university of groningen / faculty of science and engineering / zernike institute for advanced materials

NANOSCIENCE NANO SYMPOSIUM 2023

THE 20TH EDITION OF

NANO TALKS

SHINING ON THE EDGE
LOOKING TO THE FUTURE

Day Chair:

- Prof. Giuseppe Portale (RUG)

Speakers:

- Dr. Alina Rwei (TU Delft)
- M.Sc. Nanoscience Students

June 26th 2023
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This booklet is for print use for the 20th edition of the annual Nanosymposium 2023, organised by the First year Top Master Nanoscience Students under the Zernike Institute for Advanced Materials at the University of Groningen.
More information can be found at: https://nanosymposium.nl/

Contents

About

Nanoscience Programme

The Topmaster program in Nanoscience aims at interdisciplinary training in modern materials science, with a focus on nanoscale phenomena. The Zernike Institute for Advanced Materials is responsible for the program. Teachers and supervisors associated with the program represent the excellent research groups taking part in the research program of the Zernike Institute. The courses are taught by top international scientists, and a large part of the program consists of actually conducting high-level scientific research. Students are submitted to a challenging and highly demanding curriculum, combining both the broadness and depth necessary for a successful research career in modern materials science.

For more information about the program visit us at:
https://www.rug.nl/research/zernike/education/topmasternanoscience/

Nanoscience Programme

The symposium is organized solely by the First year students of the Top Master Nanoscience program as a part of the Small Research Project, to give an oral presentation on their respective topics of research. The students are evaluated for their contribution to the organization of the symposium and based on the presentation skills.

Organizing committee

Aaltje van der Molen	Marco Segura	Leander van der Zee
Harshan Madeshwaran	Konstantinos Robotis	Raul Luna Mena
Jhe-An Lin	Salim Yushau	Alexandru Mednicov

Research Groups at ZIAM

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Zernike Institute for Advanced Materials (ZIAM) at the University of Groningen is a research facility at which physicists, chemists, and increasingly biologists, theoreticians and experimentalists work closely together, giving the Institute a breadth rarely found elsewhere. In our efforts we involve the whole chain of knowledge; modelling, design, synthesis, characterization, physical properties, theory and device functionality. The Institute is formed by a team of 35 Principal Investigators, organised in 20 Research Groups, creating a multidisciplinary research environment without borders.

ZIAM Research Groups	
Research Group	Principal Investigators
Bio-inspired Circuits and Systems	Elisabetta Chicca
Device Physics of Complex Materials	Justin Ye
Macromolecular Chemistry and New Polymeric Materials	Katja Loos, Giuseppe Portale, Dina Maniar
Materials Chemistry	Moniek Tromp and Loredana Protesescu
Micromechanics	Erik van der Giessen, Patrick Onck and Andrea Giuntoli
Molecular Biophysics	Wouter Roos and Rifka Vlijm
Nanostructured Materials and Interfaces	Bart Kooi and George Palasantzas
Nanostructures of Functional Oxides	Beatriz Noheda
Optical Condensed Matter Physics	Maxim Pchenitchnikov
Optical Spectroscopy of Functional Nanosystems	Richard Hildner
Photophysics and OptoElectronics	María Loi and Jan Anton Koster
Polymer Chemistry and Bioengineering	Andreas Herrmann and Ton Loontjens
Physics of Nanodevices	Bart Van Wees, Casper Van der Wal, and Marcos Guimarães
Polymer Science	Marleen Kamperman
Quantum Interactions and Structural Dynamics	Ronnie Hoekstra and Thomas Schlathölter
Solid State Materials for Electronics	Graeme Blake
Solid State Nuclear Magnetic Resonance	Patrick van der Wel
Spintronics of Functional Materials	Tamalika Banerjee
Surfaces and Thin Films	Petra Rudolf, Antonija Grubisic-Cabo and Joost Frenken
Theoretical Chemistry	Shirin Faraji, Ria Broer
Theory of Condensed Matter	Jasper Knoester, Maxim Mostovoy Thomas Jansen and Jagoda Slawinska
Biomaterials and Bioengineering	Malgorzata Wlodarczyk-Biegun

For more information visit: `https://www.rug.nl/research/zernike/research/labs`

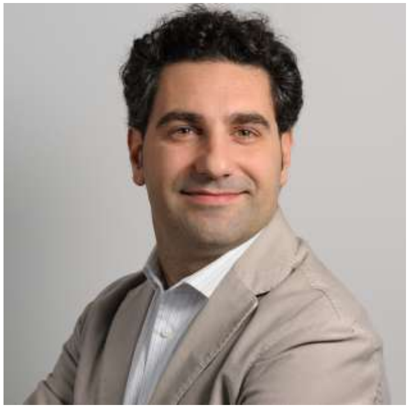
Timetable

IS: Invited Speaker, **NS**: Nanoscience Student Speaker.

