

International M.Sc. and Ph.D. Program in Optics & Photonics

Interdisciplinary Qualification in Cutting-Edge Research
at the International Graduate School of the Karlsruhe Institute of Technology

Relevance of Optics & Photonics for the Future

Executive Board Message

Since the year 2000, more than 10 Nobel Prizes directly linked to Optics & Photonics have been awarded. This includes not only basic research but also application oriented breakthroughs that facilitated the transformation of our society.

Energy-efficient light sources, optical communication and digital camera systems are impressive examples. At the same time, the discipline is mobilizing innovation-driven branches of our economy, such as industrial automation and production, digitalization of the society, autonomous mobility as well as medical technologies and personal health monitoring. The future progress and growth in this field rely on dedicated researchers and graduates trained in an interdisciplinary environment.

In 2006, the Karlsruhe School of Optics & Photonics was founded as one of the first Graduate Schools within the scope of the German "Excellence Initiative" at the Karlsruhe Institute of Technology (KIT). The Excellence Initiative was introduced to focus attention on internationally leading German universities. The excellence status of KSOP was renewed by international experts in 2012. In 2021, KSOP became sustainably funded through the KIT by the Federal Ministry of Research and Education (BMBF) and the State of Baden-Württemberg.

KSOP brings together the best talents in engineering and natural sciences.

Comprising a Master's and a Ph.D. Program in Optics & Photonics, the educational concept is designed to qualify its graduates for accelerated careers at world leading academic institutions and in high-technology industries.

The Master's program provides international students the opportunity to deepen their knowledge in optics and photonics while exploring the possibility of a future working either in industry or academia.

KSOP actively promotes the thesis work of its doctoral researchers by dedicated supervision, mentoring, networking as well as scientific and technical training. Concomitantly, KSOP augments the professional skills of its graduates by tailored personal and management training.

Currently, KSOP encompasses professors from 17 institutes and four different KIT Departments, i.e. Physics, Electrical Engineering and Information Technology, Chemistry and Biosciences, as well as Mechanical Engineering. Over 900 students, doctoral researchers and alumni have positioned KSOP as a premium education, research, and innovation hub.

Join us as a student, a doctoral researcher or as an academic or industrial partner. We are looking forward to a rewarding collaboration.

Prof. Dr. Ulrich Lemmer

Coordinator Karlsruhe School of Optics & Photonics



**The KSOP Success Story:
Over 900 Master, Doctoral Researchers
& Alumni from 70 Different Countries**



M.Sc. & Ph.D. Programs

The KSOP educational concept is designed to qualify its graduates for accelerated careers at the world's best academic institutions and in optic & photonic high-technology industries.

The **2-year Master's Program** spans the bridge between undergraduate classes in natural and engineering sciences and the required in-depth knowledge that is essential for cutting-edge research. It qualifies for a further career in the industry as well as in research.

For those who would like to continue their careers in research, KSOP established an exclusive **Ph.D. Program**.

KSOP also is a member of the European Erasmus Mundus Master's Program **EUROPHOTONICS**.

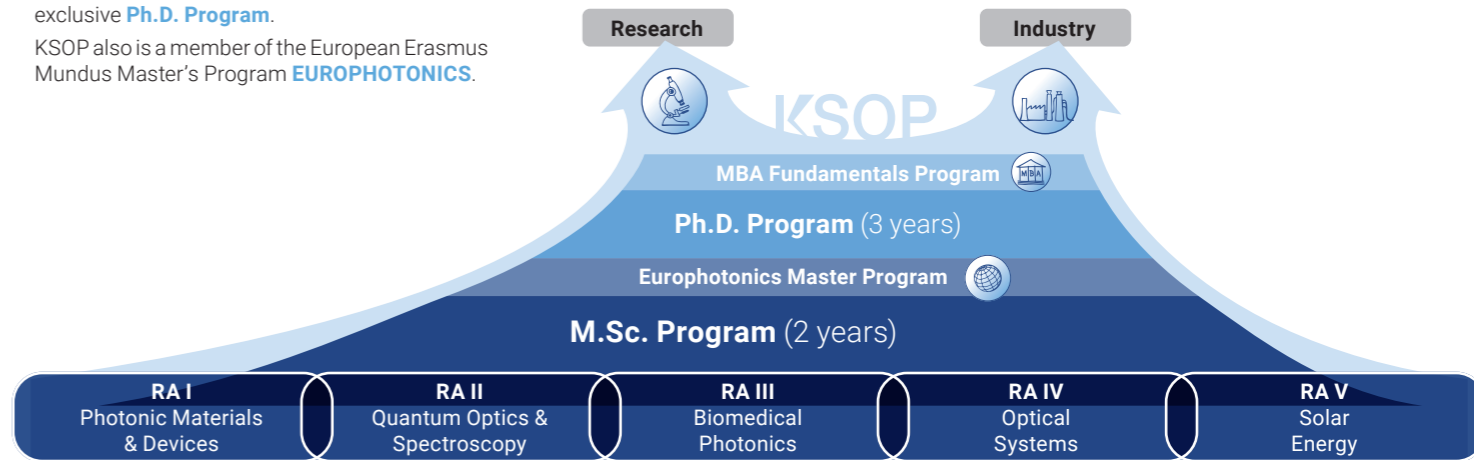
Advantages for Students, Doctoral Researchers & Industry

By boosting a strong industry partner program, KSOP identified the requirements of O&P companies on its graduates. Those demands and specifications were integrated, e.g., within the M.Sc. program including laboratory courses, research projects, industry internships, and German courses tailored to the qualification of international students.

A strong pillar of the Ph.D. qualification concept is the individual coaching and supervision of its doctoral researchers by the research area mentors.

On top of this, KSOP actively promotes the thesis work of its doctoral researchers by scientific and technical training.

Concomitantly, the professional skills of the graduates are enhanced by tailored personal and management training, e.g., in the optional **MBA Fundamentals Program** which offers the opportunity to deepen the keenly demanded knowledge. The certificate and the corresponding credit points gained in the program are recognized in any international MBA program.



Light Up Your Future! KSOP Master's Program



Interdisciplinary Approach

The KSOP M.Sc. Program aims at educating excellent students in Optics & Photonics worldwide. The interdisciplinary research structure of the international graduate school forms the basis for this outstanding 2-year Master's program. Completely taught in English, the program is developed for 40 students each year who apply with a completed Bachelor's degree in natural or engineering sciences.

KSOP unites **17 institutes of the KIT**. The KIT is the Research University in the Helmholtz Association of National Research Centers in Germany. The research and educational concept of KSOP has been established to optimally reflect the **multidisciplinary research** among natural scientists and engineers. KSOP research activities cover the most important topics in Optics & Photonics and excel, particularly in the **five research areas**. They are strongly interlinked and most institutes feature research projects in more than one of the areas.

KSOP's educational concept is supported by **Premium industry partners**. These partners provide students with internships, excursions, individualized workshops, career events, and even master thesis scholarships.

What's Unique

Industry Network: The studies include an elaborated industry internship program with partners from the Optics & Photonics industry. Furthermore, company visits and career events are offered regularly to all students. This cooperation is of high value not only for students but also for industry partners, as it provides a gateway for future employment opportunities.

Industry Lecture by ZEISS: Students have the chance to attend lectures by innovation specialists from the industry and create new business ideas.

Smart Factory@Industry: At KSOP, students can take part in industry training projects by key players in the German industry. This program is exclusive and allows a few students each year to participate.

Scholarships: For outstanding students who are among the best 10% students of their class, scholarships are offered.

International Student Community: Students from all over the world convey an international studying atmosphere to the Master's program. KSOP students also have the opportunity to join the worldwide OPTICA (formerly OSA) and SPIE network through the OSKar student chapter at KIT.

