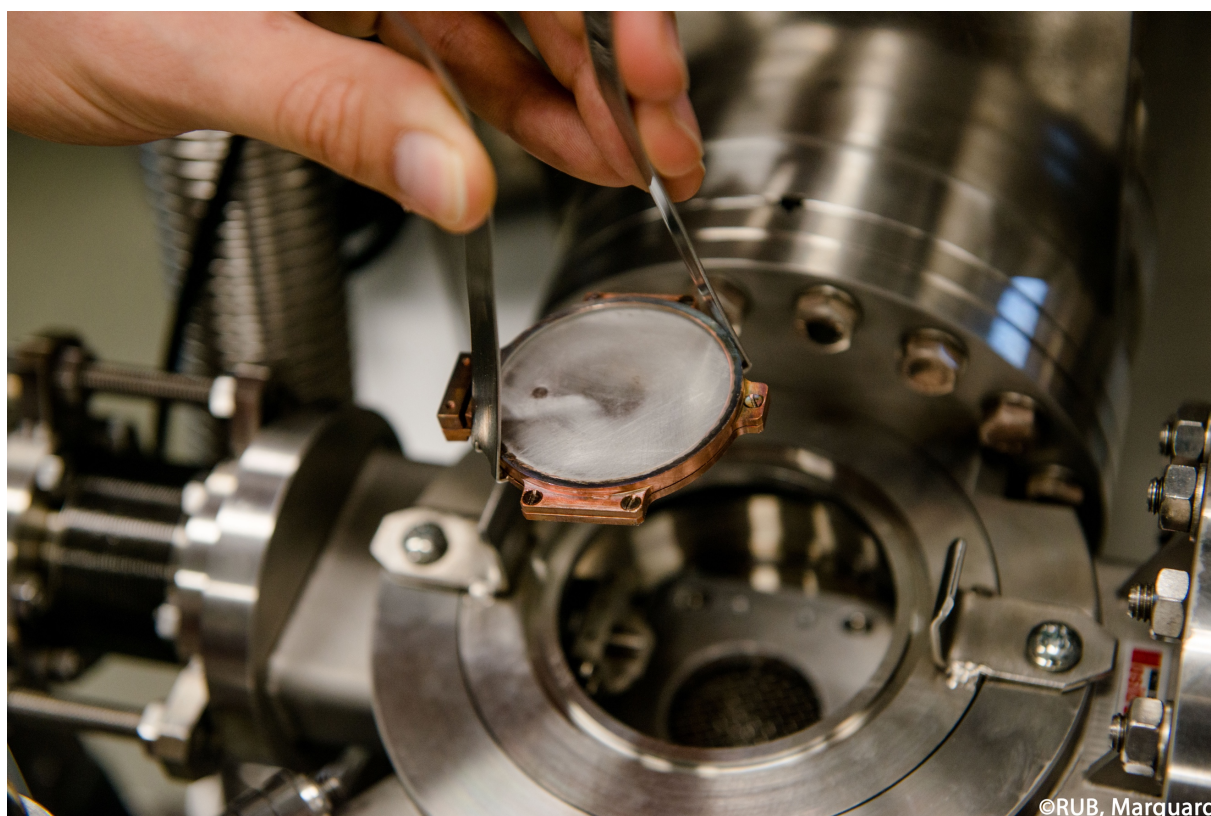


NEWSLETTER

EDITION 3



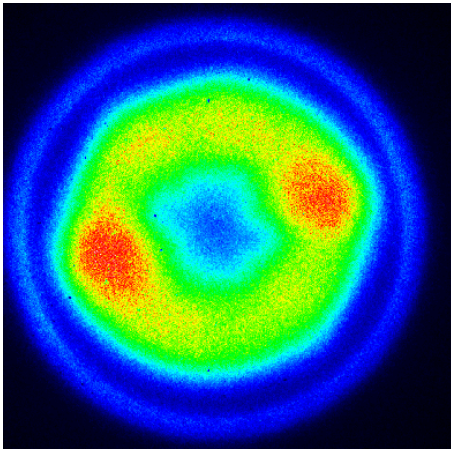
©RUB, Marquard

Successful paper about spokes in HiPPMS discharges	1
Awards for Marcus Hans and Tobias Gergs	1
Excellent cooperation in section B of the SFB-TR 87 on permeation barrier coatings	2
Meeting of members and focusing for the third period of funding	2
Dates and Review	3
Scientific Profile Teresa de los Arcos	4
Graduates/New Faces	5
Rudolf-Seeliger price 2017 for Prof. Dr. Jörg Winter	5
Recent publications in 2017	6

