30 years of colloidal quantum dots

May 26-28, 2014

ESPCI, Paris

Contents

This program is available on the web:
www.30-years-qds.com

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Welcome message

A conference to celebrate the 30th anniversary of the discovery of colloidal quantum dots May 26-28, 2014 at ESPCI in Paris

Welcome to Paris, welcome to ESPCI, welcome to the 30th anniversary of the discovery of colloidal quantum dots.

This time is a time of celebration, of history and of gathering. As the European deputy Otto von Habsburg said: " The one who does not know where he comes from can not know where he goes since he does not know where he is. In this sense, past is the launching ramp toward the future." We have a unique occasion now to visit the past of the fast growing field of colloidal quantum dots, to envision its latest development, and to ponder its future.

We can bet that it will be bright. In three decades, many unique properties have been discovered and in parallel the materials have found their way into a number of commercial applications. It seems very likely that more will follow.

Thank you to all for your presence and for your participation.

Please enjoy !!!

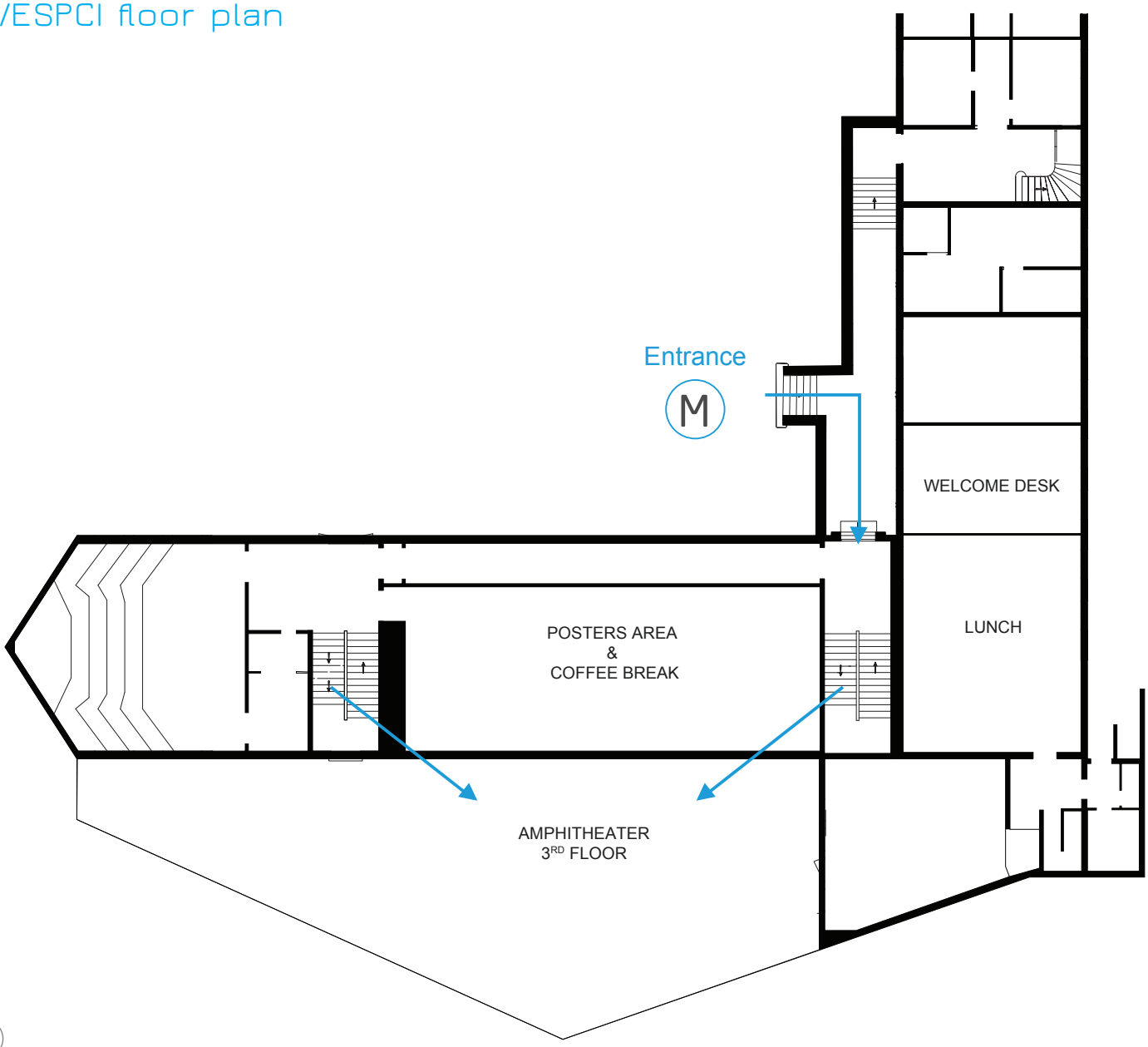
Benoit Dubertret *(CNRS, ESPCI, Paris)*
and Peter Reiss *(CEA Grenoble)*

/Conference venue:

ESPCI Paris Tech
10, rue Vauquelin
75005 Paris

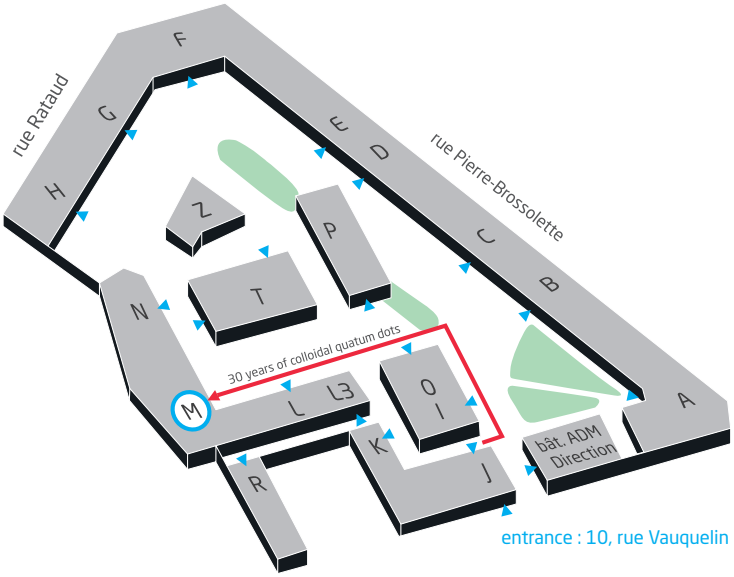
The 30th anniversary of the discovery of colloidal quantum dots will be held from May 26-28, 2014 at the École Supérieure de Physique et de Chimie Industrielles de la ville de Paris (École Supérieure of Industrial Physics and Chemistry of the City of Paris - ESPCI Paris Tech).
ESPCI ParisTech is a major institution of higher education (a French «Grande École d'ingénieurs»), an internationally renowned research center, and a fertile ground of innovation for industry.
Founded by the City of Paris in 1882, for over a century the School has attracted leading scientific innovators like Nobel Prize laureates Pierre and Marie Curie, Paul Langevin, Frédéric Joliot-Curie, Pierre-Gilles de Gennes, and Georges Charpak, who continue to contribute to the institution's international reputation.

/ESPCI floor plan



General information

/ESPCI floor plan



entrance : 10, rue Vauquelin

/Opening hours

MONDAY, MAY 26	TUESDAY, MAY 27	WEDNESDAY, MAY 28
08:00 – 17:30	**08:00 – 17:30**	**08:00 – 17:30**

/Wifi

Free wifi connection available

Wifi network : eduspot
User name (login) : 30yrqd01
Password : CjLiivNa

/Access map

City transportation

/Metro

Line 7, station Censier Daubenton or Place Monge (5 minutes' walk)

A fast and ever-developing means of transport, essential to the Parisian's life, the metro is probably the best and quickest way to travel within the city. Timetable: it operates from 5:30 to 0:30.

Information about the Metro or RER can be obtained from the RATP Website: www.ratp.com

/Bus

Local bus service is also available. Although slower than the Metro or the RER at certain hours of the day (depending on the traffic),

_ **21 & 27:** stop Berthollet-Vauquelin
_ **47:** stop Censier Daubenton (5 minutes' walk)
_ **83:** stop Port Royal - Berthollet (5 minutes' walk)
_ **91:** stop Port Royal - Berthollet (5 minutes' walk)

the RATP buses (green) are frequent from 8:00 am to 20:00. The services are more irregular after 20:00. The Noctambus service (for night-birds) operates during the night: 10 bus routes lead from the heart of Paris.

/Taxi

Where can you find a taxi? At stations, airports and near main traffic thoroughfares in more than 470 taxi ranks. 14 900 taxis are in service in Paris. You can identify a free taxi by the light on its roof and hail it. There will already be an initial charge on the meter. It is customary to leave a tip of up to 10% of the total fare.

/Bicycles

Paris provides you with an excellent Self Service "bike hire" system available 24 hours a day, 7 days a week. Multi pick up and drop off location allows you to pick up your bike from one service point and drop off to another. An unusual and pleasant way to discover the city!

_ 13 rue Erasme, 75005 Paris
_ 8 rue Jean Calvin, 75005 Paris
_ 12 rue de l'épée de bois, 75005 Paris

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/Useful web sites

_ **RATP** (City Transport Network): www.ratp.com
_ **MAPPY** (itineraries/directions): www.mappy.com
_ **PARIS TOURIST OFFICE**: www.parisinfo.com
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Contact

/Congress office

30 years QD c/o MCI France
24 rue Chauchat - 75009 Paris - France
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General information: info-30yearsqd@mci-group.com
Scientific program and abstracts: abstracts-30yearsqd@mci-group.com
Registration and accommodation: registration-30yearsqd@mci-group.com
Exhibition and sponsorship: exhibition-30yearsqd@mci-group.com

/Cocktail at «Tour Zamansky»

MONDAY, MAY 26 2014, from 18:30 to 21:30
Cocktail at “Tour Zamansky”

All participants are welcome to join this opening networking session to celebrate the launch of the **30th anniversary of the discovery of colloidal quantum dots** and catch up with colleagues and friends from all over the world!
This event offers an excellent opportunity to establish new contacts and share a nice evening in a relaxed atmosphere.

Included in the registration fees.