Key Data & Benefits



2-year International Master's Program | Prerequisites: B.Sc. Degree in Optics & Photonics, Natural or Engineering Sciences



Specializations | Photonic Materials & Devices, Quantum Optics & Spectroscopy, Biomedical Photonics, Optical Systems, Solar Energy



Benefits | Industry Internships, Networking, Intensive Lab Training, Language Courses & Business Etiquette Training



KSOP Scholarship Program | Scholarships Available for Outstanding Applicants



Program Language **English** | Start **October**

Structure of the M.Sc. Program

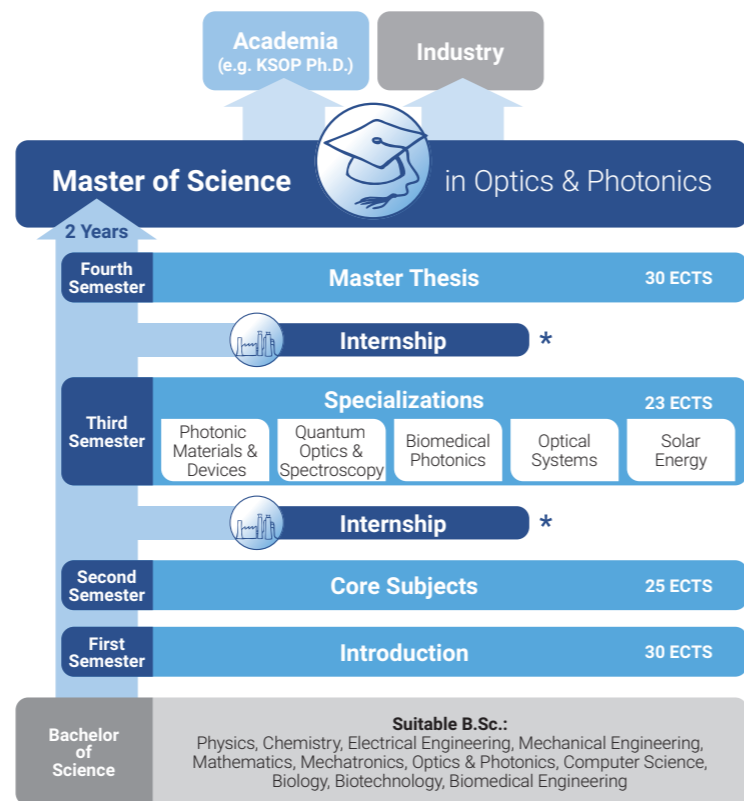
Duration	2 years
Degree	Master of Science (M.Sc.)
Workload	120 ECTS including an 8-week internship
Specializations	5 Research Areas
Teaching Language	English
Start	Yearly in October

After completing the fundamental introductory courses and core subjects in the first two semesters, each student chooses a research specialization. An optional eight-week internship will take place either between the second and third semester or between the third and fourth semester. It is credited with 12 ECTS.

During their studies, Master students come into direct contact with KSOP research groups. Graduates of the Master's program can apply for the **KSOP Ph.D. Program** to deepen their knowledge in Optics & Photonics.

Apply from December - September each year!

NEW: Students can now benefit from applying during one of the three early deadlines as well as the regular admission deadlines for a start in October of each year. **This increases the chance to be admitted earlier, allowing ample time to secure a visa, accommodation, finances, and more!**



* An eight-week internship will take place either between the second and third semester or between the third and fourth semester. This internship is optional and is credited with 12 ECTS.

Steps to Apply



- Inter-disciplinarity
- Study with the Best
- Strong Industry Network
- International Orientation
- Scholarships
- Study & Career Guidance
- Campus Housing
- Ph.D. Program
- Perfect Location
- Patents
- Awards
- Research
- Hall of Fame
- Publications

Voices of KSOP Alumni



»For a person like me who is fascinated by every aspect of Optics and Physics, the broad study plan of KSOP was definitely an eye-catching parameter. In addition, the cooperation of KSOP with the industry and its emphasis in acquiring additional soft skills were what motivated me to apply for this program. Although I am working as an Optical Engineer, I can use my experience and knowledge from other divisions proposed by KSOP and be more innovative. I guess most of KSOP students agree on the fact that studying at KSOP is not just about having great courses with sophisticated professors and being exposed to leading industries. It was also about people who were always there to support you. The different backgrounds of my classmates gave me a great opportunity to get to know other cultures and broaden my view towards the world and life. Overall, KSOP had everything that I could ask from a Master's program and then some.«

Fatemeh Hosseini is now working at Robert Bosch GmbH as Optical Engineer

»What I like about the program is the combination of theory and practice. Practical experience is highly important as all the theory is worth nothing if you can not apply it to something real.«

Lisa Kadner is now working at Polytec GmbH as Application Engineer



»I really like the internationality of the program. The fact of having colleagues from so many different science and/or engineering backgrounds and having the opportunity to work with them and learn how they approach finding solutions enhances my expertise all the time.«

Javier Mauricio Bruges Martelo completed his master's thesis at ZEISS

More Alumni Voices:
www.ksop.kit.edu/MSc_alumni.php



Looking for a Bright Future? KSOP Ph.D. Program



Research+ Concept for Success

The Karlsruhe School of Optics & Photonics offers a **3-year Ph.D. program** in one of the research areas: Photonic Materials & Devices, Quantum Optics & Spectroscopy, Biomedical Photonics, Optical Systems, and Solar Energy.

KSOP provides Ph.D. candidates with an optimal research environment at the Karlsruhe Institute of Technology (KIT) to carry out first rank Ph.D. projects in the multidisciplinary field of Optics & Photonics. Integrated into the graduate school, doctoral researchers pursue their projects autonomously. To support their endeavor, a **Thesis Advisory Committee (TAC)** and a **Co-Supervisor** accompany the research work of the doctoral researcher. All Ph.D. positions are financed.

Since successful careers in industry and academia often require leadership and interdisciplinary knowledge, emphasis is laid on management skills, which are taught as **management modules** within KSOP, in addition to the **technical and scientific modules**.

In addition to that, KSOP fosters an active **network** amongst its members - active or alumni. A scientific exchange with international peers and leading scientists is facilitated through events and international conferences.

Spezializations

RA I | Photonic Materials & Devices | Research in new materials-, synthesis-, and deposition technologies fosters new designs of photonic materials and devices, e.g., luminescent nanoparticles, organic films, or photoresists.

RA II | Quantum Optics & Spectroscopy | Spectroscopy plays a crucial role in uncovering and characterizing novel quantum and non-linear phenomena molecular photophysics or atmospheric chemistry.

RA III | Biomedical Photonics | Biomedical photonic technologies are crucial for noninvasive clinical monitoring, molecular diagnostics, or imaging of physiological parameters in living cells, humans, and whole organisms.

RA IV | Optical Systems | Sensing and machine perception systems, laserbased manufacturing, and production monitoring are examples where optical materials and devices are integrated into real-world applications.

RA V: Solar Energy | The conversion of solar radiation into electrical energy might one day cover the major part of the electricity supply. Light management by means of tailored plasmonic or dielectric structures can reduce costs of the future solar electricity.

