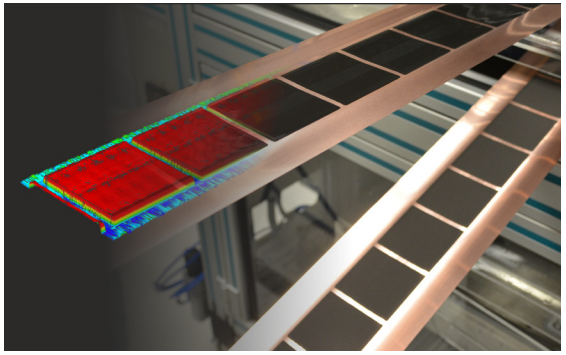
DECHEMA-Gesellschaft für Chemische Technik und Biotechnologie e.V.

DECHEMA GVT

TFT
Thin Film Technology

8th Short Course
Coating and Drying of Thin Films

4-day short course on fundamentals and applications with practical workshop in the coating and printing lab



1st Thin Film Technology Forum

1-day forum on May 12 on advances in printed electronics, direct printing for industry 4.0 & battery processing

May 9-12, 2016

KIT-Tagungszentrum (FTU)
Seminar room 157 / lecture hall (TFT Forum)
Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen

KIT Karlsruhe Institute of Technology

Organisation: Prof. Dr.-Ing. Dr. h. c. Wilhelm Schabel
Dr.-Ing. Philip Scharfer
with 18 experts from industry and academia

4-day short course program

29 contributions from 22 speakers

Schedule 09.05.2016 – Short course day 1

09:30 *Registration and hand out of course material*

10:00 *Welcome and introduction*
Prof. Dr.-Ing. Dr. h. c. W. Schabel / Dr.-Ing. P. Scharfer

10:30 *From theory to practice in coating technologies*
Dipl.-Ing. Andrea Glawe (Kroenert)

11:15 *Rheology of coating fluids*
Prof. Dr. Norbert Willenbacher (KIT)

12:15 *Lunch break*

13:15 *Coating fluids characterisation*
Dipl.-Ing. Gilbert Gugler (Polytype, CH)

14:30 *Introduction to self- and premetered coating*
Dr. Peter Schweizer (Fribourg, CH)

15:30 *Coffee break*

16:00 *Curtain and slot die coating*
Dr. Peter Schweizer (Fribourg, CH)

19:30 *Social dinner at BESITOS (Karlsruhe town square)*

Schedule 10.05.2016 – Short course day 2

09:00 *Dip and blade coating*
Prof. Dr. Hadj Benkreira (University of Bradford, UK)

09:45 *Gravure and roll coating*
Prof. Dr. Hadj Benkreira (University of Bradford, UK)

10:30 *Coffee break*

11:00 *Fluid flow in coating tools*
Prof. Dr. Dr. h. c. mult. Franz Durst (FMP)

12:00 *Inkjet printing - fundamentals and applications*
Prof. Fritz Bircher (iPrint, CH)

13:00 *Lunch break*

14:00 *Fundamentals of drying technology*
Prof. Dr.-Ing. Dr. h. c. Wilhelm Schabel (KIT)

15:00 *Film drying and drying studies*
Prof. Dr.-Ing. Dr. h. c. Wilhelm Schabel (KIT)

16:00 *Coffee break*

16:30 *Drying of particulate coatings and crack formation*
Dr. Alex Routh (Cambridge, UK)

Schedule 11.05.2016 – Short course day 3

08:30 *Simulation & design of industrial thin film dryers*
Dr.-Ing. Philip Scharfer (KIT)

10:00 *Sorption and phase equilibrium*
Dipl.-Ing. Anna-Lena Riegel (KIT)

10:20 *Impingement drying with comb nozzles*
Dipl.-Ing. Philipp Cavadini (CND Solutions)

10:40 *Coffee break*

11:10 *Coating apps and web handling*
Prof. Dr. Steven Abbott (TCNF, UK)

