Faculty of Science and Engineering

Profile report: ***Experimental nanophysics with advanced spectroscopic and structural analysis methods***
(Experimentele nanofysica met geavanceerde spectroscopische en structurele analyse methoden)

- Discipline: *Physics and Applied Physics*
- Level: *tenure-track assistant professor*
- Fte: *Full time (1,0)*

1. Scientific discipline

Surface physics, a subfield of condensed matter physics has increasingly evolved from the characterization of thin films and surfaces towards that of nanostructures. Surface science tools, including those employing synchrotron light, can determine the crystalline structure, the electronic structure (with respect to charge and spin), and the energy flow upon interaction with light pulses.

2. Vacancy

This position is opened by the Board of the Faculty in the context of the sector plans and will be embedded in the Zernike Institute for Advanced Materials, research unit Surfaces and Thin Films. The position falls within the framework of 'Career Paths in Science 4' ('Bèta's in Banen 4'). Please see link for criteria and conditions.

3. Selection committee (BAC)

Prof.dr.ir. C.H. van der Wal, scientific director of the Zernike Institute for Advanced Materials and professor Physics of Quantum Devices (Chair)
Prof.dr.ir. B.J. Kooi, education director of the Zernike Institute for Advanced Materials and professor Nanostructured Materials and Interfaces
Prof. dr. P. Rudolf, professor for Experimental Solid-State Physics
Prof.dr. M.A. Stöhr, professor for Surface Science
Prof.dr. R. Hildner, professor for Optical Spectroscopy of Functional Nanosystems
Prof. Dr. M. Golden, Professor for Condensed Matter Physics, QMat Group, University of Amsterdam

Student member

Prof.dr.ir. B.J. van Wees (advisor, professor and chair Physics of Nanodevices)
Dr. J.P. Birkner (advisor, Research Manager Zernike Institute)
Ms. A. van der Woude (advisor, Human Resources)

4. Research area

Nanostructures in 0, 1, and 2 dimensions have different properties from bulk solids due to their limited size. Their characteristics can be assessed with traditional surface

science tools, which give information about the structure, morphology as well as vibrational and electronic properties. Often also in combination with synchrotron light, crystalline arrangement of the atoms as well as the (spin-resolved) band structure can be determined, and the changes upon interaction with light pulses assessed. Currently not only space- or time-averaged knowledge can be gained but these characterization techniques see again strong development towards combining coherent imaging, ultrafast temporal resolution and high spatial resolution. Particularly interesting in the context of interaction with light is access to the far-from-equilibrium intermediate states. Key examples are ultrafast electron diffraction, time-resolved photoemission spectroscopy, as well as soft-X-ray spectroscopy and coherent imaging (note that while collaboration is encouraged, too much overlap with existing research activities at the Zernike Institute that mainly use electron microscopy, scanning-probe techniques and molecular ultrafast spectroscopy is considered undesirable). This position will focus on advancing these techniques, while applying them to studies of nanostructures such as organic-inorganic hybrids or 2D (hybrid) van-der-Waals materials. Synergy is expected with experts on synthesis and theoretical modelling of these hybrid nanostructures as well as with colleagues specialized on transport properties of nanostructures or (opto)electronic devices.

5. Embedding: institute (and base unit)

The position will be embedded within the research unit Surfaces and Thin Films at the Zernike Institute for Advanced Materials and strongly link to various education and research programmes of the School of Science and Engineering, especially courses with Physics and Applied Physics content.

The mission of the Zernike Institute for Advanced Materials lies in focused, curiosity-driven, symbiotic studies of functional materials involving researchers from physics, chemistry and bio-nanosciences. The Zernike Institute's main driving force is the desire to understand how things work at the microscopic level, i.e. the atomic and molecular scale. This is the realm of nanoscience and nanotechnology. In this field, the Zernike Institute for Advanced Materials covers the whole chain from synthesizing materials, building devices, characterizing materials and devices, and investigating the theoretical foundation of their properties. The institute performs interdisciplinary research with other Institutes of the Faculty of Science and Engineering and with the UMCG.

The research unit Surfaces and Thin Films is led by Prof. Rudolf. The group has a research program in the field of Surface and Interface Physics with particular emphasis on the preparation and analysis of crystalline organic thin films, 2D solids, functional molecules as well as molecular motors and switches on surfaces, and nanocomposites, while training

young researchers at the master, PhD and postdoctoral level in state-of-the-art surface analysis techniques and research in the field of Surface and Interface Physics.

