NIOK

Graduate program

Solar Fuels Catalysis

The global energy consumption is expected to increase beyond 20 TW in 2050, while fossil fuel resources are being depleted. At the same time, the steep increase in CO_2 emissions is damaging our environment and constitutes the main cause of global warming. Developing a clean and abundant energy supply is one of the most important scientific challenges of the 21st century, and efficient use of renewable sources is key to overcoming this challenge. The solar energy that reaches Earth every day greatly exceeds our current and future energy needs. Therefore, this is broadly regarded as the most promising sustainable source of energy. Artificial Photosynthesis for the storage of solar energy in chemical bonds is an ideal solution to the global energy problem, but significant scientific and technological breakthroughs are still required to make it possible.

Universiteit Utrecht

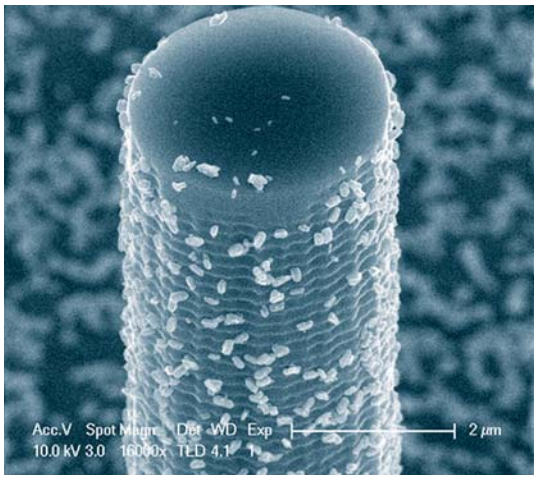
TU/e Technische Universiteit Eindhoven University of Technology

Universiteit Leiden

UNIVERSITY OF TWENTE.

Solar Fuels Catalysis refers to the storage of solar energy in energy dense chemical bonds – solar fuels – using water, CO_2 and catalysts in the process, akin to natural photosynthesis in plants. The underlying light harvesting and chemical conversion processes, however, are not trivial and major scientific and technological breakthroughs are needed before this technology is available to us for affordable and widespread application. Addressing the challenge of Solar Fuels will require a joint interdisciplinary effort, including expertise in catalysis, materials science, semiconductor physics, surface science, theory, advanced characterization and device engineering.

While photoelectrochemical production of hydrogen by water splitting is seen as the holy grail of solar fuels, there remain storage, transportation and safety issues associated with the use of hydrogen. Carbon-based liquid fuels have a high energy density and benefit from an existing infrastructure and processing technology, making them more attractive than hydrogen. However, CO_2 conversion into liquid fuels is considerably more challenging than producing hydrogen and research in this area is still in its infancy.
The Solar Fuels Catalysis graduate program aims to address a broad range of issues, from theoretical and fundamental understanding of molecular systems to device engineering for production of solar fuels from sunlight and cheap feedstocks, thus making a significant contribution to the solution of the Energy challenge.



The NIOK Solar Fuels Catalysis graduate program was established to combine the complementary profiles of each of the participating departments and, in that way, force breakthroughs in Solar Fuels Catalysis research. With experts in advanced spectroscopy, catalyst synthesis, theoretical and experimental mechanistic studies, electrochemistry, and photocatalysis, this program will equip students with in-depth understanding of Solar Fuels Catalysis. The education of the next generation of leading scientists, prepared to tackle the energy challenges of our society, is the major goal of the Solar Fuels Catalysis graduate program. Therefore, by involving the students in cutting-edge research programs, they will able to contribute to new discoveries and inventions from an early stage of their careers.

The partner groups involved in this graduate program are:

- NIOK: Netherlands Institute for Research in Catalysis (Nederlands Instituut voor Onderzoek in de Katalyse). This virtual institute comprises Dutch universities' research groups active in catalysis, and is aimed at fostering the advancement of research and education and promoting the cooperation between its members.
- Utrecht (UU): advanced spectroscopy of catalytic systems (e.g., scanning probe methods, *in-situ* and *operando* spectroscopy, synchrotron techniques).
- Eindhoven (TU/e): inorganic materials chemistry, mechanistic studies, organic solar cells, semiconductor devices, surface science.
- Leiden (UL): electrochemistry, electrocatalysis, electrochemical surface science, theoretical chemistry.
- Twente (UT): nanomaterials for energy conversion, transient analysis by spectroscopy, photoreactor concepts.

The Solar Fuels Catalysis graduate program comprises

- A two-year **Master** program in chemistry or chemical engineering with a specialization in catalysis
- A four-year **PhD** program

Graduate program

The Solar Fuels Catalysis graduate program offers outstanding MSc and PhD students a complete interdisciplinary training with a special focus on developing academic and research skills, and ultimately aiming for a future career in research. This is supported by the strong background and expertise of each of the participating groups in the four partner universities.
During the program, MSc and PhD students are integrated in one of the renowned catalysis research groups and will be actively involved in collaborative projects between the institutes. Their training as independent scientists is a priority, and the students will receive continuous support and advice in their pursuit of an academic career.
Admission to the MSc or PhD program is based on a selection procedure. A PhD position within the program is available for every successful MSc student. PhD students have a large degree of freedom in choosing their research topic and supervisor.

