

NEWSLETTER

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Foreword

Dear readers,

It is with great pleasure that we present to you a review of the exciting new activities in the CRC 1316. In the last months, a lot has happened in our research network, both within our laboratories and in terms of international collaborations and events.

One notable development has been the high number of participants of our scientists in various international events. In particular, the large number of members of the CRC 1316 who participated in ISPC 25 in Kyoto should be highlighted.

Furthermore, we installed new setups in one of the laboratories. Another welcome development is the Franco-German collaboration focusing on the topic of CO treatment in the processing of biological substrates.

In addition to the activities already mentioned, we would also like to address two other important areas in CRC 1316: Research Data Management and Public Relations.

In the area of research data management, a workshop was held to inform our members about best practices

and new approaches in handling research data. Given the ever-increasing volume and complexity of data in scientific research, efficient and responsible data management is critical.

Another focus was on outreach. We made an effort to make our research results accessible to a wider audience and to raise awareness of the importance of plasmas in society. A particular highlight was the Plasma Truck, which was completed back in 2020 and has now been presented for the first time. We use the Plasma Truck to visit schools and show the students exciting plasma experiments. The aim is to get young people excited about the subject, stimulate their interest in science and introduce them to the fascination of plasmas.

The progress already mentioned reflects the commitment and dedication of the CRC 1316 members. Their contributions are invaluable and contribute significantly to the success of our joint research.

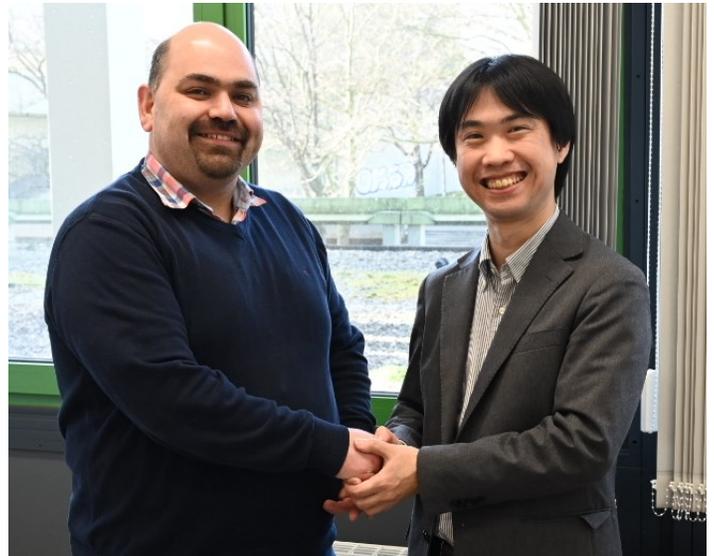
Marina Prenzel, public relations

VISITS

Visit of Prof. Katsuyuki Takahashi

Assoc. Prof. Dr. Katsuyuki Takahashi (Iwate University, Japan) visited the Chair for Atomic and Plasma Physics (Prof. U. Czarnetzki) in Bochum.

During his stay, Prof. Takahashi visited the laboratories of many groups at RUB that are working within the CRC 1316. In a seminar talk Prof. Takahashi presented the various research topics that are covered by his group and the group of Prof. Koichi Takaki (Iwate University). These include pulsed non-thermal plasmas for environmental and agricultural applications among others. The overlap in many of the topics could provide fruitful grounds for future collaborations between the Ruhr University Bochum and the Iwate University.



Tsanko Tsankov & Dirk Luggenhölscher, project A2

Visit of the company Plasmamatreat

The lecture "Introduction to Plasma Physics II" accompanied by Bachelor, Master and PhD students of the chair EP2 and the group Plasma Interface Physics visited the company Plasmamatreat in Steinhagen near Bielefeld. The company excels in the production of atmospheric pressure plasma jets for polymer functionalization.

Martha Finke, public relations



Upcoming events

08 Nov.

Autumn Project Area Meeting: Part A

Location: VZ RUB, Bochum

09 Nov.

Autumn Project Area Meeting: Part B

Location: VZ RUB, Bochum

Spatially and temporally resolved atomic oxygen densities in a micro cavity plasma array

Atmospheric pressure micro-structured plasma discharges have attracted high attention in recent years due to their wide range of potential applications such as the reduction of volatile organic compounds (VOCs) or plasma catalysis. A special type of micro structured discharges, which is characterized by its reproducibility and possibility for experiments, are micro cavity plasma arrays (MCPAs). These consist of a grounded electrode, a dielectric foil and a nickel grid, in which thousands of cavities are arranged in the μm -range. The reactor is characterized by a defined operation in which the plasma is confined in the cavities and the individual discharges can be described as enclosed surface DBDs.