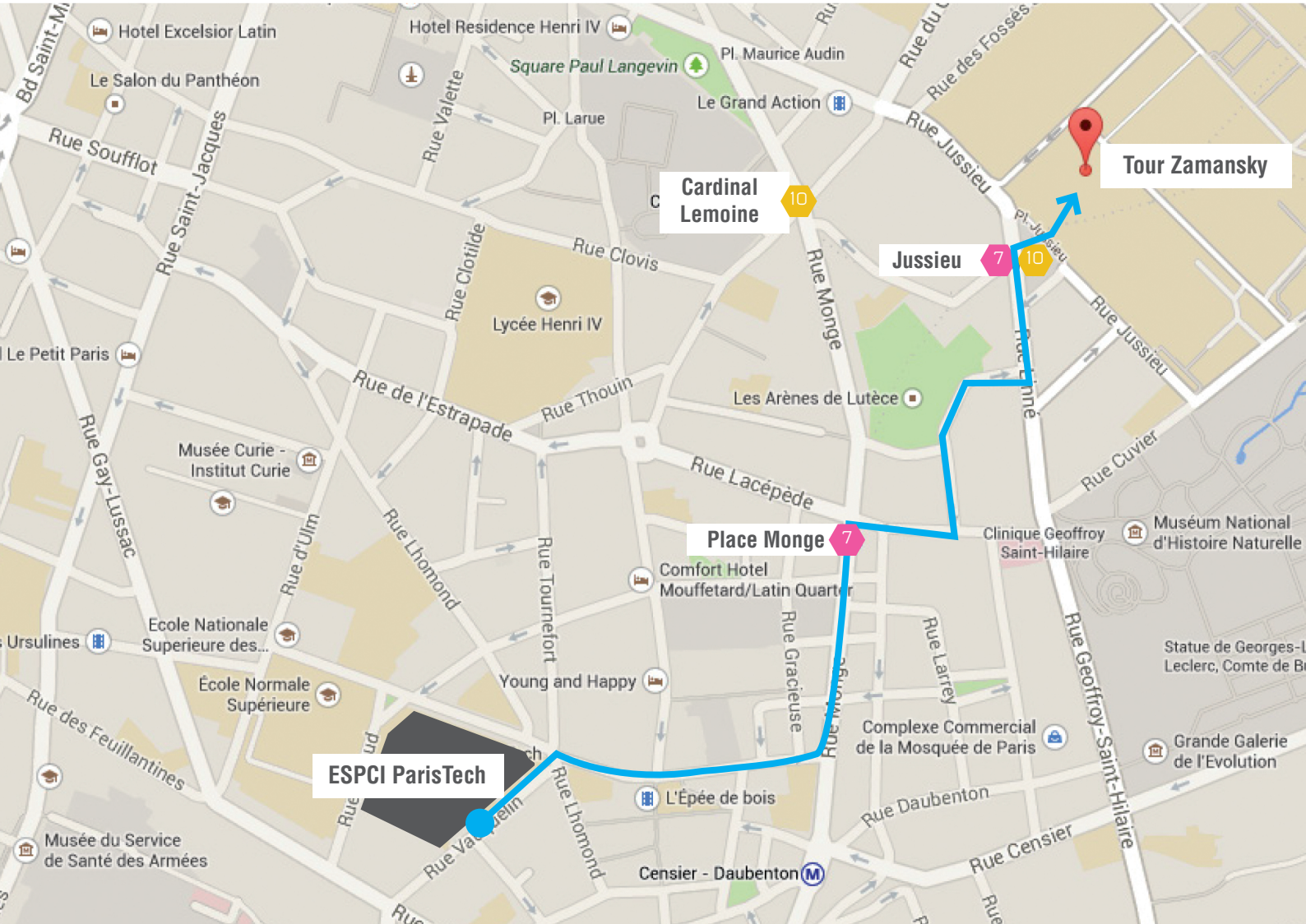
General information

/Tour Zamansky

Address:
Université Pierre et Marie Curie (UPMC)
4 place Jussieu
75005 Paris

Access:
Walking distance from the conference venue (ESPCI) :
15 minutes

Metro line 7 or 10 : station Jussieu
Bus line 89 ou 67 : stop Jussieu
Bus line 63 : stop Université Paris 6



Scientific program

The topics of the conference include:

- Synthesis and characterization of colloidal semiconductor nanocrystals
- Optical properties of quantum dots
- Quantum dot assembly and superstructures
- Quantum dot doping
- Charge transport through quantum dots and in quantum-dot assemblies
- Spins in quantum dots and quantum dots in quantum information science
- Photonic structures and plasmonic structures with quantum dots
- Hybrid structures (e.g., quantum dot - polymer/ferromagnet / superconductor structures)
- Theory of electronic structures, optical properties, transport, and many-body effects in quantum dots
- Applications of quantum dots in lasers, light-emitting diodes, displays, memories, photo-detectors, solar cells, bio-and chemo-sensing, etc.

/Monday, May 26, 2014

08:00 - 08:55	Registration
08:55 - 09:00	Welcome
09:00 - 10:00	**Nanoscience in Zero, One and Two Dimensions** **L. Brus** *(Columbia University, USA)*
10:00 - 10:40	**Semi Conductor Nanocrystals : from spectroscopy to technology** ***M. Bawendi*** *(MIT, USA)*
10:40 - 11:10	**Coffee Break**
11:10 - 11:50	**Excitons and Biexcitons Confined in CuCl Colloidal Quantum Dots** ***T. Itoh*** *(Osaka University, Japan)*
11:50 - 12:30	**Precisions synthesis of nanocrystals and their use in biomedical applications** ***H. Weller*** *(Hamburg, Germany)*
12:30 - 14:00	Lunch + Poster Session
14:00 - 14:40	**The chemical design of strongly coupled quantum dot solids and the emergence of collective behavior.** ***C. B. Murray*** *(U. Penn, USA)*
14:40 - 15:20	**Dimensionality Matters:** **Dimensionality Effects on Optoelectronic Behavior of Semiconductor Nanocrystals** ***U. Banin*** *(The Hebrew University of Jerusalem, Israel)*
15:20 - 16:00	Coffee Break
16:00 - 17:20	**Selected talks :** • 16:00-16:20 - **O01** - ***Jonathan Owen*** *(Chemistry, Columbia University, New York, United States)* **The Nucleation and Growth of Colloidal Quantum Dots** • 16:20-16:40 - **O02** - ***Angshuman Nag*** *(Chemistry, Indian Institute of Science Education and Research (IISER) Pune, Pune, India)* **Ligand-Free Colloidal Quantum Dots for Optoelectronics and Luminescence Sensors** • 16:40-17:00 - **O03** - ***Alexandros Stavrinadis*** *(ICFO- Institut de Ciències Fotòniques, Castelldefels (Barcelona), Spain)* **Cation doping of PbS quantum dots with a range of elements and the exceptional case of bismuth as a dopant for achieving air-stable homojunction solar cells** • 17:00-17:20 – **O06** - ***Alfons van Blaaderen*** *(Utrecht University, Utrecht, Netherlands)* **Entropy-driven Formation of Large Icosahedral Colloidal Clusters by Spherical Confinement**
18:30 - 21:00	**Cocktail at Tour Zamansky** *Access map on page 7-8*

/Tuesday, May 27, 2014

08:30 - 09:30	**Nanocrystals of wide band-gap metal-oxide materials** ***A. Yekimov*** *(Russia)*
09:30 - 10:10	**Ultrafast Spectroscopy of Nanocrystal Quantum Dots: Historical Perspective** ***V. Klimov*** *(Los Alamos, USA)*
10:10 - 10:50	**Colloidal Synthesis of Quantum-sized Two-Dimensional Semiconductor Nanocrystals** ***T. Hyeon*** *(Seoul National University, South Korea)*
10:50 - 11:20	Coffee Break
11:20 - 12:40	**Selected talks :** • 11:20-11:40 - **O05** - ***Pierre Gilliot*** *(IPCMS, CNRS)* **Optical properties of I-VII compound nanocrystals** • 11:40-12:00 - **O04** - ***Roman Krahne*** *(Fondazione Istituto Italiano di Tecnologia, Genova, Italy)* **Patterning of Nanocrystal films by Inhibiting Cation Exchange via Electron-Beam or X-ray Lithography** • 12:00-12:20 - **O07** - ***Ferry Prins*** *(Department of Chemical Engineering)* **Control of Exciton Transport in Quantum Dot Thin Films** • 12:20-12:40 - **O08** - ***Anna Rodina*** *(Loffe Physical Technical Institute, St. Petersburg, Russian Federation)* **Effect of dangling bonds on low temperature photoluminescence in CdSe nanocrystals**
12:40 - 14:15	Lunch + Poster Session
14:15 - 14:55	**Organometallic Approach to Complex Nano-Objects** ***B. Chaudret*** *(CNRS, Toulouse, France)*
14:55 - 15:35	**From colloidal solutions to superstructures from nanocrystals** ***A. Eychmuller*** *(Dresden, Germany)*
15:35 - 16:00	Coffee Break
16:00 - 17:20	**Selected talks :** • 16:00-16:20 - **O09** - ***Kyung-Sang Cho*** *(Nano Electronics Lab, SAIT(Samsung Advance Institute of Technology), Yongin-si, Korea)* **Controlling the charge and energy transfer of QD assemblies for the efficient QD-LED and display** • 16:20-16:40 - **O10** - ***Vanessa Wood*** *(ETH Zurich, Zurich, Switzerland)* **Quantification of Trap States in Colloidal Nanocrystal Solids and their Influence on Solar Cell Performance** • 16:40-17:00 - **O11** - ***Chiara Vicario*** *(Institut Curie, Paris, France)* **Imaging and manipulating single cellular events in living cells with functionalized nanoparticles** • 17:00-17:20 - **O12** - ***K. David Wegner*** *(Université Paris-Sud, Orsay, France)* **Multiplexed Biosensors Using Quantum Dot-Based Time-Resolved Förster Resonance Energy Transfer (FRET)**
	Free evening