9:00–9:15	**Welcome Remarks**		
9:10–9:35	NS	**Raul Luna Mena**	Reassessing existing metaphase kinetochore maps by imaging CENPA and Hec1 kinetochore proteins during metaphase using STimulated Emission Depletion microscopy
9:35–9:55	NS	**Alexandru Mednicov**	Photostability of doped C8S3 Double Wall Nanotubes (DWNTs)
9:55–10:15	NS	**Jhe-An**	Role of twin boundaries in controlling the local properties of La0.67Sr0.33MnO3 thin film grown on LaAlO3 (001) substrate
10:15–10:30	**Coffee / Tea break**		
10:30–10:50	NS	**Aaltje van der Molen**	Emergence of self-synthesizing coacervates from dynamic combinatorial libraries
10:50–11:10	NS	**Harshan Madeshwaran**	Photocurrent spectroscopy of van der Waals antiferromagnetic CrPS4 Devices
11:10–11:30	NS	**Konstantinos Rompotis**	Transforming a 2D semiconductor into a semimetal by laser-induced crystal phase change
11:30–11:40	**A talk about CogniGron**		
11:40–12:10	**Lunch**		
12:10–12:30	NS	**Leander van der Zee**	Spectroscopic measurements of single molecules (s-cbt) on a 2D material
12:30–12:50	NS	**Marco Segura**	Self-assembly and crystallisation of spiropyran-based molecules in solution
12:50-13:10	NS	**Salim Yushau**	Electrochemical Reduction of 5-hydroxymethyl furfural (HMF) with Nickel Boride (NixB) Nanocrystals
13:10–13:25	**Coffee / Tea break**		
13:25–14:15	IS	**Dr. Alina Rwei** Rwei Group @ TU Delft	Shedding light on precision therapeutics: from externally-triggerable drug delivery systems to bioelectronics
14:15–14:40	**Teacher of the Year Award and Closing of the Nanosymposium 2023**		

Day Chair

Prof. Giuseppe Portale



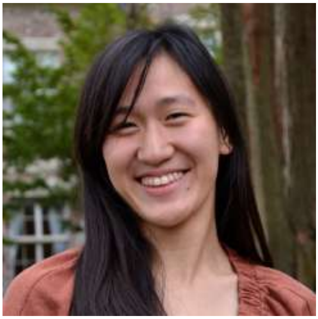
Giuseppe Portale is a professor at the Zernike Institute for Advanced Materials, University of Groningen, the Netherlands. He received his Ph.D. degree in Chemistry from the University La Sapienza, Rome and he carried out postdoc research at the ESRF in Grenoble.

From 2009 to 2015 he was a staff scientist at the ESRF and in 2015 he was appointed as assistant professor at the University of Groningen and became associate professor in 2021. He is the head of the Physical Chemistry of Polymeric and Nanostructured Materials group, focusing on the study of structure-property relationship in polymer-based materials, with special focus on energy applications and on the real time investigation of material structuring during processing.

For more information:
https://www.rug.nl/research/zernike/macromolecular-chemistry-and-new-polymeric-materials/portale-group/

Guest Speaker

Dr. Alina Rwei



Alina Rwei is an assistant professor in Technische Universiteit Delft (TU Delft).She received a Ph.D. and undergraduate degree at the Massachusetts Institute of Technology (MIT), with her undergraduate degree in Chemical Engineering and a Ph.D. in Materials Science and Engineering. Her work during her Ph.D. was focused on designing and developing light- and ultrasound triggerable drug delivery systems for the repeatable and adjustable release of local anesthetics in collaboration with Harvard Medical School. Furthermore, she pursued a postdoctoral position at Northwestern University. She was the recipient of the Postdoctoral Fellowship Research Training Award (TL1) from the Clinical and Translational Science Awards Program by NIH/NCATS.