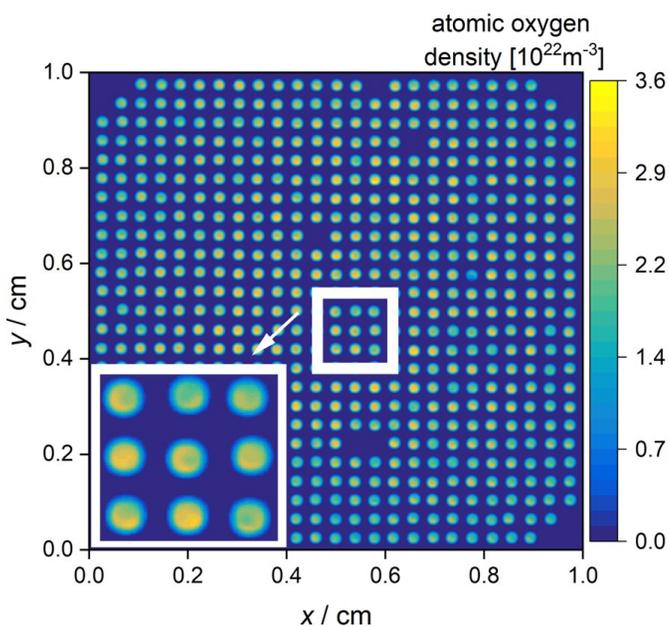


Figure 1: 2D resolved oxygen densities. Conditions: 2slm He, 2 sccm O₂, 1 sccm Ar; 800 V; d = 200 μm ; $t_{\text{exposure}} = 5\text{ s}$. [2]

Reactive species such as atomic oxygen play a key role in plasma catalytic processes, since they are produced in the plasma and can interact with the gas to be treated and the catalytic surface. Furthermore, it can serve as a role model for more complex molecules. For this reason, it is important to monitor the densities of reactive species. In this work, this is achieved using the recently introduced state enhanced actinometry (SEA) [1].

To measure the atomic oxygen density, the cavities of the micro cavity plasma array are imaged onto the sensor of an ICCD camera. An electrically tunable filter selects the wavelengths required for actinometry. With this setup it is possible to determine the atomic oxygen density for each pixel of the ICCD. This results in a very high spatial and temporal resolution for the measurements.

An example is shown in Figure 1. With five exceptions, all cavities are ignited. These exceptions can be attributed to local deviations of the electrode distance, which can result from manufacturing inaccuracies. Densities in the range of $1,022\text{ m}^{-3}$ are achieved. This corresponds to a degree of dissociation of almost 100%, which were expected due to the high electric fields within the cavities.

In addition to a density distribution over the entire array structure, in which the density in the centre is higher than at the edges, distributions within individual cavities can also be discussed. Here, a ring structure is noticeable, which can be explained by the strong electric fields at the edges.

Diagnostics were used to investigate a variation in cavity diameter, voltages and oxygen admixtures. All measurements have a very high degree of dissociation in common, which offers optimal conditions for plasma catalytic applications.

David Steuer, project A6

- [1] David Steuer et al 2022 Plasma Sources Sci. Technol. **31**, 10LT01. doi: 10.1088/1361-6595/ac90e8
- [2] David Steuer et al 2023 Plasma Sources Sci. Technol. **32**, 025013. doi: 10.1088/1361-6595/acb9b9



HONOURS

Martin Muhler receives Alwin Mittasch Award 2023

Prof. Dr. Martin Muhler was awarded the Alwin Mittasch Prize 2023 for his "fundamental contributions to the cross-scale understanding of the mode of action of catalyst materials in chemical reactions for future-oriented technologies".

This award is given to researchers for outstanding achievements in the field of catalyst research by the German Society for Catalysis. The award was handed over in Weimar on March 16, 2023.

Prof. Dr. Martin Muhler holds the Chair of Technical Chemistry at Ruhr-Universität and is vice spokesperson of CRC 1316, PI in project A7 "Plasma catalysis for conversion of volatile organic compounds (VOC)", as well as a member of the MGK.



Congratulations to this honour!

Maïke Kai, public relations

ISPC25 with poster prize winner from plasma physics

The biennial international symposium on plasma chemistry, has been held in Kyoto, Japan at the end of May. A large delegation of Bochum plasma physicists and plasma engineers attended the conference.