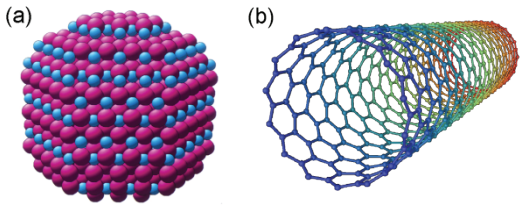
/Wednesday, May 28, 2014

08:30 - 09:30	**Dark and Photo-Conductivity in Ordered Array of Nanocrystals** **Al. Efros** *(Naval Research Lab, USA)*
09:30 - 10:10	**Charges and spectroscopy in colloidal quantum dots** ***P. Guyot-Sionnest*** *(University of Chicago, USA)*
10:10 - 10:50	**Photocatalysis with Semiconductor Nanocrystals** ***J. Feldmann*** *(LMU, Munich, Germany)*
10:50 - 11:30	Coffee Break
11:30 - 12:10	**The History of Nanocrystal Doping** ***D. Norris*** *(ETH, Zurich, Switzerland)*
11:20 - 12:00	**Multiple Exciton Generation in Quantum Dots, Quantum Dot Arrays, Quantum Dot Solar Cells: Application to Next Generation Solar Photon Conversion to PV and Fuel** ***A. Nozik (****University of Colorado, Boulder, USA)*
12:30 - 13:30	Lunch
13:30 - 14:10	**30 years of self-assembled epitaxial quantum dots** ***J-M. Gérard*** *(CEA, Grenoble, France)*
14:10 - 14:50	**Nanocrystal self-assembly: from hard-sphere structures to honeycomb semiconductors** ***D. Vanmaekelbergh*** *(Utrecht University, Netherland)*
14:50 - 15:30	Coffee Break
15:30 - 17:10	**Selected talks** • 15:30-15:50 - **O13** - ***Jacky Even*** *(INSA Rennes, France)* **Excitonic properties of II-VI semiconductor colloïdal nanoplatelets** • 15:50-16:10 - **O14** - ***Arjan Houtepen*** *(Chemical Engineering, Delft University of Technology, Delft)* **Electrochemical Control over Charge Transfer and Trapping in CdSe-CdTe QD Solids** • 16:10-16:30 - **O15** - ***Emmanuel Lhuillier*** *(Solarwell, ESPCI France)* **Novel strategies to improve the conduction properties of colloidal quantum dot solids** • 16:30-16:50 - **O16** - ***Pieter Geiregat*** *(1Information Technology, University of Ghent, Gent, Belgium)* **Near-Thresholdless Optical Gain using Colloidal HgTe Quantum Dots** • 16:50-17:10 - **O17** - ***Dmitri R. Yakovlev*** *(TU Dortmund University, Dortmund, Germany)* **Spin dynamics of negative trions in ensemble of colloidal CdSe/CdS core/shell nanocrystals**
17:10	**Posters Awards by Nature Nanotechnology and closing remarks**

Louis Brus, Columbia University, USA
Chemistry Department, Columbia University, New York, NY, 10027

/Nanoscience in Zero, One and Two Dimensions

The quantum size effect and very strong electron correlation are two hallmarks of nano electronic structure. I describe our early work in Bell Labs on colloidal CdSe quantum dots, resulting from an accidental observation of the band gap size dependence. We made efforts to understand the theory, carry out laser spectroscopy, and improve the bottom-up colloidal chemical synthesis. This was a team effort made possible by strong support from management. I then describe more recent work on strong electron correlation, and the dominance of excitons, in one dimensional carbon nanotubes. To observe the spectra of single tubes a Rayleigh scattering experiment was developed. To illustrate the general importance of strong electron correlation in one and two dimensions, I give examples including graphene, trans-polyacetylene chains, transition metal dichalcogenides, and organic/inorganic Pb iodide perovskites. In low dimensional systems of extended pi electrons, the electrons are right on the surface, screening is very weak, and correlation is especially strong.



Moungi Bawendi, MIT, USA
Massachusetts Institute of Technology, Cambridge, MA 02139, USA

/Semiconductor Nanocrystals: From Spectroscopy toTechnology

Thirty years ago semiconductor nanocrystals began a long journey from their initial discovery as a nanomaterial whose optical properties were strongly size dependent. Curiosity and fundamental experiments motivated the emergence of synthetic routes to higher quality materials. Synthetic progress begot insight into an intricate photophysical behavior. The combination eventually opened up a path to technology and the emergence of commercial applications. A sustained focus on understanding fundamental excitonic processes has been essential to progress. Synthesis of well-characterized materials as been crucial, not only of the functional inorganic particle itself, but also the ligand shell that protects it and couples it chemically to molecules and matrices of interest. This talk will explore the chemistry, photophysics, device physics, and applications of nanocrystal quantum dots, ranging from fundamental excitonic properties to commercial downshifting applications. The talk will highlight single quantum dot spectroscopic methods to uncovering fundamental excitonic and multiexcitonic properties. The talk will also highlight the chemical and optoelectronic challenges and opportunities for broadly applying quantum dots as light emitters and light absorbers in devices and for biological imaging using examples of applications of color downshifting in displays, photovoltaic energy conversion, and biological imaging.

Tadashi Itoh, Osaka University, JAPAN
Institute for NanoScience Design

/Excitons and Biexcitons Confined in CuCl Colloidal Quantum Dots

Around 1982 the pioneer works on semiconductor colloidal quantum dots (QDs) were started independently both in USSR by Alexander Efros theoretically[1] and Alexey Ekimov experimentally for QDs coagulated in silicate glass matrix[2] and in USA by Louis Brus for QDs precipitated from liquid solution[3].
In 1983, I started my work on CuCl QDs embedded in NaCl single crystalline matrix. At first my interest was to know the reason why, both in the absorption and luminescence spectra of NaCl crystal heavily doped with Cu+ ions, CuCl exciton-like bands appeared as being broadened, shifted to higher energy side and accompanied with oscillatory fine structures[4] [5].In those previous papers, CuCl microcrystals were suggested as an unknown origin.

Because of high efficiency of exciton-like luminescence, it was easy to perform selective excitation among inhomogeneously broadened exciton-like absorption band[6]. In 1984 I presented the preliminary result in the International Conference on Luminescence held in USA, where I met Brus for the first time. His impressive invited talk motivated me to continue the study on QDs. Since the quantum size effect made exciton energy size-dependent, the broadening was caused by size distribution of QDs, that made size-selective excitation possible[7]. In analogy with the case for glass matrix[2], exciton confinement model was successfully applied on the analysis of confined exciton levels[7]. Picosecond time-resolved spectroscopy revealed the size-dependent radiative decay time of excitons, the phenomenon of which was interpreted as exciton superradiance[8].

At 1990 International Conference on Physics of Semiconductors held in Greece, I met Efros and Ekimov for the first time, that was the start of our collaboration. The first work with Ekimov was the comparison of absorption spectra of CuCl QDs between two matrices, NaCl single crystal and silicate glass. The oscillatory fine structures of exciton absorption band only appeared in NaCl matrix, which indicated cubic shape of CuCl QDs with discrete sizes separated each other by half a lattice constant of CuCl[9]. In collaboration with D. Froelich, epitaxial growth of CuCl QDs in NaCl crystal was confirmed from the polarization dependence on NaCl single crystal axes for two photon absorption creating the CuCl exciton[10]. The TEM image of CuCl QDs was finally observed to be cubic, contrary to sphere for glass matrix. In collaboration with Ekimov and Efros, exciton-phonon complexes of confined excitons of CuCl QDs in glass matrix were studied [11], where 1P confined exciton became optically allowed by forming hybrid exciton-phonon complex. Later on in 1995, on the occasion of 10 years of QDs, Brus, Efros and I edited a special issue of “Spectroscopy of Isolated and Assembled Semiconductor Nanocrystals” [12].

Recently, direct two-photon excitation of confined biexcitons in assembled CuCl QDs were found to cause two characteristic phenomena on biexciton luminescence: efficient and ultrafast laser action[13] and superfluorescence with a few ps radiative decay[14]. Optical manipulation of CuCl QDs in superfluid helium was also demonstrated under the irradiation of laser beam at the excitonic resonance[15].

Finally, I would like to express my sincere thanks to Efros, Ekimov, Brus and other colleagues who have supported and encouraged me throughout my QD studies.

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1. Al.L. Efros and A.L. Efros, Soviet Phys.–Semicond.16, 772 (1982).
2. A.I. Ekimov and A.A. Onushchenko, Soviet Phys.–Semicond. 16, 775 (1982).
3. R. Rossetti, S. Nakahara, and L. E. Brus, J. Chem. Phys. 79, 1086 (1983).
4. E.F. Gross and A.A. Kaplyanskii, Soviet Phys.–Optics and Spectroscopy 2, 204 (1957)
5. M. Ueta and M. Ikezawa and S. Nagasaka, J. Phys. Soc. Jpn. 20, 1724 (1965).
6. T Itoh and T Kirihara, J. Lumin., 31 & 32, 120-122 (1984).
7. T Itoh, Y Iwabuchi and M Kataoka, Phys. Stat. Sol. (b), 145, 567-577 (1988).
8. T Itoh, M Furumiya, T Ikehara and C Gourdon, Solid State Commun., 73, 271-274 (1990).
9. T Itoh, S Yano, N Katagiri, Y Iwabuchi, C Gourdon and Al Ekimov, J. Lumin., 60&61, 396-399 (1994).
10. D Froelich, M Haselhoff, K Reimann and T Itoh, Solid State Commun., 94, 189-191 (1995).
11. T Itoh, M Nishijima, Al Ekimov, C Gourdon, Al L Efros and M Rosen: Phys. Rev. Lett., 74, 1645-1648 (1995).
12. L.E. Brus, Al.L. Efros and T. Itoh, Spectroscopy of Isolated and Assembled Semiconductor Nanocrystals, Special Issue of J. Lumin., 1-484. (North-Holland, 1996).
13. G. Oohata, Y. Kagotani, K. Miyajima, S. Saito, M. Ashida, K. Edamatsu, T. Itoh, Physica E 26, 347-350 (2005).
14. K. Miyajima, Y. Kagotani, S. Saito, M. Ashida and T. Itoh, J. Phys.: Condens. Matter 21, 195802 (2009).
15. K. Inaba, K. Imaizumi, K. Katayama, M. Ichimiya, M. Ashida, T. Iida, H. Ishihara, and T. Itoh, Phys. Stat. Sol. (b) 243 3829-3833 (2006).

Horst Weller, Hamburg, GERMANY
Department of Chemistry, University of Hamburg, Center for Applied Nanotechnology Hamburg (CAN), Interdisciplinary Nanoscience Center Hamburg (INCH), The Hamburg Center for Ultrafast Imaging (CUI)

/Precisions synthesis of nanocrystals and their use in biomedical applications

We report on the precision synthesis of CdSe/CdS/ZnS core-shell-shell nanocrystals using a preparative flow reactor. Experimental design is used to determine the crucial parameters and their influence on particle growth and size distribution.
In the second part of the talk, we will present biological applications of nanocrystals. In particular, we will present a biocompatible encapsulation technique based on amphiphilic poly(isoprene-block-ethylene oxide) (PI-b-PEO) diblock copolymers. We varied block lengths, structure and functional terminal end groups and investigated the effect on unspecific uptake. Fluorescence quenching experiments with encapsulated quantum dots show that best behavior in respect to unspecific cellular uptake is realized in those systems, in which the polymer shell yielded best protection against quenching molecules from the surrounding medium. Combination of micelle encapsulation with block copolymers and seeded emulsion polymerization finally leads to biolables for which unspecific uptake could be almost completely suppressed even under in-vivo conditions. We present various techniques for bio-conjugation with recognition molecules and show examples for specific cell and tissue targeting. In-vitro and in-vivo fluorescence and MRI data will be discussed.