Key Data & Benefits



3-year International Doctorate Program | Prerequisites: M.Sc. Degree in Optics & Photonics, Natural or Engineering Sciences



Research Areas | Photonic Materials & Devices, Quantum Optics & Spectroscopy, Biomedical Photonics, Optical Systems, Solar Energy



Benefits | English working language, Supervision & Mentoring Concept, National and International Networking, Modular Training (Management, Technical, and Scientific)

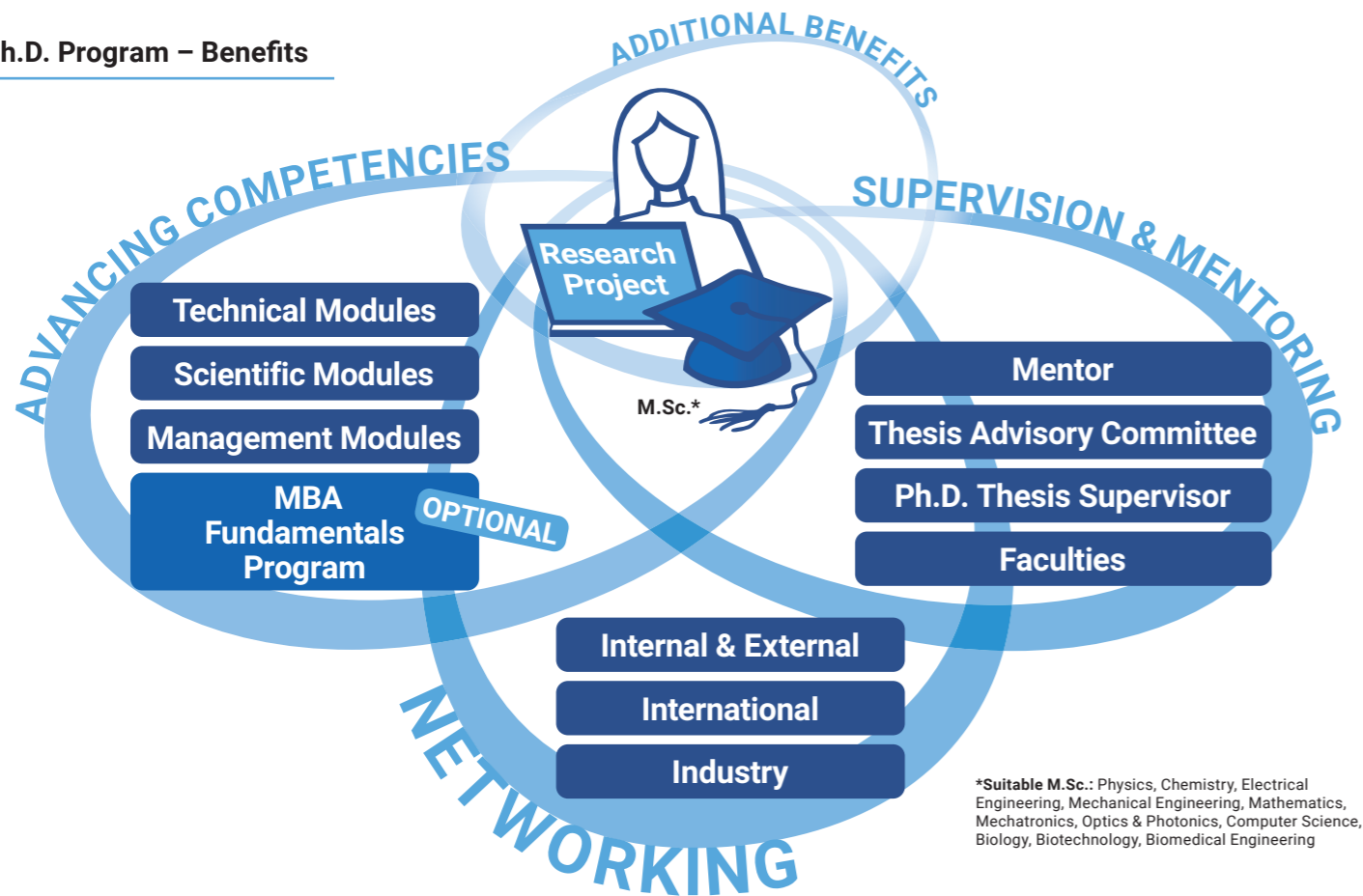


KSOP Scholarship Program | Scholarships Available for Outstanding Applicants



Program Language **English** | Start **Individual** | Location **Karlsruhe, Germany**

Ph.D. Program – Benefits



Voices of KSOP Ph.D. Alumni

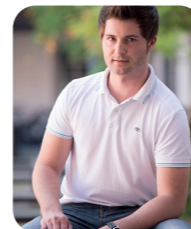


»The reason why I joined KSOP was that I hoped to broaden my horizon. And that is exactly what happened:

During the Ph.D. seminars and the Management and Technical Modules, I gained insight into more applied approaches which I, as a scientist in basic research, would not have obtained so easily otherwise.

In plus, KSOP made it possible to attend various international conferences and also financed a visiting research fellowship at Peking University, allowing me to adopt a more global perspective.«

Dr. Ninette Stürzl,
KSOP Alumna



»KSOP has supported me from the beginning of my Ph.D., starting with a scholarship, which was a great financial help to start my research.

In addition, my work benefited from contacts to other young scientists in the optics field which were mediated by KSOP and lead to several fruitful collaborations with other institutes within KIT.«

Dr. Tobias Großmann,
KSOP Alumnus



»Taking part in KSOP's Ph.D. program turned out to be an excellent opportunity to look beyond the frontiers of one's own studies.

KSOP offers a platform to get to know a variety of people from different disciplines and provides a broad program of advanced vocational training courses.

These courses are particularly valuable, and it is my experience that people in the industry share this opinion.«

Dr. Tolga Ergin,
KSOP Alumnus

More Ph.D. Alumni Voices:

https://www.ksop.kit.edu/PhD_alumni.php



Why KSOP?

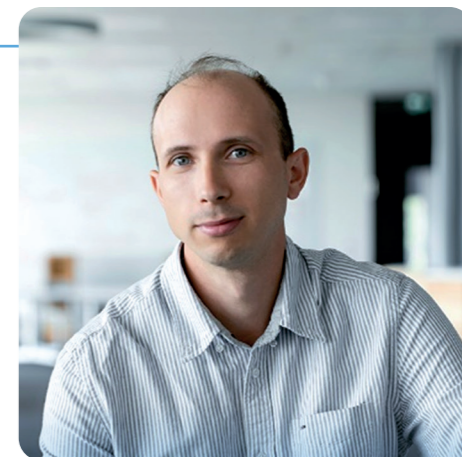
»I joined KIT in 2013 to build up my research group dedicated to light management solutions in optoelectronics. In parallel, I had the chance to be a KSOP mentor for 7 years.

It gave me the opportunity to exchange and launch successful cooperation with many KSOP members who were at different career stages and were working in different areas of Optics & Photonics.

This environment was an asset for me and my students as it enabled to develop a core technical expertise and simultaneously, to cultivate a culture of curiosity for other scientific and business-related topics.

The capacity to deep dive into certain technologies and applications while being able to rapidly comprehend and analyze new domains is a key aspect of my mission at ZEISS, and an advantage for any position in research.

The network of academic and industrial experts that I have created within KSOP is an invaluable resource, which I continue to use in order to foster innovative ideas.«



Dr. Guillaume Gomard
Senior Scientist & Innovation Scout
ZEISS Innovation Hub @ KIT

KSOP Qualification Program EUROPHOTONICS



Photonics in Europe

Next to its own Master's program, KSOP is also a member of the European Erasmus Mundus Master's Program **EUROPHOTONICS**.

The EUROPHOTONICS Master's offers excellent teaching at top-level universities and individual study mobility throughout Europe. An extensive two-year master-level teaching program focused on advanced and applied research topics that will constitute the near and extended future scientific goals in the field of Photonics Engineering, Nanophotonics, Biophotonics, and their interdisciplinary applications.

Partner Institutions

- Germany:** • Karlsruhe Institute of Technology (KIT)
- France:** • Aix Marseille Université (AMU)
• Ecole Centrale de Marseille
- Spain:** • Universitat Politècnica de Catalunya (UPC)
• Institute of Photonic Sciences (ICFO)
• Universitat de Barcelona (UB)
• Universitat Autònoma de Barcelona (UAB)
- Finland:** • Tampere University of Technology
- Lithuania:** • Vilnius University

Program & Mobility Structure

- Semester 1:** Fundamentals (AMU)
- Semester 2:** Core Subjects & Industry Internship (KIT or AMU)
- Semester 3:** Specialization (participating university)
- Semester 4:** M.Sc. Thesis (participating university)

Depending on the personal mobility structure, graduates will receive a Master of Science degree awarded with 120 credits by at least 2 universities. The language of instruction is English.