The conference covered most aspects of plasma from different fields: plasma medicine, plasma-based gas conversion, plasma in liquid, plasma process and mate-

rial engineering, plasma spectroscopy and diagnostics, etc. The symposium provided a great opportunity to make new contacts and maintain existing relationships. The poster session was also very informative and provided a great opportunity to learn about the latest developments in plasma chemistry.

Overall, the 25th Symposium on Plasma Chemistry in Kyoto was a great success.

Congratulations to Simon Kreuznacht (EP2, RUB) for winning an award at the ISPC25 in Kyoto for his oral presentation on "Space resolved temperature measurements in an argon methane microwave plasma used for hydrogen production".

The Oral Presentation Awards are assigned to the best oral presentations provided by students.

Soad Mohsenimehr & Marina Prenzel



WORKSHOPS & CONFERENCES

MGK & PI Meeting Ulm

The MGK colloquium of the CRC 1316 took place in Ulm at the “Brauereihotel Klingenstein”. Therefore, a group of 30 people consisting of PostDocs, PhD and undergraduate students associated with the CRC met March 1-4. Here, the participants had the opportunity to present their latest work, discuss their projects with each other and to enjoy the vast variety of beers from the brewery. The colloquium consisted of two poster sessions with several posters from each project, as well as eleven presentations in total with three invited speakers, including a contribution from industry on the application of plasma-based technology in exhaust gas purification.

The meeting started with a tour through the electrochemistry labs of the Ulm University and a joint dinner



with the PIs in the evening. The next morning, several PhDs presented their methodological approach in detailed “Method Talks”, which was followed by the first poster session with contributions of every project. After lunch break, Albert Engstfeld held an electrochemistry crash course.

On the last meeting day, three invited speakers, Angela Bayler (centrotherm international AG in Blaustein), Luca Vialetto (CAU Kiel) and Peter Hartmann (Wigner Research Centre of Physics, Budapest) gave talks on their respective fields of expertise. In the afternoon, participants presented so called “Challenge Talks”, a format that was invented as a counterpart to the usual highlight talks. The idea was to encourage discussion on matters that the speakers are struggling with and would normally not be presented in such an event. The MGK Colloquium finished with closing remarks about the gender board, a final poster session as well as a dinner.

Special thanks are given to the Hotel Klingenstein, the three invited speakers, as well as all participants for active participation and fruitful discussions.

Hanna-Frederike Poggemann, project B8

WE Heraeus Seminar - "Non thermal plasmas for sustainable chemistry"

The CRC 1316 was involved in the organization of the 785 WE Heraeus Seminar "Non thermal plasmas for sustainable chemistry" that was held in Bad Honnef 22 till 27 April 2023. The meeting was organized by Yiguang Yu (Princeton), Tomo Nozaki (Tokyo Tech), Annemie Boggaerts (U Antwerp), and Achim von Keudell (RUB, CRC 1316). The CRC 1316 contributed with two invited presentations and six posters. The seminar with 80 attendees provided a broad overview on the field and critical discussions about the challenges and potential of plasma methods for sustainable chemistry.

Achim von Keudell, project A3 & B7



Successful workshop on research data management in plasma science

The 2nd Workshop on FAIR Data in Plasma Science has been held at Ruhr-University Bochum (Germany) on May 3-4. The workshop was organized by INP in Greifswald, Christian Albrechts University in Kiel and the CRC 1316.

The workshop addressed researchers from plasma science at different levels for exchange on the topic of data management. Topics of the workshop were electronic laboratory journals, practical questions in the daily handling of research data management systems and the presentation of already established solutions.

In addition, an interactive part was organized by the PTB in Braunschweig with the help of Dr. Holger Israel, Hoa Nguyen, and Diana Slawig (Public Information Library) as well as Dipl.-Ing. Johanna Hickmann (Federal Physical-Technical Institute), where the participants could actively discuss research information services for physics. Here, topics such as structures for communi-

cating data management could be discussed as well as the exchange of relevant information in the community.

Marina Prenzel, INF project



Online and on-site participants during the workshop

Many CRC 1316 contributions on DPG spring meeting

The annual meeting of the DPG (German Physical Society) for the Section Matter and Cosmos has been held at the University of Dresden from March 20 to 24. 2,000 participants joined this major event with more than 1,900 contributions distributed over nine scientific sections.

The plasma groups of the RUB campus were represented with numerous contributions. At least eleven talks, including one invited talk, and eleven poster presentations were given by members of CRC 1316.