Christopher B. Murray, U.Penn, USA
University of Pennsylvania, Department of Chemistry and Materials Science and Engineering

/The chemical design of strongly coupled quantum dot solids and the emergence of collective behavior

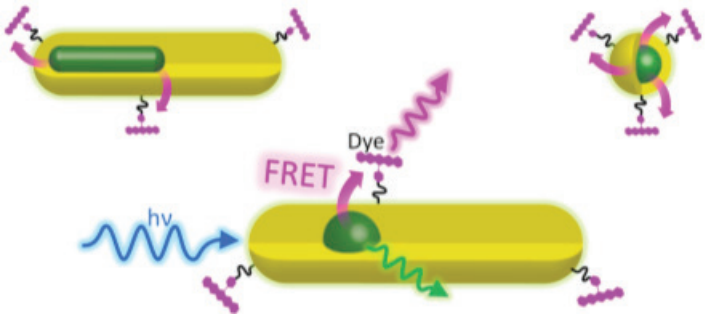
Colloidal Quantum Dots (QDs) with precisely controlled crystal shape, structure and surface passivation and internal structure provides ideal building blocks for the assembly of electronically and optically active thin films. These QDs display electronic, and optical properties that are tunable by not only by their size, but by the tailoring of their shape and the judicious introduction of magnetically and electronically active dopants. QDs are ideal building bocks to explore the emergence of new properties as combination of particles are brought together in strong coupling at mesoscopic length scales. Advances in the preparation, characterization and assembly of single component and multi-component QD solid thin films are providing both periodic and dense glassy glassy dense solids that are of intense interest in for applications from information technology to energy conversion. New techniques to exploit surface exchange and solid state processing of QD films will be discussed along with the general strategies for the modular design of QD films by directing/programmed self-assembly will be shared. Progress in the development of scalable solution processing techniques that are allowing these materials to be integrated into devices and systems will also be highlighted. A specific emphasis will be placed in the discussion of emergent physical properties that arise from the controlled coupling of proximal QDs, and in combination QDs with, plasmonic particles and nanoscale magnets.

To demonstrate the versatility of this modular approach to multi-component nanoscale materials design specific examples of how these QD solids are being explored as thermoelectric materials, and in display technologies and photovoltaic concepts.

Uri Banin, The Hebrew University of Jerusalem, Israel
Institute of Chemistry and the Center for Nanoscience and Nanotechnology,
The Hebrew University of Jerusalem, Jerusalem 91904, Israel; Banin@chem.ch.huji.ac.il

/Dimensionality Matters: Dimensionality Effects on Optoelectronic Behavior of Semiconductor Nanocrystals

Studying the transition of properties of nanostructures as they develop from the zero-dimensional to the one-dimensional regime is significant for unravelling the modifications that occur in the electronic structure of the particle as its length to width aspect ratio is increased. Such understanding can lead to better design and control of the particle properties, with relevance for a wide range of technological applications. The ongoing improvements in the control of shape and morphology of nanoparticles in colloidal synthesis, which allows forming structures of similar composition but of different dimensionalities and shapes, open the way for probing such dimensionality effects. We will present several effects involving the 0D to 1D transition in CdSe/CdS core/shell nano heterostructures of different morphologies including “sphere in a sphere”, “sphere in a rod” and “rod in a rod”. Both ensemble and single particle based measurements were used to decipher these effects providing complementary viewpoints. The first dimensionality related aspect involves the modification of emission and absorption polarizations, as the dimensionality of the particles and of their cores changes. The second aspect relates to the function of these nanocrystals as donors in energy transfer processes to multiple dye molecules bound on their surfaces and functioning as acceptors (see schematic of the FRET process in the figure below). We will show how the dimensionality of the particles’ core and shell affects the donor’s time dependent survival probability, as well as the behavior of FRET to multiple acceptors on single particle level. The opportunity to tailor the systems dimensionality with multiple acceptors on the surface results in enhanced FRET efficiencies with relevance for optical, sensing and energy funneling applications.



Aleksey Yekimov, RUSSIA
NCT Inc., Elmsford, NY, 10523 USA

/Nanocrystals of wide band-gap metal-oxide materials

Discovery of QDs has been one of the major breakthroughs in physics of semiconductors during last few decades. Dramatic progress in studies of confinement of electronic excitations has established the direct relationship between size and energy spectrum of QDs and paved the way to controllable manipulation of their optical properties. The unique properties of QDs make them attractive in various fields of applications from optoelectronics to bio-physics and medicine. Substitution of organic dyes by colloidal QDs for use as biomarkers has been one of the most successful projects to date (commercialized in 2002). This sector is responsible for about 60% of the total revenue of colloidal QD global market.

This presentation is aimed at discussion of optical and magnetic properties of some wide band-gap metal-oxide NCs and their prospective applications for High Refractive Index (HRI) optical materials with broad range of optical transparency as well as paramagnetic Contrast Agent (CA) for Magnetic Resonance Imaging (MRI).

Substitution of conventional “white” phosphor by green and red CdSe-QDs with emission peak tuned to band pass of optical filters is one of the promising color enhancement approaches for LED-backlit LCDs. Because of high mismatch of refractive indices between semiconductor (RI~2.5-3.5) and encapsulating polymer (RI~1.5), a significant portion of light emitted in LED reflects back from the chip interface. This portion becomes trapped inside the chip, resulting in significant decrease in LED light extraction efficiency. That is why significant attention is now given to developing HRI optical nanocomposites by dispersing NCs of wide band-gap materials with high refractive index in an epoxy/silicone encapsulant. Loading TiO2 nanocrystals (RI~3.5) with a size of 20-30nm in an epoxy made it possible to create HRI optical material with refractive index up to RI=1.8 and wide spectral range of clear optical transparency from 400nm to near infra-red region. Refractive index of nanocomposite depends on concentration of NCs and is well described with Maxwell–Garnett effective medium approximation. LEDs encapsulated with the HRI nanocomposite have demonstrated increase of light extracting efficiency by 15-20% with respect to conventional encapsulant.

Intensity and spectral position of QDs emission in LED-LCD devices must be thermally stabilized with high precision to produce a true color picture. Optical excitation of green and red QDs with blue LED (GaN) results in creation of electronic excitations at higher quantum levels with their subsequent thermal relaxation through emission of phonons into the QDs. Efficiency of dissipation of the energy from QDs to outer media depends on phonon boundary conditions and may vary depending on surrounding media. Resonant Raman spectroscopy studies of optical and acoustic phonons energy spectra have demonstrated confinement of the phonons in CdSe QDs grown in matrix of oxide glass. The possible impact of phonon confinement on thermal balance of the QDs in different matrices needs further investigations.

Another promising application of QDs is in the area of medical imaging. MRI is one of the most powerful medical diagnostic tools due to its high resolution and decent sensitivity. Conventional contrast agents (CA) based on paramagnetic Gd3+ ions coated with different organic molecules (Gd-chelates) boost the sensitivity through acceleration of water protons spin relaxation. As it has been found the Gd-chelates are toxic and can lead to serious illness in some patients with kidney disease (black box warning issued by FDA in 2007). Paramagnetic NCs of Gadolinium Oxide (Gd2O3:RE) are regarded now as a prospective material for substitution of conventional Gd-chelates exhibiting improved contrast of image and less toxicity. Relaxivity measurements of Gadolinium oxide NCs have shown that decrease in NC size increases the proton relaxivity. Therefore NCs with size less than 20nm start to prevail over commercial Gd-chelate CAs relaxivity. NCs doped with different RE elements exhibit different color emission which can be exploited for multi-color fluorescent imaging.

Magnetic NCs which can be functionalized to serve as vehicle for drug delivery would make it possible to carry out both therapy and diagnosis of diseases at the same time, opening a new niche of so called ‘Theranostics’.

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/Ultrafast Spectroscopy of Nanocrystal Quantum Dots: Historical Perspective

This presentation discusses the historical role of ultrafast spectroscopies in advancing the field of nanocrystal quantum dots. I will start with an overview of earlier transient photoluminescence and absorption studies focused on quantum dots in glass matrices that provided initial insights into the structure of quantized levels,[1] the nature of band-edge nonlinearities,[2] and the physics underlying the phenomenon of "photodarkening".[3,4] Then, I will discuss some later works conducted on colloidal samples that elucidated the mechanisms for intra-band relaxation (breakdown of a "phonon bottleneck")[5,6], multicarrier recombination (quantized steps in Auger recombination),[7] and the physics underlying optical-gain in quantum dots (biexciton gain).[8] Finally, I will talk about the most recent studies that have aided in the development of advanced quantum dots with tailored properties such as blinking-free emission[9], suppressed Auger decay[10] or enhanced carrier multiplication yields[11,12].

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/Colloidal Synthesis of Quantum-sized Two-Dimensional Semiconductor Nanocrystals

Two-dimensional (2D) semiconductor nanostructures (quantum wells (QW)) have attracted a lot of interest for their various potential applications in electronic and optoelectronic devices. With the growing understanding of the shape evolution, several successful colloidal synthesis of quantum-sized 2D semiconductor nanocrystals have been reported. In this presentation, I will summarize the recent advances in the colloidal synthesis of 2D quantum-sized nanocrystals of CdSe and related materials. Furthermore the crystallization mechanism of these 2D semiconductor nanocrystals will be discussed.

Keywords: Colloidal synthesiscrystallization mechanismquantum wellsTwo-dimensional (2D) semiconductor nanostructures

1. Vandyshev, Y. V., Dneprovskii, V. S. & Klimov, V. I. Manifestation of dimensional quantization levels in the nonlinear transmission spectra of semiconductor microcrystals JETP Lett. 53, 314 (1991).

2. Vandyshev, Y. V., Dneprovskii, V. S. & Klimov, V. I. Nonlinear-transmission dynamics and nonlinear susceptibilities of semiconducting microcrystals (quantum dots). Sov. Phys. JETP 74, 144 (1992).

3. Chepic, D. I., Efros, A. L., Ekimov, A. I., Ivanov, M. G., Kharchenko, V. A. & Kudriavtsev, I. A. Auger ionization of semiconductor quantum drops in a glass matrix. J. Luminescence 47, 113 (1990).