12:25 *Industrial perspectives of slot die coating*
Dipl.-Ing. Harald Döll (TSE)

12:55 *Lunch break*

13:55 *Experimental workshop at the TFT coating and printing laboratory*
- Characterisation of material systems
- Pilot-scale coating trials
- Heat and mass transfer coefficients
- Experimental drying curves

19:30 Get-together TFT Forum *at BESITOS (town square)*

Schedule 12.05.2016 – Forum & short course day 4

08:30 *Welcome & Introduction to TFT Forum*
Prof. Dr.-Ing. Dr. h. c. W. Schabel / Dr.-Ing. P. Scharfer

08:40 *Processing of organic & printed electronics*
Ir. Ike de Vries (Holst Centre, NL)

09:40 *Printed optoelectronic devices from solution*
Prof. Dr. Uli Lemmer (KIT)

10:10 *Coffee break*

10:40 *Industrial R2R processing of organic electronics*
Dr. Michael Niggemann (Eight19, UK)

11:10 *Multilayer coating of organic electronics*
Dipl.-Ing. Sebastian Raupp (KIT)

11:40 *Drying and diffusion in printed nanofilms*
Dr.-Ing. Philip Scharfer (KIT)

12:00 *Lunch break*

13:00 *Industrial production of Li-ion battery cells*
Dr. André Mecklenburg (Litarion)

14:00 *Challenges and limitations in industrial coating and drying of battery electrodes*
Prof. Dr.-Ing. Dr. h. c. Wilhelm Schabel (KIT)

14:30 *Drying of Li-ion battery electrodes*
Dipl.-Ing. Stefan Jaiser (KIT)

15:00 *Coffee break*

15:30 *Digital Direct Printing*
Prof. Fritz Bircher (iPrint, CH)

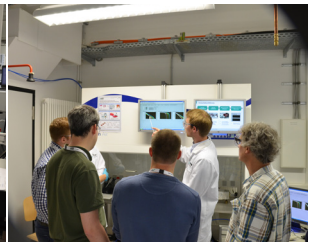
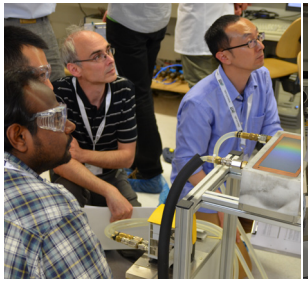
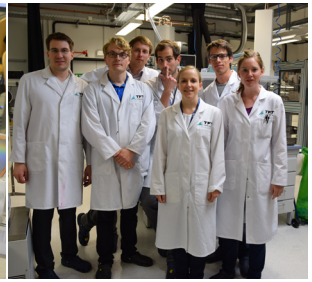
16:30 *Vista Digital Coating for Industry 4.0*
Dr. Peter Brown (TTP, UK)

17:00 *Functional Inkjet Printing for Industry 4.0*
Dr. ir. Wouter J.M. Brok (PiXDRO Meyer Burger, NL)

Introduction

The short course Coating and Drying of Thin Films addresses engineers, scientists and technicians working in the areas of coatings, functional films, direct printing, inkjet printing, sensors, adhesives, paints, automotive coatings, patches, optical foils, tapes, diagnostics, membranes, printed electronics, fuel cells and battery coatings, who intend to get insight into more fundamental aspects with industrial applications or to deepen their expertise. Leading national and international scientists and experts from academia and industry will report on topics of coating technologies, rheology, preparation of coating fluids and about fundamentals and industrial aspects of drying technology. Coating and printing processes and drying technology are explained interactively by easily accessible examples and in a practical workshop in the TFT Coating and Printing Lab instructed by TFT staff members (see photos below).

The 1st Thin Film Technology Forum will take place on the 4th day, where renowned scientists will present and discuss new trends in industry and academia with a focus on Printed and Organic Electronics, Direct Printing for industry 4.0 and Battery Processing.