»I thank Europhotonics/KSOP for accepting me in their organization, allowing me to train under their state-of-the-art facilities and most importantly shaping my personal and professional identity beyond my limitations.

Its unique and interdisciplinary scientific and management programs educated me in physics, chemistry, mathematics, biology, and business of optics and provided an exposure to world-class research, to top-notch institutions and industries.

Above all, it made me who I am – confident, broad-minded, and passionate, which facilitates the working process in every aspect of my life and career. I wish the whole team all the best to keep encouraging the bright young minds and enlightening us with next-generation innovation and technologies!«

Dr. Radwanul Hasan Siddique, KSOP Alumnus
Postdoctoral Scholar at Caltech, USA

Key Facts



2-year M.Sc. in Europhotonics



3 M.Sc. Degrees



3 Different European Countries

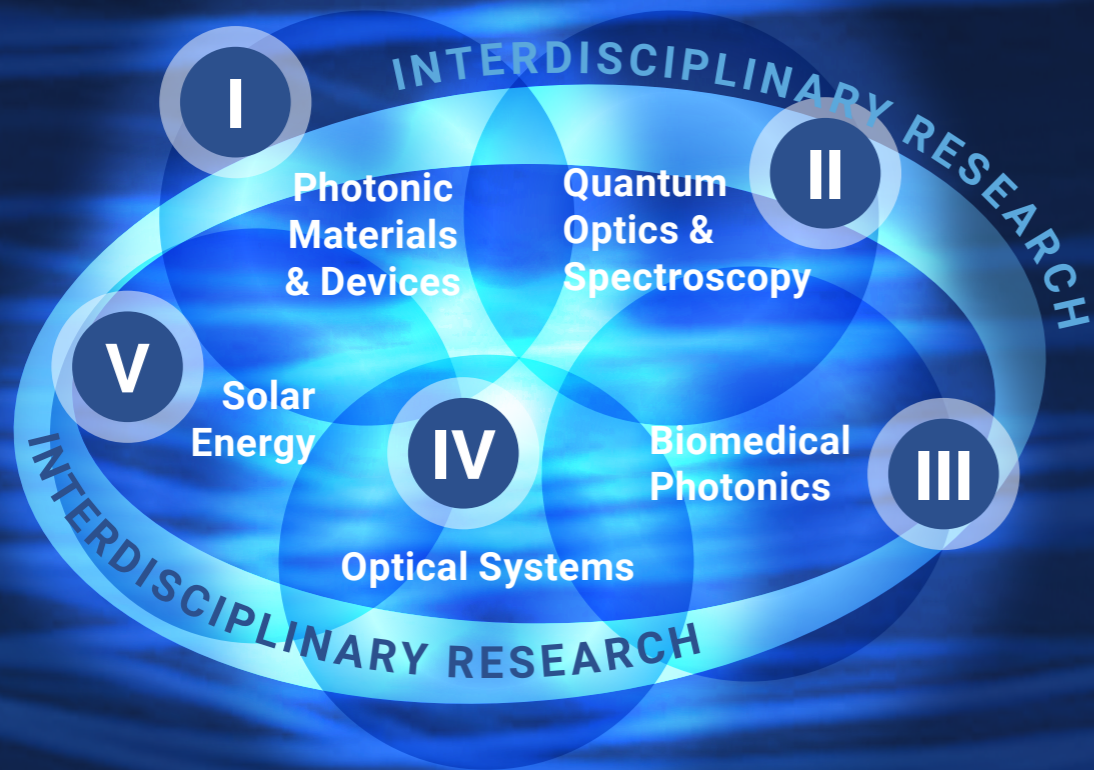


Scholarships Available



Support in Accommodation, Relocation & Administration

KSOP Research Areas



Key Technology Research

Optics & Photonics are key technologies of the 21st century. They form, e.g., the basis for today's optical communications, environmental sensing, biomedical diagnostics in the life sciences, energy efficient lighting and solar energy harvesting.

Future progress and growth rely on dedicated research and graduates trained in an interdisciplinary environment. Consequently, the KSOP research areas were set up to cover many important aspects of Optics & Photonics.

The research and educational concept of KSOP has been established to optimally reflect the spirit of multidisciplinary research among scientists and engineers. Therefore, all research areas are strongly interlinked and most institutes feature research projects in more than one of the research areas.

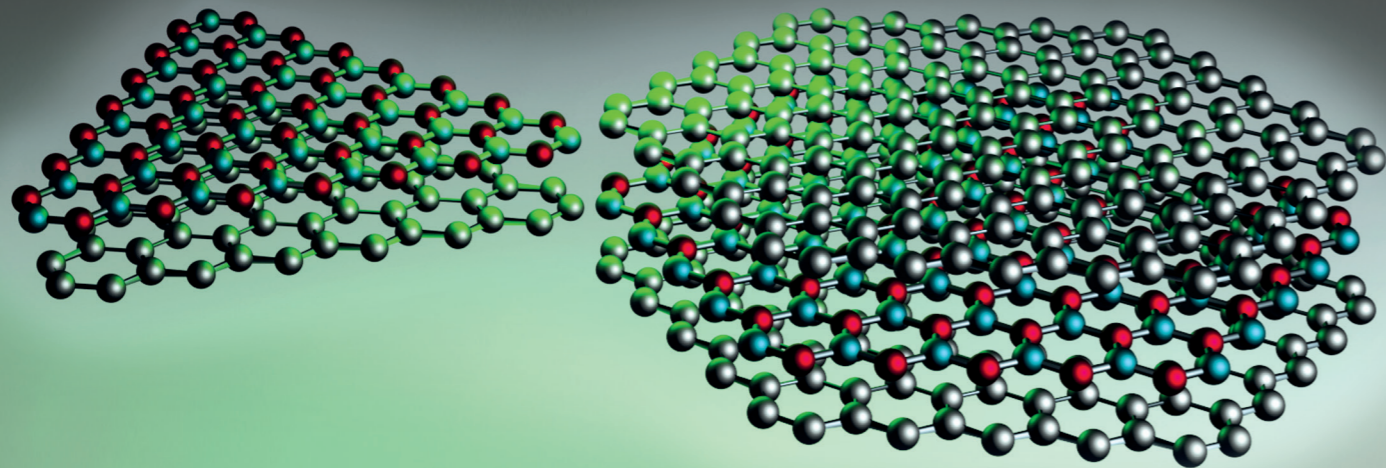
The research areas I-IV were already established in 2006. Meanwhile, sustainable energy supply has become an even more urgent global challenge. Thus, research area V Solar Energy was set up in the next funding period in 2011.

In what follows, the most significant advances in these five research areas, recent KSOP research highlights, and future KSOP measures concerning the research strategy are summarized.



Dr.-Ing. Judith Elsner
Managing Director Karlsruhe School of Optics & Photonics

RESEARCH AREA I: Photonic Materials & Devices



Optics & Photonics are all about generating, controlling, and harvesting light – which is simply not possible without linear/nonlinear optical materials.

Thus, we explore new materials-, synthesis-, and deposition technologies for, e.g., luminescent nanoparticles and NLO materials, organic films, or photoresists. In addition, novel concepts like optical imaging, plasmonics, photonic crystals, photonic metamaterials, and transformation optics have emerged throughout the last decade, providing completely new conceptual opportunities regarding the design of optical sensors, imaging probes, photonic materials and devices. Furthermore, two-dimensional and three-dimensional lithography and chemical synthesis approaches have improved considerably, such that photonic structures previously believed to be inaccessible have come into reach.

Such research cannot be pursued experimentally only but is always complemented by theory and numerics that can be used to explore photonic materials and design them on-demand. This concerns linear, nonlinear, and quantum aspects. Tools to solve forward and inverse problems, and technologies from the general field of computational material design, also inspired by artificial intelligence, are of current interest. Quantum-chemical tools to study the optical properties of molecular materials and consider them in the design of macroscopic photonic devices are of interest too. We contribute to all of these developments.