4. Dneprovskii, V. S., Efros, A. L., Ekimov, A. I., Klimov, V. I., Kudriavtsev, I. A. & Novikov, M. G. Time-resolved luminescence of CdSe microcrystals. Solid State Commun. 74, 555 (1990).

5. Efros, A. L., Kharchenko, V. A. & Rosen, M. Breaking the phonon bottleneck in nanometer quantum dots: Role of Auger- like processes. Solid State Commun. 93, 281(1995).

6.Klimov, V. I. & McBranch, D. W. Femtosecond 1P-to-1S electron relaxation in strongly-confined semiconductor nanocrystals. Phys. Rev.Lett. 80, 4028 (1998).

7. Klimov, V. I., Mikhailovsky, A. A., McBranch, D. W., Leatherdale, C. A. & Bawendi, M. G. Quantization of multiparticle Auger rates in semiconductor quantum dots. Science 287, 1011 (2000).

8.Klimov, V. I., Mikhailovsky, A. A., Xu, S., Malko, A., Hollingsworth, J. A., Leatherdale, C. A., Eisler, H. J. & Bawendi, M. G. Optical gain and stimulated emission in nanocrystal quantum dots. Science 290, 314 (2000).

9.Chen, Y., Vela, J., Htoon, H., Casson, J. L., Werder, D. J., Bussian, D. A., Klimov, V. I. & Hollingsworth, J. A. "Giant" multishell CdSe nanocrystal quantum dots with suppressed blinking. J Am Chem Soc 130, 5026 (2008).

10. Garcia-Santamaria, F., Chen, Y. F., Vela, J., Schaller, R. D., Hollingsworth, J. A. & Klimov, V. I. Suppressed Auger Recombination in "Giant Nanocrystals Boosts Optical Gain Performance. Nano Letters 9, 3482 (2009).

11. Schaller, R. D. & Klimov, V. I. Phys. Rev. Lett. 92, 186601 (2014).

12. Klimov, V. I. Multicarrier interactions in semiconductor nanocrystals in relation to the phenomena of Auger recombination and carrier multiplication Annu. Rev. Cond. Matt. Phys. 5, 13.11 (2014).

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/Organometallic Approach to Complex Nano-Objects

Organometallic nanoparticles have been prepared in our group for the past twenty years by decomposition in mild conditions of organometallic precursors in solution. In order to form metal nanoparticles, the decomposition is preferably achieved under dihydrogen which results in the formation of a clean surface, covered with hydrides and able at performing further chemistry or growth processes. Addition of various ligands may modify both the physical and the chemical properties of the particles as well as the growth process allowing the formation of particles of defined sizes and shapes. In this respect, nanospheres, nanorods, nanocubes, nanowires of iron and cobalt or nano-arrows, nanocubes, nano-stars and dendritic particles of platinum can be obtained. Depending on their shape, some of these nano-objects organize into super-lattices. The same methodology is applied to the synthesis of bimetallic nanoparticles (alloys, core-shell or nanoparticles of one metal decorated with another). The synthesis can be further extended to compounds such as oxides, sulphides, phosphides and carbides displaying optical and magnetic properties. In each case, it is possible to control the chemical order in these nano-objects and in particular the formation of core-shell species. The nanoparticles characterization may be achieved by standard techniques of material science (XPS, WAXS, HRTEM) as well as by the use of NMR (solid state, solution and gas phase).
The lecture will focus on the organometallic methodology to prepare metal nanoparticles and its extension towards the preparation of quantum dots displaying good optical properties in mild conditions. It will also describe the adjustment of size, shape and composition in iron/iron carbide nanoparticles decorated or not with a second metal to control the magnetic and catalytic properties of these objects. A new concept of catalysis using magnetic induction will finally be presented.

Keywords: Magnetic properties, CatalysisIron carbide, NMR characterization, Organometallic synthesis.

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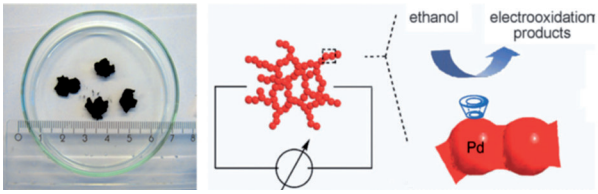
/From colloidal solutions to superstructures from nanocrystals

I will touch upon a recent direction of research in our group, namely that of gels and aerogels manufactured from a variety of nanoparticles. This has recently proven to provide an opportunity to marry the nanoscale world with that of materials of macro dimensions which can be easily manipulated and processed, whilst maintaining most of the nanoscale properties. The materials carry an enormous potential for applications. This is largely related to their extremely low density and high porosity providing access to the capacious inner surface of the interconnected nanoobjects they consist of [1]. I will report on a) enzyme encapsulated QD hydrogels as a multi-functional platform in the development of optical biosensors [2], b) the electrocatalytical activity towards the oxidation of ethanol of a freestanding palladium nanoparticle aerogel with extremely high electrocatalytic current density and good durability (cf. Fig.1) [3], and c) colloidal nanocrystals embedded in macrocrystals and their application in a colour conversion LED with good robustness, photostability, and color purity [4].
Fig.1. Pd-nanoparticle aerogel and its electrocatalytic activity towards the oxidation of ethanol



1. a) J.L. Mohanan, I.U. Arachchige, and S.L. Brock, Science 307, 397 (2005), b) N. Gaponik, A.-K. Herrmann, and A. Eychmüller, J. Phys. Chem. Lett. 3, 8 (2012).

2.a) J. Yuan, N. Gaponik, and A. Eychmüller, Angew. Chem. Int. Ed. 52, 976 (2013).

3.b) W. Liu, P. Rodriguez, L. Borchardt, A. Foelske, J. Yuan, A.-K. Herrmann, D. Geiger, Z. Zheng, S. Kaskel, N. Gaponik, R. Kötz, T.J. Schmidt, A. Eychmüller, Angew. Chem. Int. Ed. 52 9849 (2013),

4.T. Otto, M. Müller, P. Mundra, V. Lesnyak, H.V. Demir, N. Gaponik, and A. Eychmüller, Nano Lett. 12, 5348 (2012).

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/Dark and Photo-Conductivity in Ordered Array of Nanocrystals

A theory of photo- and dark-band conductivities in semiconductor supercrystals consisting of nanocrystals is developed by assuming scattering by structural defects in the supercrystals[1]. A new proposed mechanism of photo excitation, which is triggered by an efficient Auger ionization of charged nanocrystals, provides explanation for the measured photocurrent being 2–3 orders of magnitude larger than the dark current. For dark conductivity, the metal–insulator transitions and temperature dependence of mobility in the metal phase are considered.

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James Franck Institute, University of Chicago, Chicago, United States

/Charges and spectroscopy in colloidal quantum dots

Semiconductor nanocrystals started as an ideal realization of quantum confined semiconductors but the chemistry reality was not straightforward. After 30 some years of worldwide progress in monodispersivity and control of the interfacial chemistry such as with core/shell, the materials are now widely studied for applications, mostly trying to outcompete biomarkers, OLED and organic PV.
However, one less studied niche of the materials is in the infrared, because, unlike organic molecules, the low frequency phonons of the inorganic nanocrystals should not impede mid-IR electronic transitions. This simple notion led first to the search for the mid-IR intraband transitions. The subsequent observation of very long-lived (ms) infrared photoinduced absorption led to the search for the direct injection of charges in the nanocrystals. This was done both because there was a puzzle to solve, the absence of the phonon bottleneck, and because only with stable doping could one hope to take advantage of the intaband transitions. Once charges were successfully injected, this opened a number of other directions. 1) The interaction of a charge and the exciton led to the study of PL quenching, trions, and attempts to inform the blinking phenomenon and the Auger process. The proper description of the Auger interaction remains an important puzzle. 2) After the observation that a simple ligand exchange procedure could dramatically speed up the charge transfer rates between nanocrystals, the ohmic conductivity of solids of monodispersed quantum dots could be measured. The currently debated question is how transport can evolve from hopping to wavelike. 3) The mid-infrared remains a topic of interest. A partial resolution of the absence of the phonon bottleneck was provided by the quenching effect by ligand vibrations.

Recently, the interband transitions of the mercury chalcogenides have allowed direct access to the mid-IR (5microns) and beyond, with both PL and photodetection. This allowed easier access to the mid-IR photophysics and some of it is similar for interband and intraband mid-IR transitions. Applications of the materials to infrared photodetectors raises interesting basic questions on the limits of the detectivity, the quantum efficiency and current noise. At the moment, I believe that intraband transitions of charge-doped wide gap nanocrystals still have potential, the challenge being to accurately control the doping/Fermi level so that the wide gap undoped material evolves into a clean mid-IR gap material. This is a niche within a niche but it is interesting as it raises challenging basic questions on the physical chemistry of the semiconductor nanomaterials.

1.A. Shabaev, Al. L. Efros, and A. L. Efros, Nano Lett. 13, 5454 (2013)

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/Photocatalysis with Semiconductor Nanocrystals

I will review our scientific work on photocatalytic water splitting utilizing colloidal semiconductor nanocrystals decorated with catalytic metal clusters. In particular CdS nanorods and TiO2 nanoparticles will be discussed. Key issues are the role of hole scavangers, the size and density of catalytic clusters, relaxation dynamics of electrons and holes and dependencies on external parameters such as pH.

[1] Size-selected sub-nanometer cluster catalysts on semiconductor nanocrystal films for atomic scale insight into photocatalysis; M. Berr, F. Schweinberger, M. Döblinger, K. Sanwald, C. Wolff, J. Breimeier, A. Crampton, C. Ridge, M. Tschurl, U. Heiz, F. Jäckel, J. Feldmann, Nano Letters 12, 5903 (2012).

[2] Hole scavenger redox potentials determine quantum efficiency and stability of Pt-decorated CdS nanorods for photocatalytic hydrogen generation; M.J. Berr, P. Wagner, S. Fischbach, A. Vaneski, J. Schneider, A.S. Susha, A.L. Rogach, F. Jäckel, J. Feldmann, Appl. Phys. Lett. 100, 223903 (2012).

[3] Delayed Photoelectron Transfer in Pt-Decorated CdS Nanorods under Hydrogen Generation Conditions; M.J. Berr, A. Vaneski, C. Mauser, S. Fischbach, A.S. Susha, A.L. Rogach, F. Jäckel, J. Feldmann, Small 8, 29 (2012).

[4] Colloidal CdS nanorods decorated with sub-nanometer sized Pt clusters for photocatalytic hydrogen generation; M. Berr, A. Vaneski, A. S. Susha, J. Rodríguez-Fernández, M. Döblinger, F. Jäckel, A. L. Rogach, J. Feldmann, Appl. Phys. Lett. 97, 093108 (2010).