Master program

The Master program is based on a strong collaborative approach between the partner universities. In addition to the courses offered at each home university, four mandatory specialization courses, each 5 ECTS, will be provided by the partner universities:

- UU: Advanced Characterization of Catalysts
- TU/e: Modern Concepts in Catalysis
- UL: Electrochemistry & Electrocatalysis
- UT: Photocatalysis Engineering

To benefit the most from the complementary expertise profiles, the MSc students will be involved in rotations between the institutes. This will provide multiple opportunities to develop both theoretical and experimental skills in a research context: :

- An internship of 20 ECTS at one or more partner universities in the second year of the MSc program
- A graduation project to be carried out at two partner laboratories.
- Bimonthly NIOK Solar Fuels Catalysis meetings with PhDs, research leaders and invited speakers.

Students are expected to have an active role within the NIOK Solar Fuels Catalysis Consortium: they will participate in meetings and workshops, attend lectures, and have close contact with all (senior) scientists and staff. A successful MSc program results in access to the Solar Fuels Catalysis PhD program. Each student will follow a departmental MSc program, on which he/she will build up the multidisciplinary understanding necessary to advance the field of Solar Fuels Catalysis.

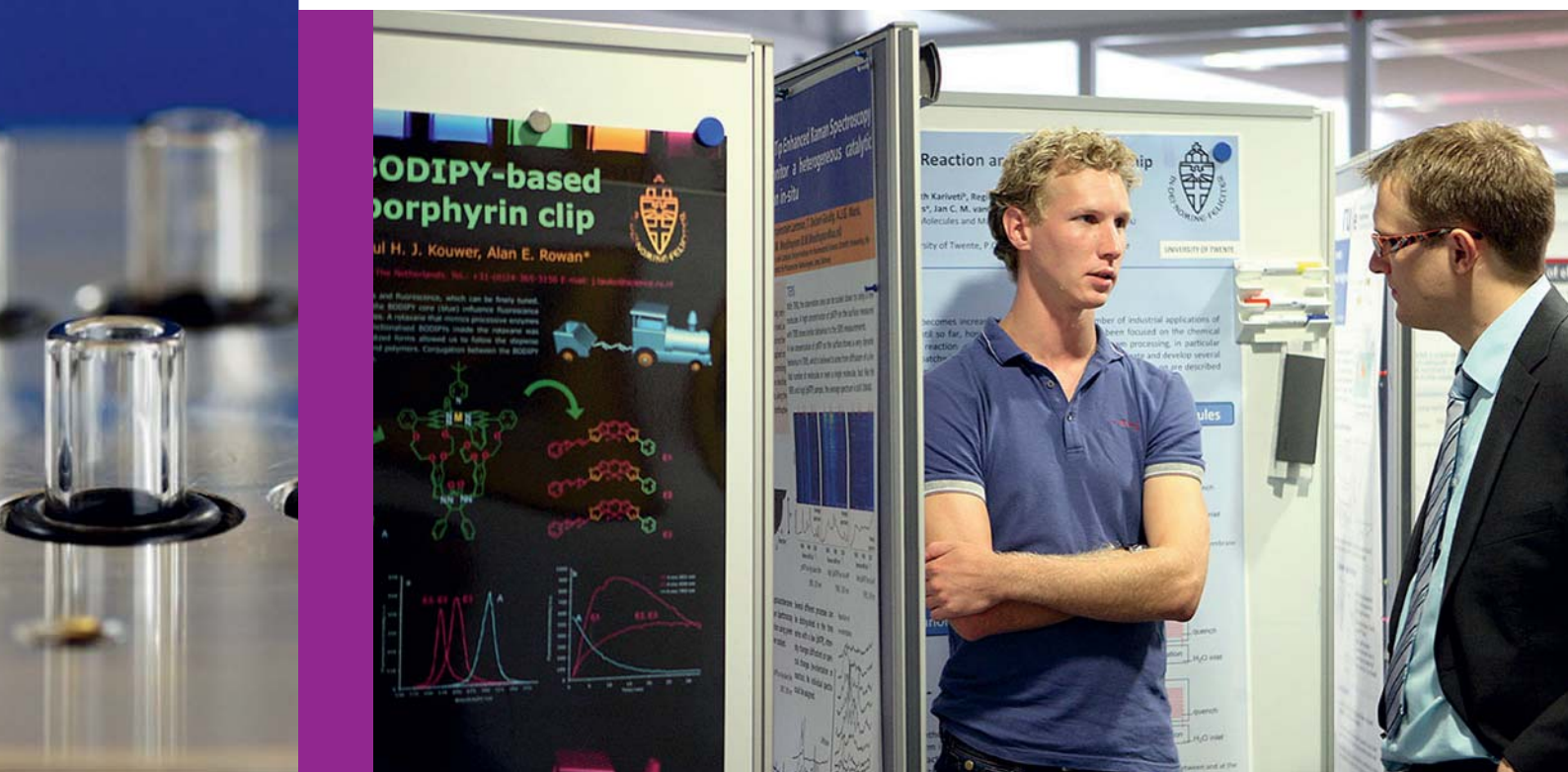
Admission requirements

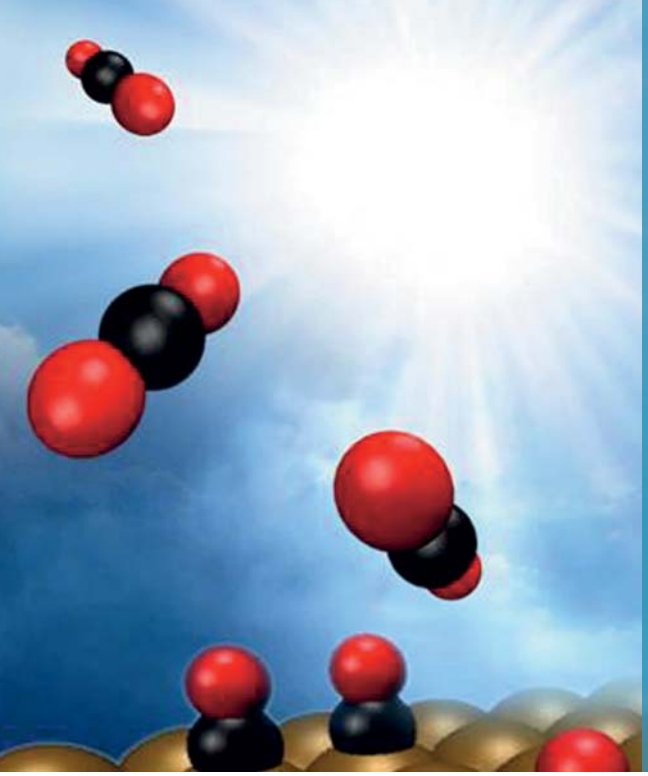
Only highly talented and motivated students will be admitted to the program. A personal interview will be part of the selection procedure. The selection will be based on:

- Grades in the BSc phase (average >7.5)
- Demonstrated multidisciplinary interest
- Ambition to follow a PhD program
- Excellent communication skills and fluency in spoken and written English
- Admission to a Master program in one of the participating departments

Master program facts

- Study possibilities: This Master program supplements a full-time MSc program in one of the participating departments
- Degree: Regular MSc degree at one of the participating universities. A certificate which indicates the additional study load and relevance of the Solar Fuels Graduate Programme will be issued.
- Language: English
- Times of entry: September and February
- Duration: Two years
- In combination with the PhD program the total intended duration is between five and a half and six years
- www.niok.eu/en/solarfuels





About NIOK:

- **Nation-wide graduate school in catalysis**
- **Recently evaluated as excellent**
- **~ 40 full- and part-time professors based at 9 Dutch universities**
- **250 PhD students**
- **Research and education covering all aspects of catalysis**