Marina Prenzel, public relations



RUB delegation at Campus in Dresden

NEW SCIENTISTS WITHIN THE CRC 1316



FATMA-NUR SEFEROGLU

studied physics with a focus on plasma physics at Ruhr-University Bochum. Since her bachelor thesis in 2019, she has been working on the project B7 in the CRC 1316 and investigated pulsed plasmas in liquids as well as the surface structure of plasma treated copper substrates. In January

2023, she joined the Forschungszentrum Jülich as a PhD student and will take over the modelling part of the project A3 in the CRC 1316.

Project A3 aims at a fundamental understanding of the plasma chemistry and the excitation transfer between molecules in plasma catalytic processes. Her research will focus on identifying dominant reaction channels of these processes by using a data driven modeling approach and developing a suitable reaction kinetic model. She will work together with Dr. Dirk Reiser, Dr. Vladislav Kotov, Dr. Laura Chauvet, and Steijn Vervloedt in project A3. The experimental part of the project are taken over by Dr. Laura Chauvet and Steijn Vervloedt.

JAN-LUCA GEMBUS studied electrical engineering with focus on plasma technology at Ruhr-University Bochum. During his bachelor project and bachelor thesis in project A7, he analyzed the conversion of volatile organic compounds with the surface dielectric barrier discharge (SDBD) set-up.



The focus was to analyze the conversion by varying electrical parameters and to analyze the by-products of the process with an GCMS. After a year abroad as an Erasmus student at Durham University (UK), he came back to Ruhr University to finish his studies. His master thesis was about the effect of the electrolyte concentration on the micro discharge behavior during plasma electrolytic oxidation on aluminum and titanium (project B5, PEO). In February 2023, he started as PhD student in the same project. Here he will work together with Florens Grimm, where Florens will do the simulation and Jan-Luca the experimental part. His task is to get a deeper understanding of the fundamental processes during PEO.

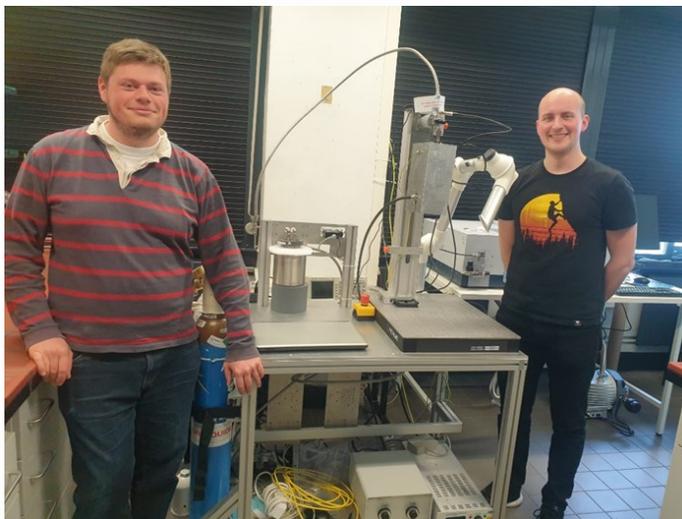
GERRIT HÜBNER studied electrical and computer engineering at Ruhr-University Bochum. He joined the AEPT in 2017 and was part of first presenting the idea of the CRC 1316 to the DFG as part of the planned project A4. For both his Bachelor and Master thesis he worked in the frame of A4 on atmospheric pressure



plasmas using different plasma diagnostics. After working on low pressure plasmas in project C1 of the SFB TR-87 in 2022, he is now working as a scientific assistant on project A5 since January 2023. The focus of his work lies on the investigation of nano-second-/ to microsecond-pulses applied to surface dielectric barrier discharges. To that end he uses various plasma diagnostics like OES, PROES and TDLAS.

COLLABORATIONS

Successful collaboration for nanocatalysts synthesis under atmospheric pressure conditions



Gabriel Boitel-Aullen and Steffen Schüttler have successfully transferred the plasma setup from the Chair of Experimental Physics II to the Chair of Analytical Chemistry II

The atmospheric pressure plasma capillary jet setup has been transferred at the end of April from Judith Golda's group to Kristina Tschulik's group in the context of the B13 project of the CRC 1316. Built by Steffen Schüttler, it

will be used for nanocatalysts fabrication within reverse micelles aqueous suspensions in toluene, acting as nanoreactors for controlled synthesis of Au and Au based bi-metallic nanoparticles (NPs).

Preliminary plasma experiments have been performed by Gabriel Boitel-Aullen, Paolo Cignoni and Steffen Schüttler with this setup on surface deposited reverse micelles solution and further directly on the micellar solution in toluene. Both have shown the possibility of nucleating Au NPs, that exhibited good electrocatalytic activity towards dihydrogen formation. Following these successful preliminary experiments, Gabriel Boitel-Aullen will investigate the mechanism of formation of the Au NPs, explore the possibility of nucleating AuPd and AuAg NPs, and compare their electrocatalytic activity to the ones obtained by electrodeposition.