Registration fees

	Early Bird (until 15.03.16)	later
General	€ 1500.–	€ 1650.–
GVT Members	€ 1450.–	€ 1600.–

Payment

According to §4 Nr. 22a USTG the registration fee is purchase tax free. Registration fees include a short course folder with documentation of lectures and workshop, coffee, refreshments, lunch and social dinner on Monday evening and the TFT Forum get-together on Wednesday evening. A participation certificate will be distributed.

Venue

The short course takes place at the KIT-Tagungszentrum (FTU), Seminarraum 157, Hermann-von-Helmholtz-Platz 1 in 76344 Eggenstein-Leopoldshafen.

Hotel recommendations

Hotel Kaiserhof, Hotel Novotel Karlsruhe City,
City Partner Hotel Berliner Hof, Hotel Rio

Further information

www.tft.kit.edu – TFT Courses

Feedback about the last TFT courses

- "Excellent introduction in coating and drying of films. Demonstrates the complexity, offers better understanding of processes."
- "Very interesting course, lots of information on all coating application! Building bridge from university to industrial applications."
- "Well built-up structure, wide range of theory and application covered too short time for discussion/break"
- "High level talks with broad range of topics but with good scientific and practical depth, also on application."
- "Good structure."

and workshop

- "Good to see how the theory of the courses works in real life"
- "Experiments were very well prepared and perfectly organized"
- "Interesting, well organized"

Further information and registration:

http://www.tft.kit.edu/745.php
http://www.gvt.org/Hochschulkurse.html

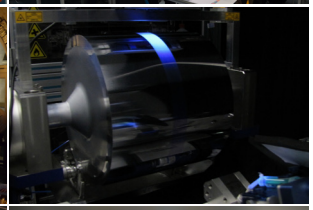
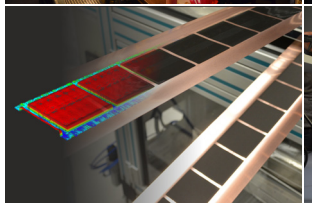
Contact

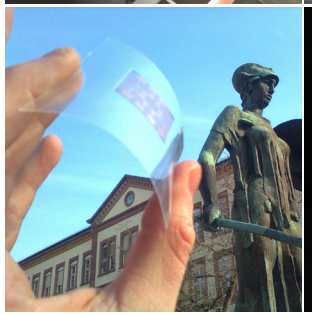
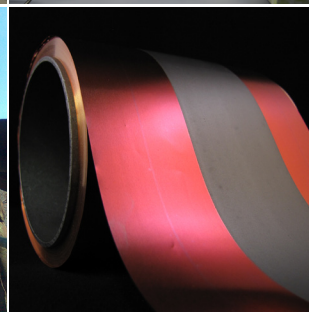
Registration:
Anna-Maria Hipp: gvt-hochschulkurse@gvt.org
Phone: +49 69 7564-118

Short course organisation:
Jochen Eser, M. Sc.: jochen.eser@kit.edu

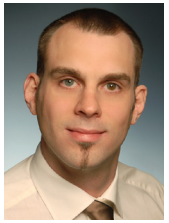
Office TFT: margit.morvay@kit.edu



Prof. Dr.-Ing. Dr. h. c. Wilhelm Schabel (KIT) holds a professorship in Thin Film Technology at KIT. He studied process engineering, his doctor thesis in the field of film drying was honored with the Carl-Freudenberg Award in 2006. He gained industrial experiences in coating technology as R&D engineer at LOFO High Tech Film/Basel (2007-2008). He received the Arnold Eucken Award from VDI in 2007 and the L.E. Scriven Award in 2008 from the ISCST (International Society of Coating Science and Technology). Prof. Schabel is active in the international ISCST and ECS committees as past chairman, director and vice president and is author and co-author of more than 60 publications in the field of coating and drying of thin films.