Our research is, for example, driven by the quest for ever faster and smaller devices for telecommunications, by biomedical material requirements, or by the need for more efficient and/or less expensive solar-energy conversion. By developing key technologies like three-dimensional direct laser writing (DLW), Research Area I also provides the basis for parts of Research Area III 'Biomedical Photonics'.

Future Aims & Goals

Future aims in this research area are designing and realizing novel materials and material functionalities and ever smaller and/or faster devices. To achieve this goal experimentally, serious lithography challenges have to be tackled, especially regarding three-dimensional structures. Furthermore, the theory has to progress towards quantitative modelling of complex photonic nanostructures with predictive power and for the inverse design. We aim to understand from a symmetry perspective photonic materials to conclude on emerging properties that they offer.

A grand challenge throughout our research concerns the translation of these insights into specific applications with societal impact.

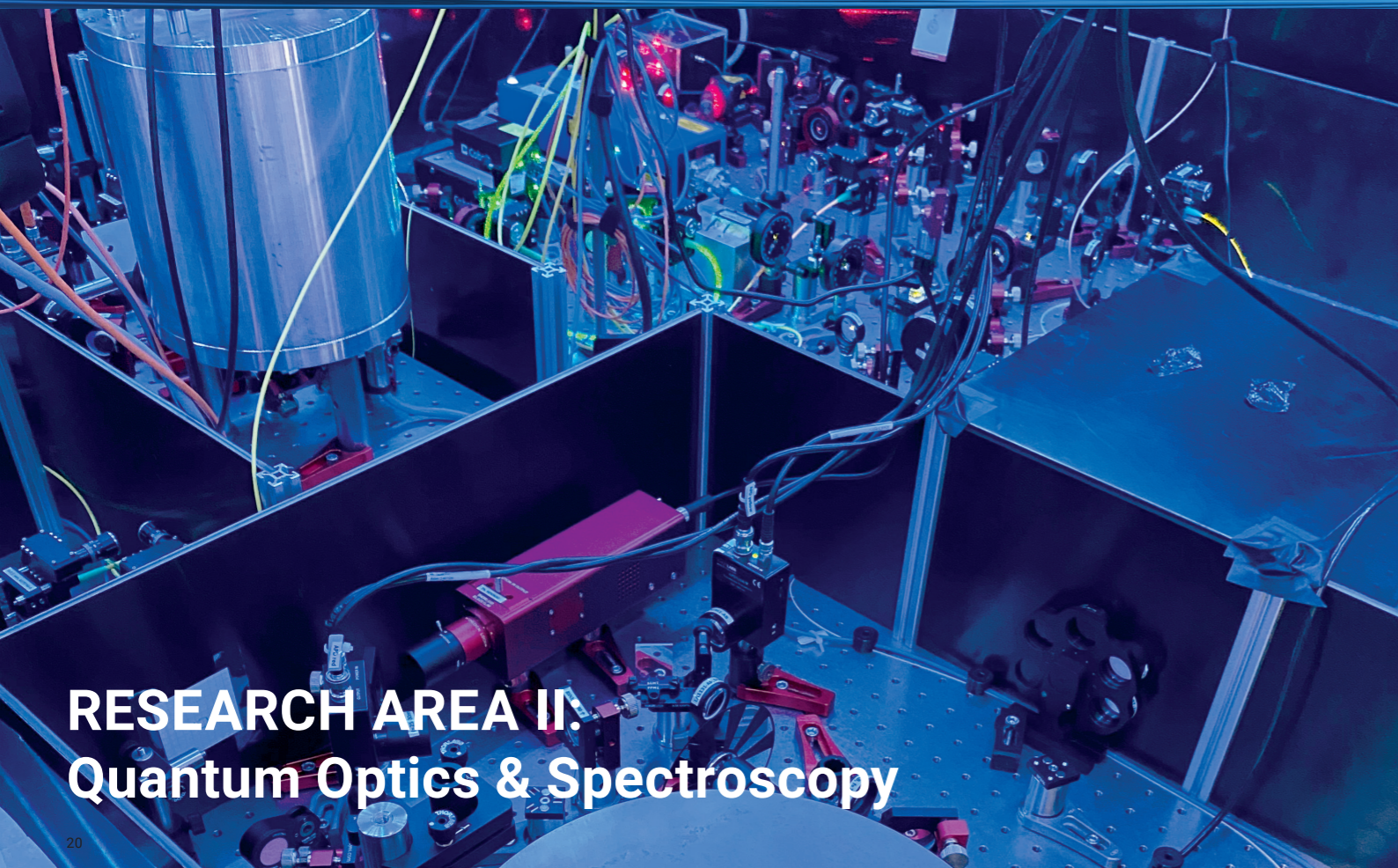
Research Highlights

Metamaterials / Telecommunication Devices / Luminescent Nanoparticles



Prof. Dr. Martin Wegener

Scientific Speaker of RA I, Institute of Applied Physics, KIT



RESEARCH AREA II. Quantum Optics & Spectroscopy

Quantum optics is a dynamic research field concerned with the properties of individual quanta of light, called photons, and their interactions with atomic-scale systems.

It comprises the fundamental understanding of the basic processes encountered in spectroscopy, the working principle of lasers, as well as applications of quantum light for quantum technologies such as secure communication, or for interconnecting future quantum computers into quantum networks.

RA II covers experimental and theoretical research on fundamental quantum optics phenomena and their applications, as well as the development and application of advanced spectroscopic methods.

One focus is the investigation of materials that can serve as quantum light sources and optically addressable quantum bits. To control light-matter interactions, engineered photonic devices are developed, ranging from optical microcavities to nanoplasmonic antennas and integrated optical circuits. Expanding a detailed theoretical understanding of novel materials and photonic devices is key to these developments.

On the other hand, advanced spectroscopic methods which can probe sample composition and properties play a crucial role in helping to uncover and characterize novel quantum and nonlinear phenomena in many fields, ranging from molecular photophysics to atmospheric chemistry. At KSOP, methods are developed and

applied, including ultrafast spectroscopy, remote sensing, and highly spatially resolved imaging. Such advanced techniques are essential for expanding research horizons, e.g., in materials science and nanotechnology.

Future Aims & Goals

Grand goals of this RA are to push the development of quantum communication over large distances, and to realize optically addressable quantum bit registers for quantum computing and quantum information storage, which could serve as building blocks of a future quantum internet.