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/The History of Nanocrystal Doping

Since the discovery of colloidal semiconductor quantum dots (nanocrystals) over thirty years ago, researchers have sought to incorporate intentional atomic impurities, or dopants, into these materials. This has been primarily motivated by three factors. First, researchers wished to study the impact of impurities on nanocrystals due to the critical role that dopants play in bulk semiconductor devices, such as the transistor. Second, impurities in nanocrystals should exhibit even more dramatic behavior than in bulk semiconductors because the dopants are confined to extremely small volumes. Finally, doping can in principle help address key problems in potential applications of nanocrystals (e.g., light-emitting diodes and solar cells). In particular, many applications utilize thin films of densely-packed nanocrystals. Electronically active impurities can provide extra electrical carriers, i.e. electrons or holes, to the particles and enhance the conductivity of these films. Due to these fundamental and technological motivations, nanocrystal doping has moved forward over the last thirty years. In this talk, we will review the progress and discuss some of the remaining challenges. In general, doping has followed the development of the broader field. Advances in nanocrystal synthesis have been exploited to understand the doping process (i.e. how impurities can be incorporated). Advances in optical and electrical characterization of nanocrystals have been utilized to understand the impact of impurities on their properties. During these efforts, interesting and important connections have also been made to related physical phenomena, such as charging, diffusion, and surface effects. Thus, the doping community has not only developed a new sub-class of nanocrystal materials that may be important for future nanocrystal devices, but have contributed to a deeper understanding of nanocrystal behavior more broadly.

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Arthur J. Nozik,Matt C. Beard 2Joseph M. Luther 2Justin C. Johnson 2Mark C. Hanna 2Octavi Semonin
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/Multiple Exciton Generation in Quantum Dots, Quantum Dot Arrays, Quantum Dot Solar Cells: Application to Next Generation Solar Photon Conversion to PV and Fuel

In quantum dots (QDs), quantum rods (QRs) and unique molecular chromophores that undergo singlet fission (SF) the relaxation pathways of photoexcited states can be modified to produce efficient multiple exciton generation (MEG) from single photons . We have observed efficient MEG in PbSe, PbS, PbTe, and Si QDs and efficient SF in molecules that satisfy specific requirements for their excited state energy levels. We have studied MEG in close-packed QD arrays where the QDs are electronically coupled in the films and thus exhibit good transport while still maintaining quantization and MEG. We have developed simple, all-inorganic QD solar cells that produce large short-circuit photocurrents and respectable power conversion efficiencies via both nanocrystalline Schottky junctions and nanocrystalline p-n junctions. These solar cells also showed for the first time external quantum yields (QYs) for photocurrent that exceed 100% in the photon energy regions of the solar spectrum where MEG is possible (i.e., energy conservation is satisfied); the photocurrent internal QYs from MEG as a function of photon energy match those determined via time-resolved spectroscopy and the results settle controversy concerning MEG. Recent analyses of the dramatic effects of solar concentration combined with MEG on the conversion efficiency of solar cells will also be discussed. The properties required for nanocrystals and SF molecules to achieve the high solar conversion efficiencies predicted by theory will be presented. Regarding production of solar fuels, all viable systems must have the following features: (1) two photosystems arranged either in a Z-scheme analogous to biological photosynthesis, or two tandem p-n junctions connected in series where sufficient photopotential (1.23 V + overvoltage for H2O splitting) is generated to drive the redox reactions; (2) strong absorption of solar photons; (3) efficient separation of the photogenerated e-h pairs, (4) efficient transport to and collection of the separated carriers at electrocatalytic surfaces; (5) low overvoltages; (6) appropriate alignment of the redox potentials in the photoelectrodes with those of the fuel-producing reactions; and (7) resistance to dark-and photo-corrosion achieving long-term photostability. Cells with buried junctions in a tandem p-n configuration or a Z-scheme can achieve these requirements.

Keywords: QD solar cells, MEG

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/30 years of self-assembled epitaxial quantum dots

In september 1984, France Télécom researchers discovered by chance a way to build quantum dots by molecular beam epitaxy, while studying the growth of highly strained InAs/GaAs superlattices (L Goldstein et al, APL 1985). Although the interest of these nanostructures for physical studies has been immediately realized, extensive exploration of the intrinsic properties of self-assembled quantum dots and of their potential application in optoelectronics did not really start before the mid 90's. Nowadays, self-assembled epitaxial QDs are used in commercial products such as laser diodes. On a more fundamental side, their unique "artificial atom" properties have enabled the spectacular blossoming of quantum optics experiments in solid-state systems, and the development of novel quantum optoelectronic devices such as single-mode single-photon sources.
In this presentation, I will first give a brief historical overview of these 30 years. I will emphasize some key properties of self-assembled epitaxial QDs and some of their differences with respect to colloidal QDs. Finally, recent developments in the field of quantum optics and quantum information processing will be highlighted.

Daniel Vanmaekelbergh, Utrecht University, Netherland
W. H. Evers [1 4], M.P. Boneschanscher [1], J.J. Geuchies [1], C. Overbeek [1], C. Delerue [2], C. Morais Smith[3], E. Kalesaki [2], G. Allan [2], T. Altantzis [5], S. Bals [5], W. Beugeling [6], L. Filion [3], R. van Roij [1 3], M. Dijkstra [1] and D. Vanmaekelbergh[1]

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/Nanocrystal self-assembly: from hard-sphere structures to honeycomb semiconductors

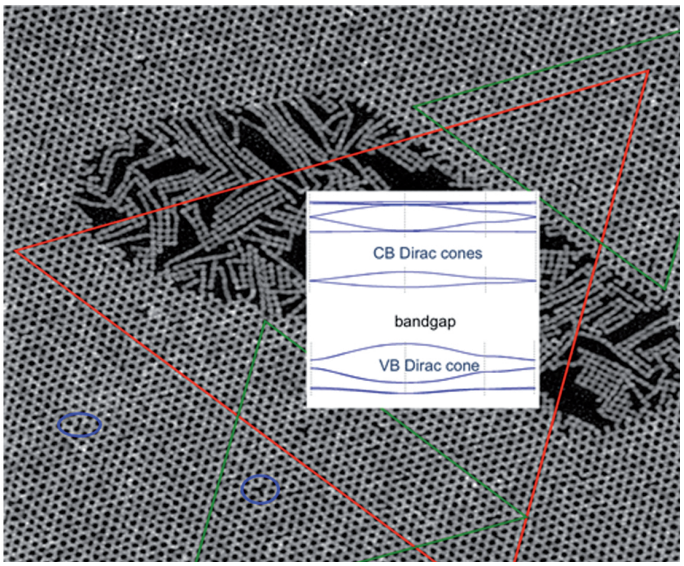
The self-assembly of colloidal nanocrystals knows a young but already intriguing history. The interest lies in the study of the fundamental concepts of the self-organization of nanometre-sized colloidal systems that are crystalline and have a specific size and shape, and in the formed NC superlattices that may have a composition and properties that cannot be found in atomic materials. In my lecture, I will not provide a historic overview. I would rather like to look to the future. I will show that semiconductor nanocrystal suspensions upon evaporation of the solvent can act as hard sphere systems, as well displaying a well-controlled reactivity, leading to truly novel materials such as “semiconductor” graphene.
The self-assembly of colloid building blocks as hard spheres has been studied extensively with larger non-crystalline colloids. Several groups in the field of nanoscience and our group1 have convincingly shown that also organically-capped semiconductor nanocrystals in an ideal solvent can form binary superlattices with a crystal structure typical for hard-sphere systems. Increasing the attraction between the nanocrystal building blocks leads to deviations from the hard-sphere structures.
On the other hand, several groups have demonstrated that semiconductor nanocrystals can also show a facet-specific reactivity, in which larger atomically coherent 1-D and 2-D systems are formed by atomic bonding between specific facets of the building blocks. When PbX (X=Te, Se, S)-nanocrystals with a truncated cubic shape are deposited on a glycol surface, atomically coherent 2-D systems are formed spontaneously. Several groups have shown the formation of simple 2-D quantum wells. In our group, atomically coherent 2-D systems have been prepared with a square and honeycomb nanoscale geometry2. Theoretical atomistic predictions show that these systems constitute a truly new class of materials, with the virtuous properties of the semiconductor combined with those due to the geometry. These materials can show a semiconductor band gap, and several Dirac-type bands, together with the quantum spin Hall effect3,4.
The formation of novel “geometric” materials with tailored band structure is the coming challenge in the field of colloidal nanocrystals. HAADF-STEM image of an atomically coherent 2-D superlattice, assembled from PbSe building blocks. The triangles show the long-range order in the honeycomb. The atomic coherence is proven by electron diffraction and GISAXS. Inside: Sketch of the band diagram for a 2-D CdSe honeycomb system with Dirac bands and a band gap.

1. Evers, W. H. et al. Entropy-Driven Formation of Binary Semiconductor-Nanocrystal Superlattices. Nano Letters 10, 4235-4241, doi:10.1021/nl102705p (2010).

2. Evers, W. H. et al. Low-dimensional semiconductor superlattices formed by geometric control over nanocrystal attachment. NanoLetters 13, 2317-1323 (2013).

3. Kalesaki, E., Evers, W. H., Allan, G., Vanmaekelbergh, D. & Delerue, C. Electronic structure of atomically coherent square semiconductor superlattices with dimensionality below two. Physical Review B 88, doi:115431, 10.1103/PhysRevB.88.115431 (2013).

4. Kalesaki, E., Delerue, C., Morais Smith, C., Allan, G. & Vanmaekelbergh, D. Dirac cones, topological edge states and non-trivial flatbands in two-dimensional semiconductors with a honeycomb nano-geometry. PRX, januari 2014 (2013).



Posters

The visits of posters will take place at breaks :

Monday, May 26, 2014	Tuesday, May 27, 2014
from 12:30 to 14:00	**from 12:40 to 14:15**
POSTER SESSION 1	**POSTER SESSION 2**

/Posters by themes

- Synthesis and characterization of colloidal semiconductor nanocrystals
- Optical properties of quantum dots
- Quantum dot assembly and superstructures
- Quantum dot doping
- Charge transport through quantum dots and in quantum-dot assemblies
- Spins in quantum dots and quantum dots in quantum information science
- Photonic structures and plasmonic structures with quantum dots
- Hybrid structures (e.g., quantum dot - polymer/ferromagnet / superconductor structures)
- Theory of electronic structures, optical properties, transport, and many-body effects in quantum dots
- Applications of quantum dots in lasers, light-emitting diodes, displays, memories, photo-detectors, solar cells, bio-and chemo-sensing, etc.