Dr.-Ing. Philip Scharfer (KIT) is head of the TFT group at KIT together with Prof. Schabel. He received his PhD in process engineering from the University of Karlsruhe (TH) in 2009. Dr. Scharfer is an expert in the fields of drying and thermodynamics of thin films. He deals with measuring methods for the investigation of polymer film drying and develops numerical simulation tools for industrial dryer applications. Since 2009, Dr. Scharfer is member of the scientific committee of the European Coating Symposium (ECS), since 2012 member of the Board of Directors of the International Society of Coating Science and Technology (ISCST). In 2014, he was awarded with the L. E. Scriven Young Investigator Award by the ISCST.

Dipl.-Ing. Andrea Glawe (Kroenert) graduated in 1992 at the Technical University of Chemnitz. She started her career at the Textile Research Institute Plauen GmbH between 1992 and 1993 and worked for the Textile Research Institute Thüringen-Vogtland e.V. Greiz between 1993 and 2001. From 2001 to 2011 she worked as Deputy sales director with responsibility for technical sales and project management at Coatema Coating Machinery GmbH in Dormagen. Between 2011 and 2012 she took her responsibility as R&D leader DRYTEC GmbH & Co KG in Norderstedt. Since February 2012 Andrea Glawe worked as Director R&D for all R&D activities of the KROENERT group in Hamburg. Since September 2015 she is responsible as Regional Sales Director for the Asian market at KROENERT.

Prof. Dr. Norbert Willenbacher (KIT) is head of the Institute of Mechanical Process Engineering and Mechanics at Karlsruhe Institute of Technology (KIT) since 2004. He received his diploma degree in Physics and his PhD from the University of Mainz. After his dissertation at the Max-Planck-Institute for Polymer Research he joined BASF SE as a research associate in the fields of rheology of complex fluids and adhesion of soft polymers for 15 years. Prof. Willenbacher is president of the German Society of Rheology and assigned member of the ProcessNet Technical Committee on Rheology. He is section editor of Current Opinion in Colloid and Interface Science and member of the Editorial Board of Rheologica Acta.

Dipl.-Ing. ETH Gilbert Gugler (Polytype) received his diploma in material science from the ETH Zurich in 1992. From 1992 to 1998 he worked in the area of chemical and physical vapour deposition. From 1998 on, he worked at Ilford Imaging Switzerland GmbH. In 2014 he started his new challenge at Wifag-Polytype Technologies AG as Senior Process Engineer for the new development group. Today he is the head of Technology Center of Wifa-Polytype Technologies AG and therefore responsible for all coating and process related topics. Gilbert Gugler is an expert in multilayer curtain coating technology, starting from the preparation of coating fluids, characterization of fluids, processing, to the multilayer curtain coating and drying.

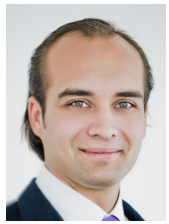
Dr. Peter M. Schweizer (Fribourg) received his PhD in Mechanical Engineering from the Swiss Federal Institute of Technology in 1979, and he did postdoctoral research in coating flows at the University of Minnesota with Prof. Scriven from 1979 – 1980. From 1981 – 1996, Dr. Schweizer worked in the photographic industry, first at Kodak in Rochester, New York for 6 years, then at ILFORD in Fribourg, Switzerland for 10 years. Then, he changed to the supplier side of coating technology, where he was Managing Director of TSE Troller Schweizer Engineering in Switzerland from 1997 – 2000, and where he worked for Wifag-Polytype Technologies in Fribourg, Switzerland from 2001 – 2016. Since his retirement in 2016, he offers consulting services in coating and drying technology.

Prof. Dr. Hadj Benkreira (Univ. of Bradford) (BEng, MSc Chemical Engineering) obtained his PhD in the Fluid Mechanics of Coating Flows in 1980 under the supervision of Professor WL Wilkinson (CBE, FRS). Following five years of EPSRC postdoctoral research, he joined the academic staff of the University of Bradford in 1985 and was endowed a Personal Research Chair in 1998 for research in Thin Film Coating and in Polymer Processing and became in 2004-2009 Associate Dean for Research. Professor Benkreira is member of several learned societies including the UK EPSRC Peer Review College and the ISCST of which he was the Vice President in 2006-8. He will co-chair with Professor Gaskell ECS 2017 at the Univ. of Durham (UK).