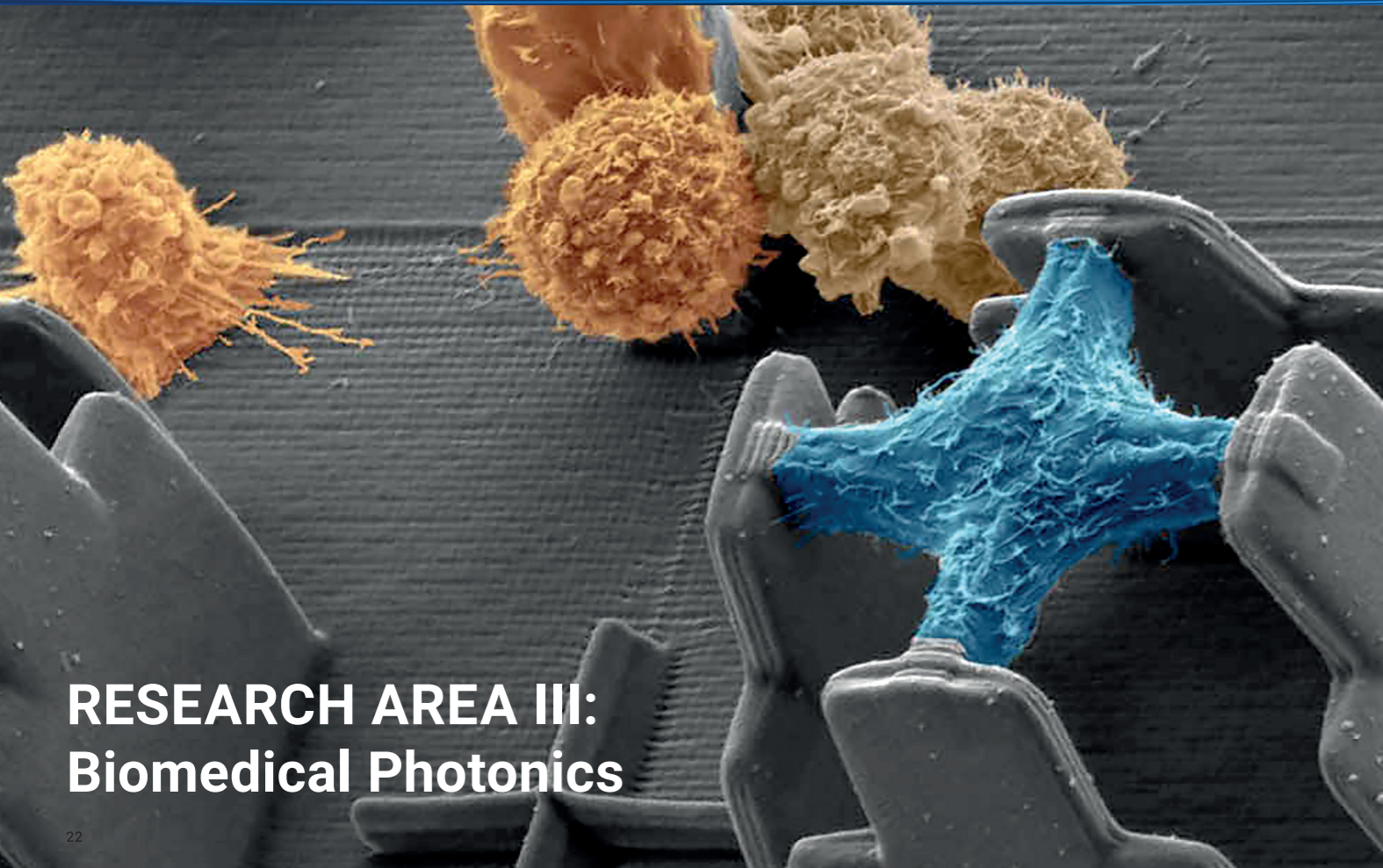
Further, RA II will be devoted to develop spectroscopic tools for molecular sensing with significantly enhanced spatial- and temporal resolution. Well-defined applications for such high-resolution nanochronoscopic tools also require parallel improvements in sample quality. Here ion- and neutral particle traps offer interesting perspectives, e.g., for controlled gas adsorption, molecular orientation, and ultralow temperatures enable access to noise-free environments.

Research Highlights

Optically Addressable Quantum Bits / Cavity Enhancement of Light-Matter Interactions / Ultrafast Spectroscopy / Remote Sensing



Prof. Dr. David Hunger
Scientific Speaker of RA II, Institute of Physical Chemistry, KIT



RESEARCH AREA III: Biomedical Photonics

Advances in Optics & Photonics have always driven progress in many areas of biology and medicine.

For example, biomedical photonic technologies are crucial for non-invasive clinical monitoring, molecular diagnostics, or imaging of physiological parameters in living cells, humans, and whole organisms. In addition, new optics-based tools have been engineered to manipulate biological systems by, e.g., laser-tweezers or light-switchable dyes and proteins for optogenetics. Regarding microscopy, several fluorescence-based microscopic techniques have been further developed and applied to image biological samples with sub-diffraction resolution. These techniques include pointillism approaches, like photoactivation localization microscopy (PALM), stochastic optical reconstruction microscopy (STORM), and structured illumination microscopy (SIM).

Research activities within KSOP span from advanced microscopy to the development of optics-based personal health monitoring. Super-resolution microscopic techniques are further developed into live-cell imaging modes. In addition, intelligent high-content screening microscopes for biological samples, e.g., zebra fish, are engineered. Furthermore, several optical methods for the detection and quantification of biomolecules are developed. These include ultra-sensitive micro-disk resonators, and other bio-functionalized nanophotonic structures for parallel detection in lab-on-a-chip applications

(see Research Area IV). Moreover, non-invasive monitoring of essential human blood parameters such as pressure and glucose levels has been developed. Finally, direct laser writing (see Research Area I) is applied to fabricate three-dimensional 'designer petri-dishes' to study cell behavior and stem-cell differentiation.

Future Aims & Goals

With these novel multifunctional substrates, the effects of spatial ligand distributions and mechanical scaffold stiffness on cell behavior and stem-cell differentiation can now be systematically studied in three-dimensional environments. Further work in Research Area III aims at developing light microscopy super-resolution methods into live-cell imaging modes to study biomolecular interactions in living systems at the highest achievable spatial and temporal resolutions. The basic research activities on biomolecular sensing techniques shall be targeting the ultimate goal of label-free single-molecule detection.

Research Highlights

Super-resolution Microscopy / Optical Biosensing / Tailored three-dimensional Scaffolds for Cell Culture



Prof. Dr. Martin Bastmeyer

Scientific Speaker of RA III, Zoological Institute, KIT

RESEARCH AREA IV: Optical Systems



In real-world applications, optical materials, devices and spectroscopic approaches are integrated into optical systems.

Examples are sensing and machine perception systems, laser based manufacturing, optical metrology for production monitoring, and optical communications. Research and development have led to tremendous performance improvements and have enabled new fields of applications. Thus, the market for optical systems has grown considerably throughout the last five years.

KSOP research in this area addresses a wide variety of optical systems with a broad spectrum of applications. For example, driver assistance systems have significantly reduced accidents of automobiles. The development of three-dimensional visual perception systems for autonomous vehicles is one of our long-term goals. Similar approaches form the basis for cognitive machines and robots. Furthermore, our research addresses the ever increasing demand for more energy efficient, ultra-high bandwidth optical communication systems. This requires novel architectures and data-transmission schemes that take advantage of newly emerged linear and non-linear photonic devices (see Research Area I). In addition, novel optical sensor systems for visual inspection as well as optical lab-on-a-chip systems for biomedical purposes are investigated within KSOP.

Future Aims & Goals

Future research in the field shall investigate Bayesian techniques for robust three-dimensional optical scene perception and scene understanding for mobile machines. We aim at fully autonomous navigation of robots and vehicles. The long-term impact of such technological advances can hardly be overestimated. Accident-free automobiles and fully automated multimodal logistics are two innovations enabled through optical scene perception. Furthermore, we will further increase the energy efficiency and band-width of optical communication systems by the integration of novel photonic signal processing concepts that combine the advantages of energy-efficient passive photonic circuits with FPGA-based digital techniques. The third field offering unprecedented innovations is addressed by lab-on-a-chip optical systems. The integration of optical and fluidic functions on one chip and an increased sensitivity by applying both fluorescent and label-free biomedical detection with efficient read-out schemes will be in the focus of future research in this field.