Installation and removal of posters as follows :

Poster Session 1
The posters must be installed on Monday, May 26th, 2014 between 8:00am and 10:00am at the latest and should remain on display until 10:00am on Tuesday, May 27th, 2014. Posters should then be removed on Tuesday, May 27th, 2014 from 10:00 to 11:00am at the latest.

Poster Session 2
The posters must be installed on Tuesday, May 27th, 2014 between 11:00 am and 12:00 pm at the latest and should remain on display until 6:00pm on Wednesday, May 28th, 2014. Posters should then be removed on Wednesday, May 28th, 2014 from 6:00 pm to 7:00pm at the latest.

List of poster by session, by theme :

May 26-27 2014
Poster Session 1

/Applications of quantum dots in lasers, light-emitting diodes, displays, memory, photo-detectors, solar cells, etc...

P001
Improved performance and stability in quantum dot solar cells through band alignment engineering
Chia-Hao M Chuang [1,*] Patrick R Brown[2] Vladimir Bulovic[3] Moungi G Bawendi [4]
[1]*Materials Science and Engineering,*
[2]*Physics,*
[3]*Electrical Engineering and Computer Science,*
[4]*Chemistry, Massachusetts Institute of Technology, Cambridge, United States*

P002
Synthesis of CuInTe2-xSex and photovoltaic application
Joong Pill Park[1,*] Sang Wook Kim[1]
[1]*Ajou University, Suwon, Republic of Korea*

P003
Heavy-Metal-Free Quantum Dot-Sensitized Solar Cells Employing Band Energy Engineered Copper-Indium-Selenide Quantum Dots
Jiwoong Yang[1 2,*] Taeghwan Hyeon[1 2]
[1]*School of Chemical and Biological Engineering, Seoul National University,*
[2]*Center for Nanoparticle Research, Institute for Basic Science, Seoul, Republic of Korea*

P005
Unravelling the role of Auger recombination in the performance of light-emitting diodes based on nano-engineered colloidal quantum dots
Jeffrey M. Pietryga [1,*] Wan Ki Bae[2] Young-Shin Park[1] Jaehoon Lim[1] Lazaro A. Padilha[3] Victor I. Klimov[1]
[1]*Chemistry Division, Los Alamos National Laboratory, Los Alamos, United States,*
[2]*Photo-Electronic Hybrid Research Center, Korea Institute of Science and Technology, Seoul, Korea, Republic Of,*
[3]*Instituto de Fisica "Gleb Wataghin", Universidade Estadual de Campinas, Campinas, Brazil*

P006
All 2D graphene-metal chalcogenides hybrid photodetector
Adrien Robin[1 2,*] Emmanuel Lhuillier[2] Emiliano Pallecchi [3 4] Abdelkarim Ouerghi[4] Benoit Dubertret [1]
[1]*LPEM, CNRS - ESPCI ParisTech,*
[2]*Nexdot, PARIS,*
[3]*IEMN, Université de Lille, Lille,*
[4]*LPN, CNRS, Marcoussis, France*

P007
Quantum Dot Based Luminescent Solar Concentrators with Reduced Reabsorption
Igor Coropceanu [1,*] Moungi G. Bawendi[1]
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P008
LED application of highly photoluminescent silica hybrid nanostructure containing assembled QD layer
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P010
Plasmonic hybrid nanosystems for solar water splitting
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Synthesis and optimization of colloidal quantum dots for thin film transistor (TFT) applications
Uladzimir Sayevich [1,*] Nikolai Gaponik [1] Alexander Eychmüller [1]
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P012
Using colloidal quantum dots to boost photovoltaic cell performance
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[2]Department of Chemistry, Bar Ilan University, Ramat Gan, Israel

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Low turn-on voltage Near Infrared LEDs based on core-shell PbS/CdS quantum dots with inverted device structure
Rafael Sánchez Sánchez [1,*]Enrico Binetti [2]Jose Angel de la Torre [1]Germà García Belmonte [1]Marinella Striccoli [3]Iván Mora Seró [1] and Photovoltaic and Optoelectronic Devices Group (GDFO)
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P015
Energy level modification in lead sulfide quantum dot thin films through ligand exchange
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Colloidal Quantum Dot-based Red, Green, Blue, and Natural White Light Thin Flexible Low-voltage Driven Light-Emitting Devices
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Large area luminescent solar concentrators based on "Stokes-shift-engineered" nanocrystals in mass polymerized polymethylmethacrylate matrix
Francesco Meinardi[1] Annalisa Colombo[1] Monica Lorenzon[1] Kirill Velizhanin[2] Roberto Simonutti[1] Ranjani Viswanatha[3] Luca Beverina[1] Victor Klimov[2] Sergio Brovelli[1,*]
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Solar Photochemical Fuel Generation using Semiconductor Nanocrystals
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Dmitry N. Dirin[12] Sébastien Dreyfuss[1] Maryna I.Bodnarchuk[12] Georgian Nedelcu[12] Grigorios Itskos[3] Paris Papagiorgis[3] Maksym V. Kovalenko[12]
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Zhenhua Sun, Gary Sitbon, Thomas Pons, Zhuoying Chen

/Charge transport through nanocrystals and assemblies of nanocrystals

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Herve Aubin [1,*] Hongyue Wang [1] Qian Yu [1] Emmanuel Lhuillier [1] Christian Ulysse [2] Valentina rebuttini [3] Alexandre Zimmers [1] Alireza mottaghizadeh [1] Benoit Dubertret [1] Nicola Pinna [3]
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Telegraph Noise in Transport through Colloidal Quantum Dots
Claudine Nì. Allen [1,*] Dany Lachance-Quirion [1 2] Samuel Tremblay [1] Sébastien A. Lamarre [1] Vincent Méthot [1] Daniel Gingras [1] Julien Camirand Lemyre [2] Michel Pioro-Ladrière [2]
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/Fabrication and characterization of nano crystals, nanocrystal assemblies, and hybrid structures

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Coupled exciton-plasmon state in colloidal nanoparticle combinations
Holger Lange [1,*] Horst Weller [1] Andreas Knorr [2] Christian Schmidtke [1] Sverre Theuerholz [2]
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Precise location and concentration of dopant insertion inside colloidal quantum dots: synthesis strategy and optical properties
Nathan Grumbach [1,*] Anna Rubin-Brusilovski [1] Georgy Maikov [1] Evgeniy Tilchin [1] Efrat Lifshitz [1]
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P030
Ultrathin Size- and Shape-Controlled Colloidal Cu2-xS 2D Nanosheets
Ward Van Der Stam [1,*] Quinten Akkerman [1] Xiaoxing Ke [2] Sara Bals [2] Celso de Mello Donegá [1]
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Highly luminescent CuGaxIn1-xSySe2-y nanocrystals from organometallic single-source precursors
Taleb Mokari [1,*]
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P032
Synthesis, structure and optical properties of II-VI colloidal heteronanoplatelets
Artsiom Antanovich [1] Anatol Prudnikau [1] Mikhail Artemyev [1,*]
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P033
Complex nano-particle self-assembly directed by molecular entities
Simon Tricard [1,*] Bruno Chaudret [1]
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P034
Relationship between Au nanoparticle morphology and 2 D & 3 D superstructures
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Atomic-resolution imaging and chemical mapping of anisotropic cation exchange in CdSe/PbSe quantum dot nanostructures
Marijn Van Huis [1,*] Marianna Casavola [1] Bart Goris [2] Anil O Yalcin [3] Frans D Tichelaar [3] Henny W Zandbergen [3] Alfons van Blaaderen [1]
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The Chemistry of the Nanocrystal Surface: A Missing Link for a Mechanistic Interpretation of Cationic Exchange Reactions
Yolanda Justo [1,*] Chiluka Laxmi Kishore Sagar [1] Zeger Hens [1]
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P037
Fabrication of superparamagnetic hybrid structure containing assembled QD layer for on-site biosensor
Kyoungja Woo [1,*] Wooyoung Park [1] Sang Kyung Kim [2]
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Study of colloidal Quantum Dots heterostructures by aberration-corrected Scanning Transmission Electron Microscopy
Gilles Patriarche [1,*] Silvia Pedetti [2] Michel Nasilowski [2] Mickael D. Tessier [2] Cécile Bouet [2] Benoit Mahler [2] Benoit Dubertret [2]
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P039
One-pot low temperature synthesis of wurtzite ZnS nanoplatelets
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P041
One step synthesis of silicon nanocrystals with ultra-narrow linewidth
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Interfacing Quantum Dots and Graphitic Surfaces with Chloride Anions as Ligands

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Kinetics of semiconductor nanocrystals growth in non-injection synthesis observed in-situ

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Non-Injection Synthesis of Cu2ZnSnS4 and Cu2ZnGeS4 Nanocrystals Through a Binary Precursor Approach

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Enhanced stability of lead chalcogenide colloidal quantum dots via surface control

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P051

Phonon spectra of CdSe and CdSe/CdS nanoplatelets probed by Raman and IR spectroscopies

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Band-gap engineering of core/shell and core/crown nanoplatelets: synthesis and optical properties.