As a principal investigator at TU Delft, she aims to work in the interdisciplinary fields of precision medicine and chemical engineering, developing novel biomedical technologies for next-generation medicine. Her research interests work in tandem to bridge the gap between biology, materials science, and biomedical engineering to create a profound practical impact on patients' lives. With her expertise in different fields, she plans to work towards more effective drug delivery systems by engineering various aspects of the delivery platforms. At the moment, she is working on light-, ultrasound- and magnetically-triggered therapeutics for cancer therapy, wearable electronics for diagnostics, and the study of nanoparticle and cellular interactions for improving the design of drug delivery systems.

For more information: *https://www.tudelft.nl/tnw/over-faculteit/afdelingen/chemical-engineering/principal-scientists/alina-rwei/rwei-group*

List of Abstracts – Talks

Guest Speaker

Shedding light on precision therapeutics: from externally-triggerable drug delivery systems to bioelectronics

Alina Rwei

TU Delft

Current medical treatments, such as chemotherapy, often impose significant toxicity onto healthy tissues. Smart drug delivery systems may provide an effective solution. Here I present the development of externally-triggerable drug delivery systems for on-demand, repeatable and adjustable drug release, where the timing, duration, and intensity of therapy can be controlled through external energy triggers such as light. In addition to traditional pharmacological approaches, optical-based biosensing platforms to enhance our insights into personalized, real-time diagnostics will also be discussed. Through pharmacological, optical, and electrical toolsets, we aim to develop effective therapeutic solutions to complex disease states.

Nanoscience Students

Reassessing existing metaphase kinetochore maps by imaging CENPA and Hec1 kinetochore proteins during metaphase using STimulated Emission Depletion microscopy

Raul Luna Mena

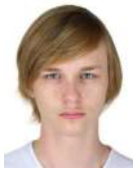
Molecular Biophysics

The kinetochore is a key network of many proteins with an important role in cell division which ensures the correct segregation of chromosomes by facilitating a connection between the centromere and microtubules. Studies using different types of assays have shown CENPA is essential for the recruitment of kinetochore proteins and Hec1 is one of the primary binding sites of microtubules. Imaging, localization and structural conclusions about these proteins have been drawn using confocal microscopy, which is limited by the well known diffraction limit. The project consists of using STED microscopy to image kinetochore proteins CENPA and Hec1 during metaphase and draw conclusions that help us better understand the structures these proteins form during cell division.

Photostability of doped C8S3 Double Wall Nanotubes (DWNTs)

Alexandru Mednicov

Optical Condensed Matter Physics

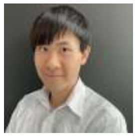


Developing technology capable of efficient solar energy absorption and long-range lossless transport of it has recently been a point of research interest in nanoscience. A lot of inspiration has been drawn from nature, especially in the case of photosynthesis. In order to replicate the functionality of such complex systems (e.g. green sulfur bacteria [1]), research attention has been drawn towards self-assembled molecular aggregates (J-aggregates) which represent molecular clusters that are capable of dipole moment alignment upon light excitation. This in turn creates a highly delocalized exciton state spanning across hundreds of tightly packed molecules. Key properties of interest represent higher absorption coefficients upon aggregation in solvents, low loss transmission of energy from one site onto another, etc.

In the following project, the self-assembled C8S3-3 dye molecules DWNT structure is investigated upon laser irradiation. Furthermore, we are modifying the tubular structure by incorporating C8S3-5 molecules into the J-aggregates with concentrations given by a 25:1 ratio of C8S3-3 molecules to C8S5-3. Due to the overlap of the dopant molecule's absorption spectrum with the exciton photoluminescence (PL) spectrum, the excitonic energy is funnelled towards the dopant through Forster-like energy transfer. The goal is to experimentally check the stability and control the exciton diffusion length in the C8S3-5 doped nanotubes, which will be correlated to the laser dosage. The irradiation effects will be studied through ultrafast time-resolved spectroscopy, which is used for detailed characterization of energy transport and transfer dynamics.

References:
[1] Chen, Jing-Hua, et al. "Architecture of the photosynthetic complex from a green sulfur bacterium." Science 370.6519 (2020): eabb6350.
[2] Kriete, Björn. Exciton dynamics in self-assembled molecular nanotubes. Diss. University of Groningen, 2020.