Research Highlights

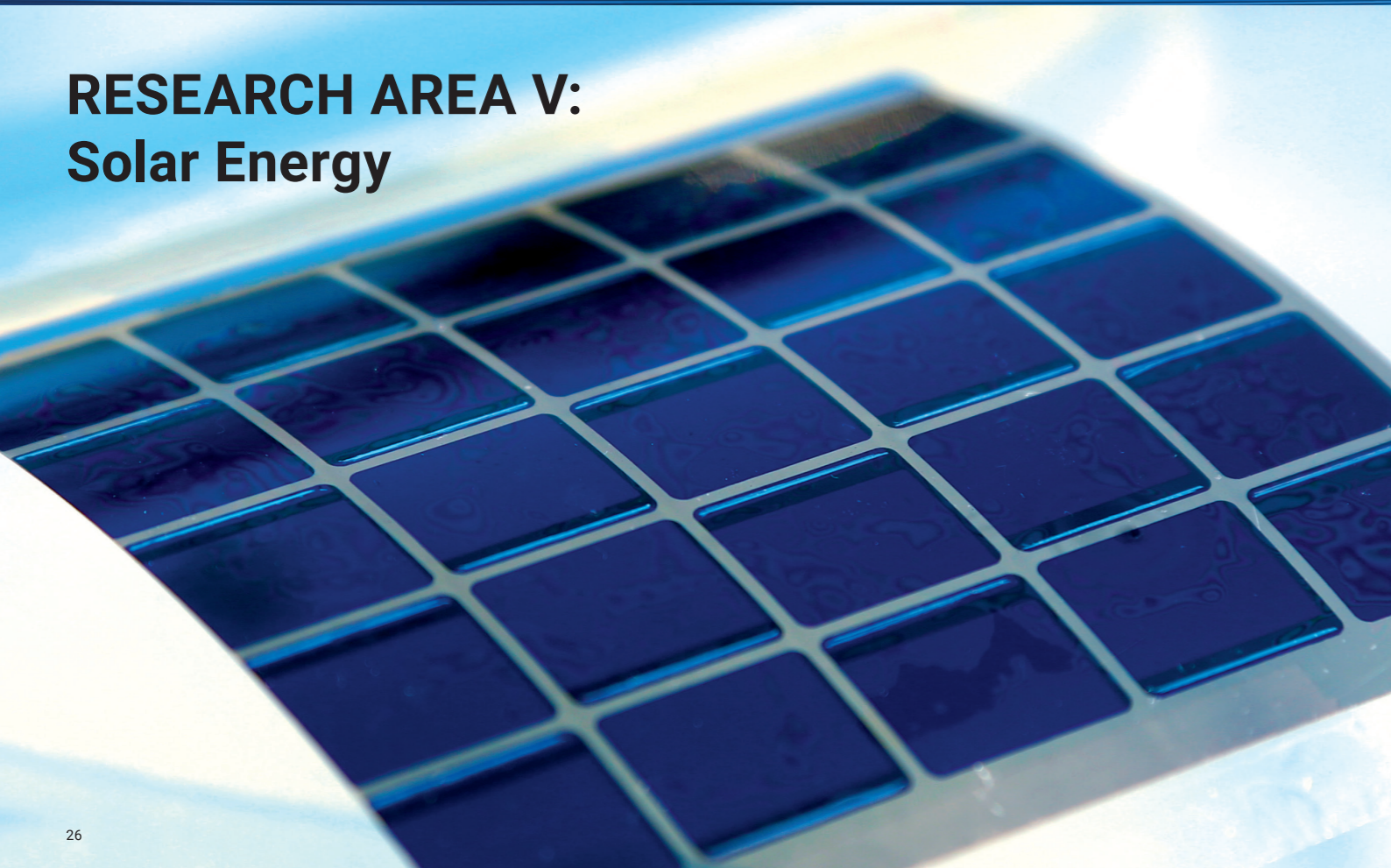
Autonomous Vehicles / High Bit-rate Optical Communications / Lab-on-a-chip Systems



Prof. Dr.-Ing. Christoph Stiller

Scientific Speaker of RA IV,
Institute of Measurement & Control Systems, KIT

RESEARCH AREA V: Solar Energy



The direct conversion of solar radiation into electrical energy is expected to cover a major fraction of the electricity supply in the upcoming decades.

While solar-panel installations have impressively increased throughout the last decade, corresponding to a total electrical peak power of more than 700 GWp in 2020, further breakthroughs in efficiencies and in low-cost materials and processes are necessary.

Optics & Photonics research can contribute in various ways to the goal of affordable future solar electricity: Light management by means of tailored plasmonic or dielectric structures can reduce the costs since it allows for a thickness reduction of the solar cells. Another central aspect is the research on novel materials with improved photovoltaic properties.

Cost reduction can not only be achieved by improved efficiencies but also by reduced deposition costs. Thus the study of novel semiconductors that can be deposited by cost effective methods is another important aspect of solar cell research.

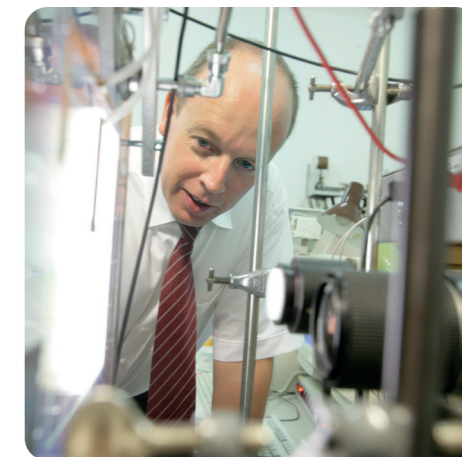
Future Aims & Goals

We have extended our facilities for the fabrication and the characterization of novel photovoltaic materials and cells and have implemented several new laboratories over the last years. We are ramping up activities in the field of perovskites semiconductors and are covering all aspects from novel materials (including lead-free compounds) over device architectures towards module fabrication and building integration. RA V has furthermore started significant activities on tandem solar cells combining perovskite semiconductors with silicon and CIGS solar cells.

The development of low-cost, high efficiency all printed foils for light and spectrum management is an additional important goal of our research.

Research Highlights

Perovskite solar cells / Solution processable solar cells / Tandem solar cells / Light management and spectral conversion / Advanced spectroscopy



Prof. Dr. Uli Lemmer

Scientific Speaker of RA V, Light Technology Institute, KIT

Karlsruhe



Weather

25.5°C Max. average monthly temperature (July)

1,935 Annual hours of sunshine

One of the warmest & sunniest places in Germany!



Mobility

Comfortable & fast to reach via train:
International Airport Frankfurt 1,
Paris 2.5, Amsterdam 5.5,
London 6, Prague 7 hours

Bicycle-friendly city

High frequency tram network
for a car-free city center



Karlsruhe – In the Heart of Europe – A Great Place to Live and Study

City's population: 300,000

Students at the KIT: 23,000

What's special about Karlsruhe?

Its unique fan-shaped city architecture was a role model for Washington DC in the USA.

Karlsruhe is also called "the city of justice", since the German Federal Constitutional Court and Federal Court of Justice are seated there.

It is a UNESCO City of Media Arts.


In the heart of Europe, it offers easy access to mountains, lakes, rivers, forests, castles, skiing and other outdoor sports.


Technology Region Within A Leisure Paradise

Karlsruhe offers direct access to the world renowned **Black Forest**. It is surrounded by numerous **lakes** for swimming, the **Rhine**, one of Europe's most important rivers, runs through it, and it has a direct view of the **French Alsace region**. Students therefore enjoy a high quality of living with a wide variety of leisure activities and are surrounded by nature.



Figures of interest

 Frankfurt Airport as Europe's 4th largest airport is only one hour away by train

 The technology region Karlsruhe is one of the leading commercial and innovation regions in Europe

 The federal state Baden-Württemberg, in which Karlsruhe is located, is one of the safest states in Germany

Extensive Cultural & Sports opportunities

Karlsruhe offers something for everybody's taste with its academic centers of excellence in music, art, design, media and technology.

Museums & Galleries | The world-famous Center for Art & Media Karlsruhe, called "ZKM" is located there.

Music Festivals | "DAS FEST" in July each year, for example, is one of Germany's largest open-air festivals.

Sports | Karlsruhe has more than 1,500 sport clubs that offer 60 different kinds of sports. A wide variety of sport clubs are also based within the KIT for students.

Trade Fair Center | Innovative events & international trade fairs



Karlsruhe Institute Of Technology (KIT) - Campus & Infrastructure

Study With the Best

The Karlsruhe Institute of Technology (KIT) is one of the leading technical universities in Germany and Europe. Outstanding rankings and evaluations vouch for the standard of research and education at KIT.