The research unit consists of two staff members, Prof.dr. Petra Rudolf and Prof.dr. Meike Stöhr, 3 Postdoctoral fellows, 13 PhD students, and technical and secretarial support.

6. Local and (inter)national position

The position is created to strengthen the Faculty´s profile in physics. It will focus on advancing characterization techniques, like e.g. ultrafast electron diffraction (also in combination with optical excitation and probing), time-resolved photoemission spectroscopy, and soft-X-ray coherent imaging, while applying them to studies of organic-inorganic hybrid nano-materials and 2D (hybrid) van-der-Waals materials. Synergy is expected with experts on synthesis, pump&probe optical spectroscopy and theoretical modelling of these hybrid nanostructures. The focus of the position may open further collaborative avenues within the Zernike Institute and other institutes of the Faculty of Science and Engineering.

In the Netherlands complementary fundamental research on materials with ultrafast techniques is carried out in the Coherence and Quantum Technology group at Eindhoven University of Technology (Prof. Jom Luiten, Ultrafast diffraction), the ultrafast spectroscopy laboratory of AMOLF (Prof. Huib Bakker, femtosecond nonlinear spectroscopic techniques at frequencies ranging from the far-infrared to the extreme ultraviolet), the High-harmonic generation and EUV science at ARCNL in Amsterdam (Peter Kraus, nanometer-scale imaging of semiconductor structures; attosecond and femtosecond transient absorption and reflection spectroscopies),the Ultrafast Spectroscopy of Correlated Materials group at the Radboud University in Nijmegen (Prof. Alexey V. Kimel, time-resolved studies in ultrahigh magnetic field, time resolved THz spectroscopy, femtosecond-single shot imaging), the Inorganic Chemistry and Catalysis group within the Debye Institute of Nanomaterials Science of Utrecht University (Prof. Frank de Groot, femtosecond X-ray absorption spectroscopy and resonant inelastic X-ray scattering).

Also internationally, there is much interest in materials characterization with advanced ultrafast techniques, as evidenced by many papers on the topic in top-quality journals. The state-of-the-art in ultrafast techniques are four-dimensional electron microscopy as carried out at the EPFL in Switzerland (Prof. Fabrizio Carbone) or the University of Illinois in the USA (Prof. Renske van der Veen); ultrafast low-energy electron diffraction as developed at the Georg-August-Universität Göttingen in Germany (Prof. Claus Ropers); and various experimental possibilities at the European X-Ray Free-Electron Laser Facility in Hamburg, Germany, the FERMI Free Electron Laser in Trieste, Italy or the LCLS at the SLAC National Accelerator Laboratory, USA. As far as time-resolved photoemission with high harmonics is concerned, the setup closest to Groningen is situated at the Center for Soft Nanoscience of the Westphalian Wilhelms University of Münster, Germany (Prof. Helmut Zacharias, with whom the Surfaces and Thin Films group regularly collaborates).

7. Expected contributions to research

The candidate is expected to initiate and develop his/her own research program in the field of Materials characterization with advanced ultrafast techniques. She/he is expected to interact closely with other research groups of the institute. The research should have a visibility both at the national and the international level and lead to scientific publications. The research is expected to cross-fertilize the existing research within the Zernike Institute, and other institutes of the Faculty of Science and Engineering.

Obtaining substantial external funding is crucial. Supervision of PhD students is an important part of the research activities. The research is expected to strengthen the existing efforts within the Zernike Institute in the field of Materials characterization with advanced ultrafast techniques and to take an international leadership role.

8. Expected contributions to teaching

The candidate is expected to teach at the bachelor and master level and to contribute to the Topmaster program in Nanoscience organized by the Zernike Institute. She/he is expected to participate in the teaching program of specialized courses in relation to Materials characterization with advanced ultrafast techniques and other related topics. Furthermore, the candidate will be involved in supervising bachelor, master and PhD students.

9. Expected contributions to the organization

The candidate is expected to have an active interest and to provide a positive contribution to the management and organizational tasks of the institute. At the level of the FSE, the candidate will contribute to the organization of the faculty, for example by participating in working groups and committees, in the fields of teaching, research and management. The candidate will participate in relevant national and international organizations.