit universal colloidal behaviour with slope 0.5 (Erwin et al, *Soft Matter*, **6**, 2825, 2010). The ultimate goal is to tailor the rheology by molecular design.





Selected publications:

1) B. M. Erwin, D. Vlassopoulos, and M. Cloitre, "Rheological Fingerprinting of an Aging Soft Colloidal Glass", *J. Rheol.*, **54**, 915 (2010).
2) E. van Ruymbeke, D. Vlassopoulos, M. Mierzwa, T. Pakula, D. Charalabidis, M. Pitsikalis, and N. Hadjichristidis, "Rheology and Structure of Telechelic Linear and Star Polyisoprene Melts", *Macromolecules*, **43**, 4401 (2010).
3) K. M. Kirkwood, L. G. Leal, D. Vlassopoulos, P. Driva, and N. Hadjichristidis, "Stress Relaxation of Comb Polymers with Short Branches" *Macromolecules*, **42**, 9592 (2009).
4) C. Mayer, E. Zaccarelli, E. Stiakakis, C. N. Likos, F. Sciortino, A. Munam, M. Gauthier, N. Hadjicristidis, H. Iatrou, P. Tartaglia, H. Löwen, and D. Vlassopoulos, "Asymmetric Caging in Soft Colloidal Mixtures", *Nature Materials*, **7**, 780-784 (2008).
5) M. Kapnistos, M. Lang, D. Vlassopoulos, W. Pyckhout-Hintzen, D. Richter, D. Cho, T. Chang, J. Roovers, and M. Rubinstein, "Unexpected Power-Law Stress Relaxation in Entangled Ring Polymers", *Nature Materials*, **7**, 997-1002 (2008).