 2022
Employability Ranking

#1 #10 #46

Germany | Europe | Worldwide

This is without a doubt the most beneficial result of the 2006 merger of the Karlsruhe Research Center and the former University of Karlsruhe, which dates back to 1825. Currently, KIT is one of the largest research and teaching institutions in the world. The student satisfaction in Karlsruhe is among the top in Germany due to a systematic, balanced curriculum and excellent teaching staff.

KIT Infrastructure

KIT offers a very comprehensive university infrastructure. Young scientists get a fascinating framework for their explorations at projects, experiments and plants in major research institutions. Furthermore, there is a 24/7 library and a diverse culture, music, and sport offerings. KIT has numerous student organizations where students can, for example, put the theory from their lectures into practice. There is, for instance, a group working on autonomous model cars (KITcar) or a team for innovative field robots (KaMaRo Engineering e.V.).



Optic Students Karlsruhe (OSKar)

OSKar is part of a worldwide network of student chapters of the OPTICA (formerly OSA) and of SPIE and comprises a group of enthusiastic students coming from different academic and cultural backgrounds, united by the common interest in sharing Optics & Photonics knowledge. The combination of Engineering, Physics, and Optics students in the team gives rise to diverse and complementary ideas that are materialized in different projects and events.



»When I started my Master's degree in KSOP, I found the opportunity in OSKar to achieve one common vision: To meet passionate students who want to spread knowledge about Optics & Photonics. OSKar has focused on participating in outreach activities of KIT and KSOP and provides a great opportunity to integrate in the local community.

Additionally, activities like company excursions, invited lectures, "Stammtisch", and many more provide academic, industrial, and networking spaces to further advance our careers. My key takeaway from OSKar is the network it has built: OSKar alumni give an unparalleled advantage at the beginning of our professional careers. From all this, I highly recommend joining the group and sharing the love of optics with everyone.«

Orlando Torres Perales (left), (Former) President of the Student Chapter Optic Students Karlsruhe

Strong Partner for Industry



Qualification for Innovation

The KSOP prepares students and doctoral researchers for the labor market of the German and worldwide Optics & Photonics industry. The close cooperation to industry partners is of high value for industry on the one hand and KSOP students and doctoral researchers on the other hand.

Advantages for Industry

KSOP industry partners have an exclusive access to high potential and international junior staff. The research and teaching environment fosters innovations and empowers the industry partners to ensure their technological competitiveness.

On top of this, the challenge to solve social and technological problems can only be managed by cooperations between research, industry, and politics. Therefore, the initiative Promotion of Junior Researchers in Optics & Photonics was founded by KSOP. Industry partners can choose from a gold, silver, platinum & start-up cooperation partnership with KSOP and profit from its network, e.g. recruit young professionals for practical training, a master's thesis or jobs.

Advantages for Students & Doctoral Researchers

By gaining experiences in well-known international companies via internships or master's thesis projects, students get in contact with potential future employers and prepare for their professional careers.



The KSOP Career Events:

A Meeting Point Both for Industry & Future Employees

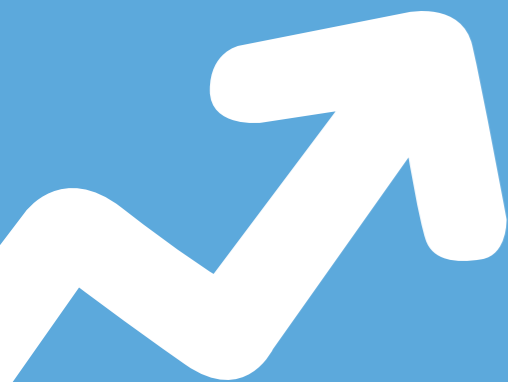


An Interface between industry and its members:

- + Internships & master's thesis projects
- + Recruiting events & industry workshop
- + Networking events between science & industry, i.e. the symposium "Karlsruhe Days of Optics & Photonics" (KDOP), and the KSOP Summer School

What makes KSOP unique?

- + An international multi- and interdisciplinary environment and network for first-class research in the field of Optics & Photonics
- + Training of highly professional young talents in close cooperation with the industry and according to its needs
- + Transfer of research results to industry applications
- + International students & alumni from over 70 different countries
- + Students with a B.Sc. in Electronic Engineering, Physics, Information Technology, Mechanical Engineering, Mathematics, Chemistry or Biology, who are expanding their training with an interdisciplinary M.Sc. in Optics & Photonics



Our Premium Industry Partners



BOSCH
Technik fürs Leben



Benefits for Premium Partners

- + **Influence the choice of scholarship holders:** Through the sponsorships, KSOP finances the studies and further education for numerous scholarship holders. With a partnership, you can influence the selection of suitable candidates and thus control the education of potential young talents for your company.
- + **Get a personal impression:** Get to know students at networking events and start recruiting early during their studies.
- + **Present your company to potential future employees:** Strengthen your employer branding through excursions and career days at your company.
- + **Educate young talents according to your needs early on and tie them to your company:** Gain future employees through internships and master's theses.
- + **Employer branding through professional marketing by KSOP:** Benefit from KSOP's communication channels and place your company with future experts.
- + **Become a partner and enable the training of international junior staff for the Optics & Photonics industry!**

Cooperation Packages

		BRONZE (start-up) € 2,500	SILVER € 10,000	GOLD € 15,000	PLATINUM € 25,000	DIAMOND € 70,000
Visibility	Logos on all Promotional Materials	✓	✓	✓	✓	✓
	Company Teaser in KSOP Newsletters			✓	✓	✓
	Industry Representative Inclusive at KSOP Scientific Event			✓	✓	✓
Social Media Package	KSOP Facebook & LinkedIn Contributions		✓ Basic	✓ Advanced	✓ Premium	✓ Premium +
	Video Clip for KSOP YouTube Channel					✓
International Recruiting Package	Advertised Positions * on KSOP Career Website	✓	✓	✓	✓	✓
	Social Media Distribution of Positions			✓ Basic	✓ Advanced	✓ Premium
	Career Opportunity Mailings to KSOP Students				✓	✓
	Two Online Career Meetings				✓	✓
	On-Site Networking Events				✓ **	✓
	Profile Hunting Package					✓
Scholarship Package	Selection of Scholarship Holders (Advisory Vote)			✓	✓	✓

Packages all tax-deductible; prices p.a. * One job advertisement available for trial and include VAT ** Offered within Karlsruhe county

Scientific Events

At **KSOP** we do not only feel as a school in **Optics & Photonics** but also as a forum on **scientific exchange in Optics & Photonics topics**. Each year we offer our students the opportunity to follow us into the fascinating world of Optics & Photonics.

Three days of each year are fully in light of Optics & Photonics: Alternating the **KSOP Summer School** and the **Karlsruhe Days of Optics & Photonics (KDOP)** take place.

While the **KSOP Summer School** is taking place usually at the countryside which is a great baseline for undisturbed discussions, the **Karlsruhe Days of Optics & Photonics** are located at the Karlsruhe Institute of Technology (KIT).

Commonly, they allure experts of Optics and Photonics each year to share their knowledge with students, young scientists and doctoral researchers in presentations and fruitful discussions.

Thus, they offer a great chance to get extensive insights into latest advancements in Optics & Photonics.

Follow us into the fascinating world of Optics & Photonics!



KSOP Summer School & Karlsruhe Days of Optics & Photonics

Bi-Annual Summer School
for Young Researchers

Bi-Annual Symposium
with Renowned International Guest Speakers



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KSOP Ph.D. Program
www.ksop.kit.edu/phd_program.php



KSOP M.Sc. Program
www.ksop.kit.edu/msc_program.php



KSOP Research Areas
www.ksop.kit.edu/research_areas.php



Erasmus Mundus Europhotonics Program
www.europhotonics.org



KSOP MBA Fundamentals Program
www.ksop.kit.edu/mba_fundamentals_program.php



KSOP Events
www.ksop.kit.edu/2902.php



KIT Rankings
www.ksop.kit.edu/KITRankings.php



2022 Employability Ranking

#1

#10

#46

**GERMANY
EUROPE
WORLDWIDE**

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