Prof. Dr. Dr. h. c. mult. Franz Durst (FMP TECHNOLOGY GMBH) graduated from Imperial College at the London University and received his doctor's degree in 1972 (PhD). In 1972, he returned to Germany and worked as subproject leader of various research projects at the Collaborative Research Center 80 at the University of Karlsruhe for ten years. Prof. Durst was offered a C3 professorship for Fluid Mechanics at the University of Karlsruhe in 1978 and was appointed chair of the Institute of Fluid Mechanics at the University of Erlangen-Nuremberg in 1982. In 2006, Prof. Durst retired from the University of Erlangen-Nuremberg and founded the company FMP TECHNOLOGY GMBH, whose CEO and shareholder he has been to this day.

Prof. Fritz Bircher (iPrint) studied electrical engineering at ETH Zurich. After graduating he worked as an R&D engineer for different companies developing mechatronic system solutions. In 1993 he was appointed professor at Bern University of Applied Sciences in Burgdorf, where he started his research in inkjet printing studying and exploring all possible jetting and dispensing principles with all kinds of materials in a wide range of applications. In 2012 he joined the University of Applied Sciences Western Switzerland in Fribourg, where he founded iPrint institute and iPrint Center for Digital Printing on the technology park blueFACTORY of Fribourg. Fritz's main research interests based on inkjet include: packaging printing with optic and haptic effects, material printing including 3D and bio printing.

Dr. Alex Routh (Cambridge University) received his PhD from Princeton University in the United States in 2000. Since 2006 he has been a lecturer in Chemical Engineering at the University of Cambridge. His position is a joint appointment with the BP Institute for Multi-Phase Flow; a multi-disciplinary research institute, within the University, spanning the physical sciences. His research is in the field of colloid science and Dr. Routh has worked in the areas of encapsulation, dispersion stability, formulation and drying. Within the film drying topic, Dr. Routh has been active for the past 15 years and has published extensively in the specifics of film cracking and the flows within thin films. Dr. Routh has published 75 articles and a textbook called fundamentals of latex film formations: Processes and Properties (Springer 2010).



Dipl.-Ing. Philipp Cavadini (CND Solutions) graduated in Aerospace Engineering at the University of Stuttgart. In his PhD studies at KIT/TFT until 2015 he investigated surface tension driven convection and the optimisation of impinging jet systems from the viewpoint of homogeneity of the distribution of the heat and mass transfer coefficient. Currently Mr. Cavadini works on cooling technologies in the department of "Methods and Technology" at Siemens Energy. In secondary employment, he is working on the spin-off creation "Comb-Nozzle drying solutions".

Prof. Dr. Steven Abbott (TCNF) has received his Oxford PhD in Chemistry from Harvard University in 1978 and was postdoc in the Nobel Prize winning lab of Prof. J.-M. Lehn in Strasbourg before working for ICI where he was Senior Manager before joining the high-tech coating company Autotype near Oxford as Research Director. He worked closely with coating experts at U. Leeds (appointed Visiting Professor in 2000) and co-created the TopCoat and TopWeb programs for the coating industry. He now teaches, consults and troubleshoots around the world on coating, solubility, surfactant and adhesion science, using his own apps and software to bring the science to life.

Dipl.-Ing. Harald Döll (TSE) successfully graduated from the Technical University in Darmstadt in Mechanical Engineering in 1989. After some year in web-guiding systems Harald Doell joined TSE Troller AG in 1997. In the beginning, he was the head of the engineering team; since 2008, he is in charge of the entire application technology. Design of die internals, experiments with customers, start-ups and technical customer support are part of his assignment. Furthermore, he is giving talks at several short courses and international conferences in the US, in Europe and in Asia.

