CONDENSED MATTER AND INTERFACES (CMI)

The research of the group, headed by Prof. A. Meijerink, Prof. D. Vanmaekelbergh, Dr. C. de Mello Donega, Dr. I. Swart, is focused on atomic and low-dimensional quantum systems. Examples include lanthanide ions in host lattices, colloidal semiconductor quantum dots, quantum rods, quantum wells, graphene- nanostructures, and nano geometric superlattices, e.g honeycomb semi-
conductors. Our mission is to control and manipulate the electronic structure and opto-electronic properties of these systems by chemistry and geometry. Besides advanced synthesis and nanocrystal self-assembly, we perform optical and electrical spectroscopy on the ensemble and single-molecule (single-dot) level. Our systems show potential for application in LEDs and Lasers, light detectors, solar cells, biological labels, sensors, and quantum computing.

Synthesis: We have an extended chemical lab including glove-boxes, Schlenk-lines and ovens. We synthesize and study II-VI, III-V, IV-VI semiconductor compounds (e.g. CdSe, InP, PbSe), $CuInSe_2$-type compounds, $MPbX_3$ perovskites, and 2-D molecular systems, such as graphene. In addition, we form extended nanostructured systems by colloidal nanocrystal assembly. Finally, we exploit the lateral manipulation capability of the scanning tunneling microscope to build matter atom-by-atom. The nanoscale and atomic structure of these systems is characterized by advanced TEM, elemental analysis, and scattering techniques in Utrecht and elsewhere.

Electrical spectroscopy: The atomic structure of single molecules, graphene nanostructures and low dimensional materials is measured with scanning tunneling microscopy and force microscopy, while on the same time the local energy level structure is measured with scanning tunneling spectroscopy, allowing to relate the atomic configuration to the electronic structure. For this, several ultra-high vacuum cryogenic tunneling microscopes are available. The electronic transport characteristics of these systems are measured in the transistor geometry with electrolyte gating.

Optical spectroscopy: The group has apparatus to measure the absorption, photoluminescence and photoluminescence excitation of the prepared systems, both in the UV-Visible and near-IR. We perform ensemble measurements and measurements on the single-molecule level, the latter using a very sensitive detector based on superconducting leads. We also work together with several other groups in the Debye Institute.

COLLABORATIONS AND INTERNSHIPS

There is extensive collaboration between the CMI group and the other groups in the Debye Institute. On the national and international level we collaborate with AMOLF, the High Magnet Lab. Nijmegen, EMAT Antwerp, University of Gent, IEMN- ISEN (Lille), ETH-Zurich and the university of Seattle.

The CMI group is subsidized by the European Research Council, European Institutions (Marie Curie Actions), and FOM, NWO-CW, and STW on the national level.

REQUIREMENTS

Students wishing to do their thesis research in this group are expected to pass at least one of the following master courses:

- Solids and Surfaces
- Advanced Spectroscopy of Nanomaterials
- Photon Physics

FOR MORE DETAILS CONTACT

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