Role of twin boundaries in controlling the local properties of La0.67Sr0.33MnO3 thin film grown on LaAlO3 (001) substrate



<u>Jhe-An Lin</u>

Spintronics of Functional Materials

Manganites are strongly correlated oxide materials, well known for their competing ground states with nearly equal energies. This forms an important playground in which the dominant energy interactions, can be controlled by an external stimulus such as temperature, strain, doping, and electric field. We show how the morphology of LSMO thin films, grown by Pulsed Laser Deposition, can be controlled by growing them on textured substrates, such as LaAlO3 (LAO). We find that a 10 nm thick LSMO film grown on an LAO substrate shows stripe-patterned twin domains with an overall out-of-plane magnetic anisotropy. The combinations of twins and strains locally alter the physical properties of the grown film. Using magnetic and electrical probing, we investigate the local change of functional properties, which is important in the context of designing brain-inspired computing schemes.

Emergence of self-synthesizing coacervates from dynamic combinatorial libraries

Aaltje van der Molen

Otto Group

Compartmentalization is one of the main characteristics allowing living systems to protect themselves from the outside world. Among different compartment materials, coacervates have shown great potential as models to study the origin of life. However, the mechanism by which these compartments can emerge from their building blocks is still unexplored. Recently, a building block was found that can form coacervates through dynamic combinatorial chemistry. The main focus of this project will be on the study of making self-synthesizing coacervates. In this project, we aim to figure out how environmental changes, such as temperature and mechanical agitation, can affect the coacervation ability of the building blocks. In order to investigate the role of these changes, a building block will be studied and techniques, such as LC-MS and UPLC, will be used to investigate the library formed by the building block. In addition, the emergence of coacervates will be studied using UV-Vis spectroscopy, and fluorescence/confocal microscopy.

Photocurrent spectroscopy of van der Waals antiferromagnetic CrPS4 Devices

Harshan Madeshwaran

Opto-spintronics of Nanostructures

Magnetic devices have been prominent for data storage for several decades due to their long retention times and low power consumption. However, the transport of magnetic information in these devices is complex and their speed still needs to catch up to their more recent electronic counterparts. The recently discovered two-dimensional (2D) magnets open the door for studying magnetism in low dimensions and combining semiconducting and magnetic properties.
In this project, I explore the interplay between light, magnetism, and electric currents in a new 2D van der Waals antiferromagnet, namely-CrPS4. To investigate the effect of crystal symmetries on the photocurrent, I fabricated CrPS4 field-effect transistors with a circular geometry of electrodes, where the photocurrent can be measured at different crystal directions. I will also show how the photocurrents respond to different temperatures, and light polarizations and wavelengths. Finally, I will show how the photocurrent mechanisms in nanometer-thick flakes can be elucidated using scanning photocurrent spectroscopy.

Transforming a 2D semiconductor into a semimetal by laser-induced crystal phase change

Konstantinos Rompotis

Opto-spintronics of Nanostructures

In this work, I explore the controlled modification of the crystal structure of the two-dimensional (2D) semiconductor 2H - $MoTe_2$ to its metallic tetragonal (1T′) phase by means of local laser irradiation. This effect can be used to create a one-dimensional lateral contact between the 2D semiconductor and the 2D metal, with excellent contact properties. The phase change is confirmed by Raman scattering, which probe the change in lattice vibrations due to the phase transformation.Finally, I will show how we can use these 2D metal semiconductor-metal lateral heterostructures for functional devices using the state-of-the-art nanofabrication techniques. Through electronic transport and photocurrent measurements, I will demonstrate the excellent contact properties of these structures and their potential for future electronic devices.

Characterization of single molecules (sCBT) and effects of 2D materials on the properties of single molecules

Leander van der Zee

Optical Spectroscopy of Functional Nanosystems

Single-molecule spectroscopy developed into a powerful tool during the past decades. Organic molecules at very low concentrations (nM to pM) are used to study local interactions in a variety of systems, e.g. protein folding and association in life sciences or establishing structure-property relationships in novel materials for organic solar cells, transistors or thermoelectric generators. At the same time 2-dimensional materials, such as graphene or transition metal dichalcogenides (TMD) attracted substantial attention in recent years due to their outstanding properties and their potential for applications e.g. in sensors and electronics.

In this project we want to unite those fields and perform spectroscopy of single organic molecules deposited on 2D materials with the aim to study the interaction of a localised (Frenkel) exciton on the molecule with the delocalised Mott-Wannier excitons of the 2D material.

Self-assembly and crystallisation of spiropyran-based molecules in solution

Marco Segura

Physical Chemistry of Polymeric and Nanostructured Materials Group

Molecular switches are molecules that can change between two or more stable states, each with slightly different properties. Spiropyrans are a type of molecular switches which have been studied for close to a century and that can change between the closed spiropyran form and the open merocyanine form where a C-O bond is broken. They change their properties as a response to external stimuli and have therefore found growing interest in fields such as photodetection or advanced drug delivery.