EDITION 06/2017

ABOUT NOVEL RESEARCH ACTIVITIES

SUCCESSFUL PAPER ABOUT SPOKES IN HIPIMS DISCHARGES



The paper "*Species transport on the target during high power impulse magnetron sputtering*" by Vincent Layes, Sascha Monje, Carles Corbella, Jan Trieschmann, Teresa de los Arcos, and Achim von Keudell is published by AIP Publishing: Appl. Phys. Lett. 110, 081603(2017); doi:20.1063/1.4976999.

The paper analyses the lateral transport of target material on a HiPIMS target. The motivation of this work is to prove the presence of an electric field at the trailing edges of spokes.

HiPIMS is a technique to deposit superior materials due to the very energetic growth flux. The origin of the flux is an electric potential structure inside the localized ionization zones (spokes).

In the sputter process, target material is mostly transported in the ExB direction independently of the presence of spokes. *The group of authors* observe an enhanced transport in the opposite ExB direction when spokes are present which can be explained by the mentioned electric field at the trailing edge of spokes.

To conclude about the fields at the location of the spokes, the authors compare a low power case without spokes with a high power case with rotating spokes. These cases produce different decay lengths along the racetrack (ExB direction). When spokes are present, the leading edge is very diffuse which indicates a small electric field. The trailing edge is rather sharp and indicates a strong electric field.

The cooperation between the different institutes in Bochum worked very well. Within the SFB-TR 87 a complementary paper is published with the title "*Composite targets in HiPIMS plasmas: Correlation of in-vacuum XPS characterization and optical plasma diagnostics*".

AWARDS

During the ICMCTF conference (see below), the SFB-TR 87 member, **Marcus Hans** from the group Materials Chemistry, RWTH Aachen University won the *Graduate Student Award* (Silver Medal) for his oral presentation during the conference. The Award is intended to honor outstanding students.



Congratulations!

His talk had the title "Grain Size-Dependent Metastable Phase Formation".

The "Plasmatechnologie-Tagung" PT18 was a successful platform for **Tobias Gergs** to present his recent research. The presentation of his poster was very conclusive, so that the awarding committee decided Tobias Gergs for winning the Poster Award of this conference. His contribution had the title "Molecular dynamics simulation of the plasma-enhanced nucleation of titanium nitride thin films: analysis of interaction potentials."





ABOUT NOVEL RESEARCH ACTIVITIES

EXCELLENT COOPERATION IN SECTION B OF THE SFB-TR 87 ON PERMEATION BARRIER COATINGS



The novel paper coordinated by the PhD student Dennis Kirchheim from the Institute for Plastics Processing (IKV), RWTH Aachen University demonstrates the already very good established cooperation within the section B of the SFB-TR 87 embedding the projects B1, B2, B4, and B5. The paper has the title *“Transport mechanisms through PE-CVD coatings: influence of temperature, coating properties and defects on permeation of water vapour”* and is published in the Journal of Physics D: Applied Physics, Volume 50 (8), 085203 in January 2017.

The motivation of this work is the main use of plastics in the packaging sector, where especially certain goods require various characteristics of the packing, for example permeation prevention. The paper covers the challenge of describing the gas transport mechanism through plastics depositing protection coatings on the plastics. The research of Kirchheim et al. could show that the model of diffusion fitted best with experimental data using solid body diffusion. Common methods for simulation of the diffusion applying defect models are very sensitive on the defect sites, so the fit between experimental data and fit is uncertain for arbitrary sets of data.

Research on two kinds of barrier coating deposition methods was executed on various types of polymers by the group. The industrially applied plasma-enhanced chemical vapor deposition process was compared with the plasma-enhanced atomic layer deposition. Both systems result in high quality SiO_2 , TiO_2 , or Al_2O_3 barrier coatings for polymer applications. Determination of coating characteristics are required for the evaluation of the diffusion through the film. The analysis of these data is completed with a fitting to a certain diffusion model to understand the mechanism.