- **NIOK PhD's in high demand among employers**

Participants in NIOK's Solar Fuels Catalysis graduate programme:

- **Prof. dr. Bert Weckhuysen (Utrecht University, scientific director NIOK)**
- **Prof. dr. Emiel Hensen (Eindhoven University of Technology, chairman NIOK)**
- **Prof. dr. Marc Koper (Leiden University)**
- **Prof. dr. Guido Mul (Twente University)**

More information about the program, admission and enrollment:

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PhD program

Each student participating in the NIOK Solar Fuels Catalysis PhD program is appointed in one of the participating departments. To reflect the interdisciplinary and collaborative nature of the program, PhD students have a second supervisor whose expertise complements that of the first supervisor. Each student will write a proposal for his/her PhD research. The research is based on the student's project proposal and fits one or more research groups participating within the NIOK Solar Fuels Catalysis Consortium. The education is research related and aims to strengthen scientific skills. Participants will take part in teaching by guiding BSc or MSc students. In the third year, training in proposal writing will be provided (e.g. NWO, Marie Curie, etc.) to prepare students for all aspects of a career in science. During the full period, intensive coaching by the advisor and supervisors is provided. The duration of the PhD program is 4 years.

Admission requirements

MSc students participating in the graduate program can continue within the PhD program after successfully completing the MSc Program (excellent grades and positive feedback from their undergraduate project supervisor). Master students from outside the NIOK Solar Fuels graduate program can submit a formal application for a PhD position within the PhD program. The selection is based on:

- A PhD research proposal
- MSc grades (minimum average 8)
- A motivation letter
- Feedback from the research groups in which the student performed the undergraduate studies

PhD program facts:

- Degree: Doctor of Philosophy (PhD) from the department in which the student is formally appointed
- Language: English
- Times of entry: September and February
- Duration: 4 years. In combination with the MSc program a total intended duration of five and a half to six years
- Evaluation moment: Go/no-go decision after one year
- Universities involved: Utrecht University, Eindhoven University of Technology, Leiden University, Twente University
- www.niok.eu/en/solarfuels

Application process

To apply for the Solar Fuels Catalysis graduate program, please send a motivation letter, curriculum vitae, BSc phase grades (when applying for the MSc program) or MSc phase grades (when applying for the PhD program) to the program coordinator.