Rather than just studying their molecular properties, the purpose of this line of research is to study how they self-aggregate in water in order to form supramolecular structures. This is done by turning the initial hydrophobic spiropyrans into a more amphiphilic molecule through the binding of ethylene glycol groups.

This process is commonly known as PEGylation, coming from attaching hydrophilic polyethylene glycol chains to nanostructures or macromolecules in order to make them more soluble in water. Using various techniques, such as UV/Vis spectroscopy, GISAXS and DLS, I will be characterising the supramolecular self-assembly of various different spiropyrans with varying ethylene glycol (EG) groups attached. The self-assembly occurs when the initial acetonitrile solution is added to water, in which the spiropyrans are much less soluble. Both the aggregates' shape and size and the kinetics behind the self-assembly are of interest, in order to establish how the varying EG size changes these. It is also of interest to identify if these aggregates can change shape in response to stimuli, such as light irradiation.

Electrochemical Reduction of 5-hydroxymethyl furfural (HMF) with Nickel Boride (NixB) Nanocrystals

Salim Yushau

Nanomaterials Chemistry & Electrocatalysis Group

Electrocatalysis is an interface-dominated process in which the activity of a catalyst strongly depends on the adsorption / desorption behaviours of the reactants / intermediates / products on the active sites. Based on a catalyst design, surface functionalization and nanostructuring will inevitably affect the reaction processes, and are considered to be an effective strategies to tune the electro-catalytic performance of noble metals and colloidal nanocrystals. Recently, colloidal nanocrystal-based electrocatalysts received great attention due to their high surface / volume ratio which leads to an exceptional catalytic selectivity / activity and durability relative to the existing bulks.

In this research, the electrocatalytic activity of NixB Nanocrystals towards reduction of 50 mM, 5-hydroxymethylfurfural (HMF) at a current density range of 10-50 mA/cm2 and pH = 9.2, was investigated. The electrochemical measurements including: Electrochemical Impedance Spectroscopy (EIS), Linear Sweep Voltammetry (LSV), and Chronopotentiometry were employed to study different behaviours of the systems. The HMF conversion, and selectivity towards the formation of 2,5-bis(hydroxymethyl) furan (BHMF) and 2,5-dimethylfuran (DMF) was then determined after product analysis with High - Performance Liquid Chromatography (HPLC). Overall, the study provided insights on the potential of using NixB colloidal nanocrystals as an electrocatalyst for HMF reduction.

Sponsors

Cognigron - Groningen Cognitive Systems and Materials Center

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Ambition and Mission - Founded to Make a difference

CogniGron was founded in 2018 to create the fundamental building blocks for a new type of computing, that is **cognitive computing** or **computing inspired by the brain**. These building blocks consist of self-learning materials that can perform the tasks that are currently assigned to thousands of transistors and complex algorithms in a more efficient and straightforward manner. Hence, these building blocks form the basis for a new generation of computer platforms for cognitive applications, such as pattern recognition and analysis of complex data.
Towards this ambition, CogniGron aims to create the conditions for researchers from materials science (physics and chemistry), computer science, artificial intelligence and mathematics to work closely together with a common mission: **to develop cognitive computing at all levels: from materials that can learn to devices, circuits and algorithms**.To the best of our knowledge, CogniGron is the first collaborative initiative of its kind.

In-House Expertise at CogniGron

The strength and uniqueness of CogniGron lies in the physical systems that are investigated (with scalability potential beyond current solutions) and in the multidiscip-linary character of the approach. Therefore, collaborations beyond disciplinary boundaries are a number one priority. CogniGron brings together expertise from two prominent institutes within the Faculty of Science and Engineering, the **Zernike Institute for Advanced Materials, the Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence**, building on their strengths in various disciplines: materials science, physics, mathematics, computer science and artificial intelligence. Thereby, CogniGron is creating an environment that encourages creativity and open communication to solve scientific questions more efficiently.

Super Travel & Tourism / Super Cargo

SUPER CARGO

Opening up to tourism

In 1998, Super Cargo founded Supertravel & Tourism in Patras. In this way, and underpinned by its experience and technical know-how, it offers a wide range of high-quality services for business and leisure trips: ticket issuance for all means of transport, hotel booking and car rental, group excursions and cruises, excursion packages, organisation of conferences and sporting events.