Here, the cooperation between the different groups in Aachen and Bochum worked very well. Deposition within the projects and the consequent analysis of permeation and film thickness was coordinated hand in hand in between the different scientists.

The group of authors already worked on the following paper with the title *“Influence of PE-CVD and PE-ALD on defect formation in permeation barrier films on PET and correlation to atomic oxygen fluence”*, which is already accepted by the Journal of Physics D: Applied Physics. The contribution is published by Felix Mitschker, a PhD student of the faculty of electrical engineering at Ruhr-Universität Bochum, merging all projects in section B of the SFB-TR 87, namely B1, B2, B3, B4, and B5.

MEETING OF MEMBERS AND FOCUSING FOR THE THIRD PERIOD OF FUNDING

The annual meeting of members took place in Raesfeld on April 4th and 5th, 2017. The focus was the objective of each project for the third funding phase. The general idea of the special research field was recovered in the presentations of the individual projects. Moreover, three new projects were introduced and two projects were integrated into one project for the next phase. Based on the fruitful discussions, the members left the meeting with the aim to write the proposal for the final funding phase from 2018 until 2022.



DATES

70th Gaseous Electronics Conference in Pennsylvania

The 70th GEC Conference will take place in Pennsylvania from November 6th to 10th, 2017. The conference will be hosted this year by the West Virginia University. The GEC conference is one of the most famous meetings for plasma physicists, because around 450 scientists from all over the world meet on this large conference.

REVIEW

The 44th International Conference on Metallurgical Coatings and Thin Films (ICMCTF) in San Diego – Interview with Tobias Gergs



SFB-TR 87 members at the ICMCTF, Tobias Gergs is 2nd from right

What are you working on?

My work is about the plasma surface interaction within the project C8 with Jan Trieschmann. While he is working on the theoretical description of the plasma model, I am basically dealing with the surface. The idea is to couple these two approaches in order to develop a self-contained system.

Why was this year's ICMCTF important for your work?

The conference focused on thin-film deposition, diagnostics and film growth for different materials, such as metal oxynitrides, which are very interesting for us. In addition, there was one session about the model-based design of film growth in which very interesting concepts have been discussed, for example by Joe Greene.

What was your personal highlight?

Definitely Joe Greene's short course about thin film nucleation, growth, and microstructural evolution. It was awesome. Marcus Hans' talk about "Grain Size-Dependent Metastable Phase Formation" was quite impressive as well

What was your contribution?

I gave a presentation which focused mainly on the question which potentials would be eligible for metal oxynitrides and which also dealt with defining the accuracy of these potentials.

MORE DATES

Eighth International Conference on Fundamentals and Industrial Applications of HIPIMS 2017

June 13th – 14th, 2017

Civic Centre "Stadthalle Braunschweig", Germany

Section A+B+C Workshop, Aachen

June 20th - 21st, 2017

Aachen, Germany

ExB Workshop for Space and Industrial Applications

June 21st – 23rd, 2017

Toulouse, France

The International Conference on Phenomena in Ionized Gases (ICPIG)

July 9th – 14th, 2017

Estoril/Lisbon, Portugal

CIP MIATEC 2017

June 26th – 30th, 2017

Nice Acropolis Convention Centre, France

International Plasma School

October 7th – 12th, 2017

(Summer School)

October 12th – 14th, 2017

(Master Class)

Physikzentrum Bad Honnef, Germany

V 2017: Vakuumbeschichtung und Plasmaoberflächentechnik Workshop

October 24th-26th, 2017

Dresden, Germany

The 20th Workshop on the Exploration of Low Temperature Plasma Physics (WELTPP-19)

November 30th – December 1st,

2017 Old Convent Rolduc, Kerkrade, The Netherlands

AN INTERVIEW WITH PD DR. DE LOS ARCOS

Teresa de los Arcos is co-PI in the SFB-TR 87. She is specialist on the research on surface characterization, especially X-ray spectroscopy (XPS) analysis. Her former work at the University of Basel in Switzerland concentrated on carbon nanotubes.



Teresa, you are working within the SFB-TR 87 in project C7 in Paderborn linked to the group in Bochum. What is the objective of your research?