Gabriel Boitel-Aullen, project B13

Scientific results of DAAD exchange presented at ISPC 25

Prof. Judith Golda from RUB and Prof. Claire Douat from GREMI in Orléans have arranged several exchange visits between the groups with measurement campaigns in the respective laboratories within the framework of a DAAD exchange program (part of a PROCOPE project) and have already partially carried them out. The focus of the exchange is on the investigation of the role of CO in the treatment of biological substrates.

At the end of April, the French delegation consisting of Prof. Claire Douat, Eloise Mestre and Dr. Inna Orel was again in Bochum to measure rotational temperatures on the kHz-jet from Orléans. Here, with the support of Dr. Laura Chauvet as well as Daniel Henze in the laboratory of Prof. Judith Golda, experimental results could again be obtained. In the end, several successful measurement campaigns were carried out over the last few visits. Therefore, the revisit was used to lay the founda-



Dr. Laura Chauvet, Daniel Henze, Prof. Dr. Judith Golda (all from RUB), Prof. Dr. Claire Douat, Eloïse Mestre, Dr. Inna Orel (all from GREMI); from left to right

tion for a cooperative publication of the two groups, which will be submitted soon. Finally, Eloïse Mestre presented their results at the ISPC 25 conference in Kyoto, Japan.

Marina Prenzel, public relations

PUBLIC RELATIONS

Plasma Physics for high school students

The project week for high school students is an educational program of the CRC 1316, the Faculty of Physics and Astronomy at the RUB and of zdi (Zukunft durch Innovation; *Future through innovation*). Which takes place twice a year.

From April 3-6, the project week was hosted for 60 female students in grades 8 to 10. The girls chose between four workshops: plasma physics, astronomy, physics in medicine and sustainable house design. The project "From Plasma to Gold Layers" allows the students to gain an insight into the generation and applications of plasmas. Using the sputter coater and professional laboratory equipment, the students could deposit and examine gold layers themselves. During the project week, the students attended a lecture given by Prof. Dr Judith Golda on "hands-on plasmas – between material science and medicine", and visited laboratories and the Planetarium Bochum. On the closing day, the results of the students' research were presented in a poster session, followed by a quiz and lunch together. The next project week in Autumn for female and male students in grades 8 and 9 will take place from October 9-13.

The Faculty of Physics enables students to complete a school internship in Physics. From March 27-31, we welcomed two interns from grade 9. After a short introduction to plasma physics, the students worked on

the sputter coater. They examined the coated samples. For this purpose, they determined the transmission with a spectrometer, the layer thickness with the profilometer and the conductivity. The interns also gained experience in handling data and in data evaluation. The goal of the internship is to also give an impression of laboratory work and current research. Therefore, doctoral students, bachelor's and master's students guided the interns through the labs and presented their experiments. The interns also visited the NRW state competition "Jugend forscht", which took place at the Ruhr University Bochum March 27-29.

The "mobile plasma workshop" took place for the first time on June 5 and visited an 11th-grade physics class in Essen. In the beginning, the students watched a short movie and received basic knowledge about plasmas and their applications. After a short quiz, they worked on the experiments in smaller groups. The students examined the light emitted by plasmas with an optical spectrometer and observed how plasmas can be influenced by electric and magnetic fields. Information on the experiments on the students' tablets guided the workshop. The workshop was a success and the students showed great interest. Through the students' feedback, we have gained insights on how to improve our workshop going forward.

Ida Hülsbusch, public relations

Kick-off event of the Science Year 2023

On Saturday, 11 February 2023, the kick-off event of the Science Year 2023 "Our Universe" took place. The CRC 1316 was represented with a booth at the Zeiss Planetarium Bochum.

Besides live experiments, there was a diverse program with a plasma quiz, colouring pictures and slide show. As live experiments, the plasma sphere and plasmas were presented as hands-on experiments, and the plasma speaker and COST jet were shown for demonstra-

tion. Here, the new portable COST-Jet could be used for the first time outside the university. Thanks to its construction on a plate with gas supply, generator and holders for optical fibre and spectrometer as well as authentic diagnostics from the laboratory can now be shown at events.

A big thank you to the many helping hands and all interested people who visited us!

Maike Kai, public relations

IMPRESSIONS FROM THE ISPC JAPAN



IMPRESSUM

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