Silvia Pedetti[1,*] Sandrine Ithurria[1] Hadrien Heuclin[1] Emmanuel Lhuillier[1] Piernicola Spinicelli[1] Gilles Patriarche[2] Benoît Dubertret[1]

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P053

Colloidal quantum dots: the mechanism of precursor conversions at low temperature with the presence a primary amine

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/Photonic structures and nanocrystals

P055
Photonic effects on the energy transfer efficiency in doped nanocrystals
Freddy Rabouw[1,*] Stephan den Hartog[1] Tim Senden[1] Andries Meijerink[1]
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Vertically slotted ring resonators coupled to colloidal PbS nanocrystals for Si based telecom applications
Markus Humer[1] Romain Guider[2] Florian Hackl[1] Thomas Fromherz[1,*]
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/Theory in quantum dots

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Theory of the quantum Hall transport in the quantum dot ensembles
Andrey Greshnov[1,*] Yaroslav Beltukov[1]
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P060
Silicon nanostructures for third-generation solar cells: carrier multiplication effects
Stefano Ossicini[1,*] Marri Ivan[1] Marco Govoni[1]
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A new type of intraband absorption spectroscopy based on the shape-induced optical anisotropy of a semiconductor nanocrystal
Anvar S. Baimuratov[1] Ivan D. Rukhlenko[1,2] Vadim K. Turkov[1] Mikhail Yu. Leonov[1] Alexander V. Baranov[1] Yurii K. Gun'ko[1,3] Anatoly V. Fedorov[1,*]
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DFT modeling of CdSe bulk crystals and stabilized nanoplatelets of various thicknesses
Alexandra Szemjonov[1,*] Frédéric Labat[1] Ilaria Ciofini[1] Sandrine Ithurria[2] Nicolas Lequeux[2] Benoit Dubertret[2] Thierry Pauporté[1]
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Terbium to quantum dot FRET-based nanobody-immunoassays for in-vitro diagnostics of epidermal growth factor receptors
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P070
Cadmium free multimodal quantum dot probes for in vivo magnetic resonance and near infrared fluorescence imaging
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High-Resolution Three Photon Fluorescence Microscope Imaging with Biocompatible Mn2+:ZnS Nanocrystals
Kwangsoo Shin [1 2,*] Jung Ho Yu [1] Taeghwan Hyeon [1 2]
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Multicolor colloidal quantum dots for FRET-based multiplexed detection of cancer biomarkers
K. David Wegner [1,*] Xue Qiu [1] Niko Hildebrandt [1]
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P073
Near infrared biocompatible quantum dots for time-gated imaging and in vivo cells tracking
Sophie Bouccara [1,*] Alexandra Fragola [1] Emerson Giovanelli [1] Gary Sitbon [1] Nicolas Lequeux [1] Thomas Pons [1] Vincent Loriette [1]
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P074
Multidentate polyzwitterionic ligands for long-term bioimaging based on highly stable and functionalized quantum dots
Emerson Giovanelli [1,*] Eleonora Muro [1] Mariana Tasso [1] Gary Sitbon [1] Mohamed Hanafi [2] Thomas Pons [1] Benoît Dubertret [1] Nicolas Lequeux [1]
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P076
Biofunctional quantum dots as specific cell markers for diagnostics and cell identification
Mariana Tasso [1,*] Emerson Giovannelli [1] Nicolas Lequeux [1] Alexandra Fragola [1] Thomas Pons [1]
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P077
Developing QD-DNA bioconjugates for biological applications
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Paramagnetic, near-infrared colloidal semiconductor nanoparticles
Lyudmila Turyanska[1,*] Fabrizio Moro[1] Amalia Patane[1] Michael W Fay[2] Tracey D Bradshaw[3] Rebecca Trueman[4] Peter Wigmore[4] Phil Clarke[4] Henryk Faas[4] Anna M Grabowska[4] Neil R Thomas[5]
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P079
Water Soluble Quantum Dots (CdSe/ZnS) for Optical Imaging
Siti Fatimah Abdul Ghani[1,*] Maya Thanou[1] Melanie Bottrill[2] Juan Gallo Paramo[3] Nick Long[3] Michael Wright[1]
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P080
Quantum dot-core silica glass shell capsules by using alkoxide molecules as surface ligands for biomedical applications
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Quantum dot – antibody conjugates for FRET immunoassays
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/Optical properties of nanocrystals

P081
Temperature-controlled size dependence of photoluminescence decay time in PbS quantum dots
Alexander Baranov[1,*] Elena Ushakova[1] Aleksandr Litvin[1] Anatoly Fedorov[1]
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Exploring the structure and the influence of the ligand shell on the emission properties of water-soluble CdTe and CdHgTe quantum dots
Susanne Leubner[1,*] Soheil Hatami[2] Tommy Lorenz[1] Jan-Ole Joswig[1] Nikolai Gaponik[1] Ute Resch-Genger[2] Alexander Eychmüller[1]
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Relationships between Photoluminescence Spectra, Lifetime, and Polarization Anisotropy on Single Heterostructured Nanocrystals Exhibiting Blinking
Toshiyuki Ihara[1,*] Ryota Sato[1] Toshiharu Teranishi[1] Yoshihiko Kanemitsu[1]
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P089
Charge separation dynamics in type-II CdS/CdTe heteronanopencils revealed by femtosecond pump-probe spectroscopy
Makoto Okano[1,*] Masanori Sakamoto[1] Toshiharu Teranishi[1] Yoshihiko Kanemitsu[1]
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Exciton density dynamics and dephasing in CdSe nanoplatelets

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Easily-Synthesized Au-Cu2O Nanocrystals and Their Optical Properties

Noga Meir[1,*] Omri Bar-Elli[1] Dan Oron[1] Taleb Mokari[2]
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Thick shell CdSe/CdS quantum dots with improved optical properties

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Spectral and temporal properties of sub-10 nm fluoride nanocrystals doped with lanthanide ions

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Tuning the Emission Colors of Semiconductor Nanocrystals Beyond their Bandgap Tunability: All in the Dope

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Distance scaling of the energy transfer rate between a single semiconductor nanostructure and a graphene monolayer

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CdSe/CdS dot-in-rods photon statistics

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Absolute photoluminescence quantum yields of quantum dot-rods with various aspect ratios

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Anisotropic colloidal nanocrystal: an Efficient, Non-Blinking, Single Photon Source at Room-Temperature

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Amplified spontaneous emission from water-soluble CdSe/CdS quantum dot-in-rods

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Surface composition controls the optical properties of alloyed QDs encapsulated in silica shells

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Determination of the orientation of a single nano-emitter by polarisation analysis

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Thermal activation of Auger recombinations and blinking suppression in thick-shell CdSe/CdS colloidal nanocrystals

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Reduced Auger recombination in single CdSe/CdS nanorods

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Electroabsorption by 0D, 1D and 2D Nanocrystals: A Study of CdSe Colloidal Quantum Dots, Nanorods and Nanoplatelets

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Relaxation dynamics of excited states in CdSe and PbS nanocrystals grown in a glass matrix.

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Studying Colloidal Quantum Dots with 2D-Fourier Transform Spectroscopy

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Chemical transformations in Colloidal Inorganic Nanocrystals
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/Plasmonic structures and nanocrystals

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Suppressed-blinking plasmonic quantum dot/gold heterostructures
Botao Ji [1,*] Emerson Giovanelli [1] Piernicola Spinicelli [1] Benjamin Habert [2] Francois Marquier [2] Jean-Jacques Greffet [2] Nicolas Lequeux [1] Benoit Dubertret [1]
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Plasmon excitation and induced emission with a plasmonic self-organized crystal
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/Spins in nanocrystals

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Manipulation of electron spins in Mn-doped colloidal PbS quantum dots
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100% Energy transfer in molecules/nanotubes supramolecular assemblies
G. Delport[1] C. Roquelet[1] F. Vialla[2] G. Clavé[3] B. Langlois[2] V. Ardizonne[1] C. Diederichs[2] Ph. Roussignol[2] A. Filoramo[3] E. Deleporte[1] S. Campidelli[3] C. Voisin[2] and J.S. Lauret[1]
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Low frequency vibrations from CdSe nanoplatelets
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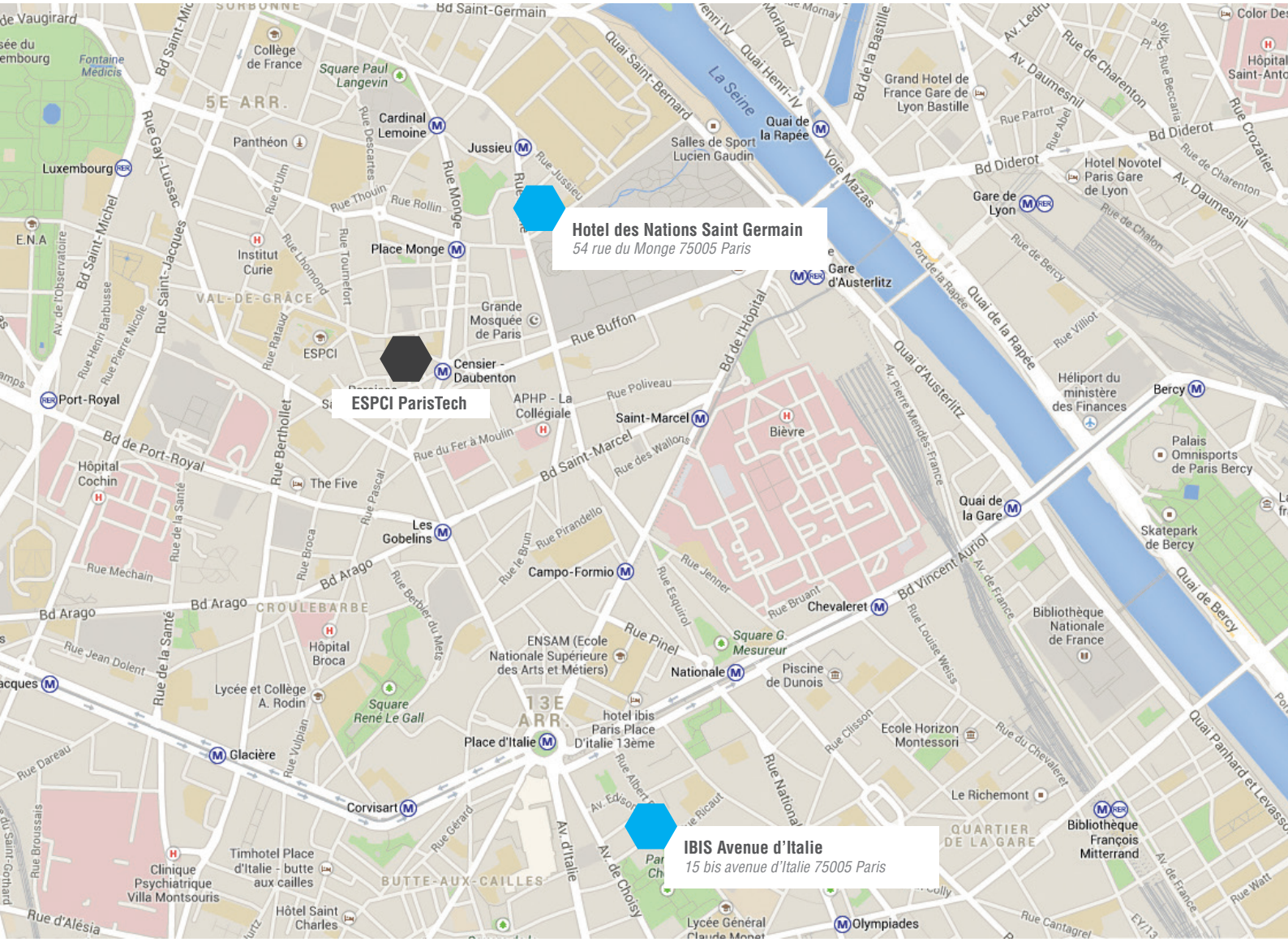
Accommodation



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