Actually, my role within the TR87 is a little bit more convoluted than that. I am a co-PI of the project C7, centered in Bochum. Within this project, we investigate basic plasma-target interaction effects such as the mechanism of secondary electron emission and the role of the surface chemistry. Additionally, since my incorporation in March 2015 to the group of Prof Grundmeier in Paderborn, I am also “unofficially” involved with the two Paderborn-based projects: A2 and B3. A2 is placed within the “metal route” and the focus is the experimental determination of structural, electronic and adhesive properties of wear-resistant coatings. B3 belongs to the “polymer route” and there we focus in growth mechanisms and the resulting barrier properties of coatings on polymer substrates.

In how far do your results help other projects within the SFB-TR 87?

All three projects have in common a strong experimental approach based in surface characterization by a combination of techniques (XPS, AFM, electrochemistry, FTIR, etc). Our work provides experimental ratification and support to different projects. For example, within the A part, an important goal is to close the bridge between, at one extreme, the theoretical description of adhesion at a molecular level in ideal coated metal-polymer systems and, on the other extreme, the prediction of the actual response of a forming tool. The combined XPS-AFM UHV setup (“PIA”) in Paderborn is a crucial setup, since it allows for the in-situ chemical characterization and modification of surfaces (XPS) with the measurement of adhesion forces (UHV-AFM).

How do you profit from the collaborations with the other scientists?

The work within the TR87 is highly collaborative. The interchange of knowledge, ideas, and experience between the different groups participating in this project has been and still is one of the most rewarding aspects of working within the TR87. Over the many years, we have been working together, we have developed close relationships both at the scientific and the personal level.

How long are you a member of the SFB-TR 87? In which projects did you already work?

I am involved within the TR87 since the beginning. In the first phase I was co-PI of the A5 project. As already said, in the second phase I work officially within the C7 (and within the Paderborn-based projects A2 and B3). For the third phase, it is planned that I will be co-PI in the B3.

You wrote a book about science for the broad public. What else motivates you for your work?

First of all, the check arriving every month is high in my motivation list! That said, I feel that I am fortunate in having a job that is stimulating at both an intellectual and a creative level. It is interesting, it is challenging, and it is fun. Communicating and sharing the fascination of science to the broad public has also been high in my priorities. Also, highly rewarding is to see scientific and personal growth of the many young students that have participated in the TR87 along the years, and see their evolution as they proceed from Bachelor, to Master, to PhD... to life.



At April 1st, 2017 *Jan Benedikt* was appointed full professor for experimental plasma physics at Christian-Albrechts University Kiel.

In 2004 Dr. Jan Benedikt joined RUB as a PostDoc in the research group reactive plasmas of Prof. von Keudell. In 2010, he was appointed a junior professorship for Coupled Plasma-Solid State Systems at the faculty for plasma physics and astronomy.

He was co-PI of project B2 and C3 within the SFB-TR 87. The members of the SFB-TR 87 wish all the best for Prof. Benedikts future.

Jan Trieschmann was member of the SFB-TR 87 in project C8 for five years. Besides his organizational commitment in the IGK, he finished his PhD thesis in May 2017 within the field of plasma simulations. His PhD thesis has the title "Particle transport in technological plasmas".

Karim Bahroun working at IKV could finish his PhD thesis about plastic materials in batteries successfully on May 22nd, 2017. His PhD thesis was part of project B1 in the SFB-TR 87.

Another graduate is *Ante Hecimovic* from project A5. He was member of the SFB-TR 87 from its beginning. His research was focused on HiPIMS plasmas, in which he was focused on the evolution of spokes in the last years. Within his work, Mr. Hecimovic could publish at least eighteen paper and contributed to many conferences and workshops.

Ante Hecimovic left for the Max-Planck institute for plasma physics in Garching near Munich.



The Institute of Materials of Prof. Ludwig has a new PhD student. M.Sc. *Lars Banko* started his thesis in project C2 and is then following to *Dario Grochla* who finished his PhD thesis.

RUDOLF-SEELIGER PRICE 2017 FOR PROF. DR. JÖRG WINTER



The Rudolf-Seeliger price 2017 of the German society for plasma technology was hand over to Prof. Dr. Jörg Winter during the annual conference PT18 for his scientific contribution in the field of micro plasma physics on February 22nd, 2017.