Founded in Patras, the second largest port of the country, and very soon emerged as one of the most dynamic and pioneering companies in the field of trucking. The next step came in 1998 with the establishment of **Supertravel & Tourism** which has followed a path of rapid development and expansion of its activities, so as to cover more and more sectors of the complex sector of tourist services. In 2010, Supertravel Tourism became an official member of the International Air Transport Association (IATA). **Driven by the profit of its customers, both in money and in time, our company has built a dense network of partnerships that allows it to cover almost any need or desire, regardless of the destination, the means of transport or the purpose of the trip.**

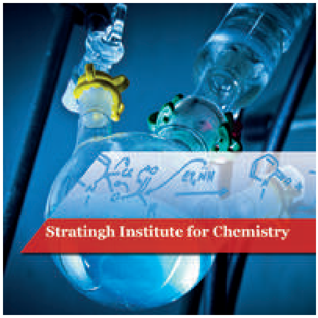
The goal of Supertravel & Tourism is to form a permanent, long-term partnership with each of its clients, whether it concerns business trips or leisure tourism. Some of the services offered by Supertravel Tourism are:

- Issuance of ferry, air and train tickets
- Hotel reservations
- Organized travel packages
- Cruises around the world
- Organization conferences

For more information visit: https://supertravel.gr/ and https://www.supercargo.gr/

Stratingh Institute for Chemistry

The Stratingh Institute for Chemistry is a research institute at the Faculty of Science and Engineering of the University of Groningen.



The Stratingh Institute for Chemistry aims to perform excellent research and teaching in molecular and supramolecular chemistry. The major activitie integrated in institute includes the chemical sciences such as bio-organic chemistry, organic chemistry, molecular inorganic chemistry, and molecular materials chemistry. The institute’s research programs focused on synthesis, catalysis, functional materials, bio-organic chemistry/chemical biology, and systems chemistry/complex molecular systems.

ASML

ASML is an innovation leader in the semiconductor industry. We provide chipmakers with everything they need – hardware, software and services – to mass produce patterns on silicon through lithography. An innovation leader in the semiconductor industry, ASML’s lithography solutions have been making giant leaps on this tiny scale since 1984. In our technology, hardware meets software to provide a holistic approach to mass producing patterns on silicon. Together with our partners, we provide leading patterning solutions that drive the advancement of microchips. We enable groundbreaking technology to solve some of society39;s toughest challenges. In collaboration with our customers, partners, and stakeholders we expand our knowledge, learn from each other and share approaches in order to find best solutions to any technical challenges. As an industry leader, we act with integrity and respect, realizing that our impact extends beyond technology to people , society, and planet. We take personal responsibility in creating a safe, inclusive and trusting environment where people from all backgrounds are encouraged and enabled to speak up, contribute, make mistakes, learn, grow.

JEOL

The JEOL Group is a leading company in state - of - the - art scientific instruments in the fields of nanotechnology, semiconductors, biotechnology, life sciences, forensics, optical communication and green technology. Based on a philosophy of "Creativity and Research Development" since being founded in 1949, JEOL has been offering a range of solutions designed from a user's perspective.JEOL is the leading global supplier of electron microscopes, ion beam instruments, mass spectrometers, and NMR spectrometers. It has headquarters in Tokyo, Japan, and foreign subsidiaries and associated companies across the world. JEOL also provides a variety of support services including; manufacturing, marketing, development research of Scientific and Metrology Instruments (Electron Optics Instruments, Analytical Instruments, Measuring Instruments), Semiconductor Equipment, Industrial Equipment, and Medical Equipment.JEOL aim to empower scientific discoveries by enabling scientists to characterize complex systems that fuels our understanding of the world. Again, It offers innovative solutions towards sustainability.

QDI Systems

QDI systems is a high-tech start-up, spin-off from Zernike Institute for Advanced Materials, University of Groningen. At QDI systems, they develop imaging devices for medical applications based on quantum dots. The developing QDs technology for various applications, such as high performance X-ray detectors. Our mission is to provide high-quality images for radiologists for more precise and early-stage diagnostics. The value that they offer includes high-quality and easy-to-use quantum dot material and the detailed recipe on how to make a high-performance device out of it. Our mission is to provide high-quality images for radiologists for more precise and early-stage diagnostics. The ambition of QDI systems is to become a major technology provider for various X-ray applications. The value that we offer combines high-quality and easy-to-use quantum dot material and the detailed method on how to manufacture high-performance X-ray sensors.