The laudation was held by Thomas Mussenbrock who honored especially his work in the field of physics of micro plasmas. Prof. Jörg Winter was a pioneer in this field who saw the potential of micro plasmas long before other scientists started to work in this field.





K. Bobzin, N. Bagcivan, S. Theiss, R.H. Brugnara, N. Bibinov, P. Awakowicz

Characterization of DC Magnetron Plasma in Ar/Kr/N₂ Mixture During Deposition of (Cr,Al)N Coating

Journal of Physics D: Applied Physics, **50** (2017), 075203, doi:10.1088/1361-6463/aa4ea2

W. Breilmann, C. Maszl and A. von Keudell

Fast charge exchange ions in high power impulse magnetron sputtering of titanium as probes for the electrical potential

Plasma Sources Sci. Technol. **26** (2017) 035007, doi:10.1088/1361-6595/aa56e5

A. Hecimovic, C. Corbella, C. Maszl, W. Breilmann, A. von Keudell

Investigation of plasma spokes in reactive high power impulse magnetron sputtering discharge

Journal of applied physics, **121** (2017), 171915, doi:10.1063/1.4978348

O. Hunold, M. Wiesing, T. de los Arcos, D. Music, G. Grundmeier, J.M. Schneider

Influence of O₂ exposure on the interaction between CH₄ and amorphous AlYB₁₄

Applied Surface Science, **392** (2017), 1165–1172, doi:10.1016/j.apsusc.2016.09.092

E. Kemaneci, F. Mitschker, M. Rudolph, D. Szeremley, D. Eremin, P. Awakowicz, R.P. Brinkmann

A global model of cylindrical and coaxial surface-wave discharges

Journal of Physics D: Applied Physics, **50** (24) (2017), 245203, doi:10.1088/1361-6463/aa7093

V. Layes, S. Monje, C. Corbella, V. Schulz-von der Gathen, A. von Keudell, T. de los Arcos

Composite targets in HiPIMS plasmas: correlation of in-vacuum XPS characterization and optical plasma diagnostics

Journal of applied physics, **121** (2017), 171912, doi:10.1063/1.4977820

V. Layes, S. Monje, C. Corbella, J. Trieschmann, T. de los Arcos, A. von Keudell

Species transport on the target during high power impulse magnetron sputtering

Applied physics letters, **110** (2017), 081603, doi:10.1063/1.4976999

Y.-X. Liu, I. Korolov, E. Schüngel, Y.-N. Wang, Z. Donkó, J. Schulze

Striations in electronegative capacitively coupled radio-frequency plasmas: analysis of the pattern formation and the effect of the driving frequency

Plasma Sources Science and Technology, **26** (2017), 055024, doi:10.1088/1361-6595/aa66b9

A. von Keudell, C. Corbella

Review Article: Unraveling synergistic effects in plasma-surface processes by means of beam experiments

Journal of Vacuum Science & Technology A, **35** (2017), 050801, doi:10.1116/1.4983275

D. Kirchheim, M. Jaritz, F. Mitschker, M. Gebhard, M. Brochhagen, C. Hopmann, M. Böke, A. Devi, P. Awakowicz, R. Dahlmann

Transport Mechanisms through PE-CVD Coatings: Influence of Temperature, Coating Properties and Defects on Permeation of Water Vapour

Journal of Physics D: Applied Physics, **50** (2017), 085203, doi:10.1088/1361-6463/aa511c

J. Trieschmann, F. Schmidt, T. Mussenbrock

Particle-in-Cell/Test-Particle Simulations of Technological Plasmas: Sputtering Transport in Capacitive Radio Frequency Discharges

Plasma Processes and Polymers, **14** (2017), 1600140, doi:10.1002/ppap.201600140

J. Trieschmann, T. Mussenbrock

Kinetic analysis of negative power deposition in inductive low pressure plasmas

Plasma Sources Science and Technology, **26** (2017), 24004, doi:10.1088/1361-6595/aa51f2

IMPRESSUM

Öffentlichkeitsarbeit SFB-TR 87

Universitätsstr. 150

Gebäude NB 5/126

44801 Bochum

info@sfbtr87.de