Additional speakers at the 1st TFT Forum on May 12

Ir. Ike de Vries (HOLST CENTRE) studied Chemistry and Agricultural Science at the Wageningen University, Netherlands. After graduation in 1985 he was for a period of 3 years a researcher at the Wageningen University. From 1988 to 2006 Ike de Vries was a project leader and process/research engineer in the field of extrusion coating and substrate development for ink jet and photographic paper at Fuji Photo Film. Since 2006, he is a research scientist at the Holst Centre in Eindhoven, The Netherlands. He utilizes his experience to develop new (R2R) processes which enable large scale production of organic light emitting diodes (OLEDs) and photovoltaic (PV). He is a board member of the European Coating Symposium (ECS) and the International Coating Science and Technology Symposium (ISCST).

Prof. Dr. Uli Lemmer (KIT) received the diploma degree in physics from RWTH Aachen University in 1990 and a Ph.D. from the University of Marburg in 1995. From 1995 to 1996, he held a postdoctoral position with the University of California at Santa Barbara. He was with the University of Munich from 1996 to 2002. In 2002, he was appointed a full Professor and director of the Light Technology Institute, Karlsruhe Institute of Technology (KIT). Since 2006 he is also the coordinator of the Karlsruhe School of Optics & Photonics (KSOP) and he is also heading the device physics competence center within the InnovationLab in Heidelberg. His research interests are in the technology and the applications of printable organic and inorganic semiconductors.

Dr. Michael Niggemann (Eight19) has more than 10 years of experience in the development, investigation and scale-up of organic solar cells and was previously heading the organic photovoltaics activity at the Fraunhofer Institute for Solar Energy Systems (ISE) in Freiburg, Germany. He holds a Doctorate in Natural Sciences from the Faculty of Applied Sciences at the Albert-Ludwigs-University of Freiburg, Germany. In 2009 he was involved with the technology development of organic solar cells in the Optoelectronics Group of the Cavendish Laboratory at the University of Cambridge. Since 2010 he is CTO of Eight19 Ltd in Cambridge. Eight19 develops and manufactures flexible solar cells for indoor and off-grid applications.

Dr. André Mecklenburg (Litarion) graduated in Chemical Engineering at University of Technology in Clausthal in 1997, followed by a doctoral degree in 2001 (design of components for direct methanol fuel cells). He started his career in the chemical industry at Evonik Industries (former Degussa AG) in 2000, working at different positions and chemsites within Evonik. From 2008 to 2015 he was head of process technology and later of operations at Evonik Litarion GmbH (a then 100 percent subsidiary of Evonik Industries) and responsible for electrode and separator production for large format lithium ion cells at both sites Kamenz and Marl. 2015, Dr. Mecklenburg moved to the newly formed Electrovaya Litarion and took over responsibility as CTO.

Dr. Peter Brown (TTP) is a Consultant with 13 years experience at The Technology Partnership (TTP). After graduating from St Andrews University in 1996 with a 1st class MSci degree in Physics, Peter moved to the University of Cambridge to study for a PhD in the optoelectronics of semiconducting polymers under Prof. Sir Richard Friend. Peter joined TTP in 2002 to help develop its two proprietary digital printing technologies. Now embedded in the Applied Science group, today Peter's role has evolved to that of a senior consultant with duties including business development and project leadership. Interests include TTP's Vista Inkjet technology, plus spray coating, nanostructured coatings and optics.

Dr. ir. Wouter J.M. Brok (PiXDRO Meyer Burger) is Research Manager at PiXDRO, the inkjet printing division of Meyer Burger. He studied applied physics and earned a Ph.D. in gas discharge physics. In 2007 Wouter joined OTB Engineering, which later became Meyer Burger (Netherlands) B.V. At this company he worked on systems and processes for manufacturing of different solar cell concepts. His present focus is on industrial inkjet printing for applications in various fields, such as photovoltaics, semiconductors, displays and touch sensors.

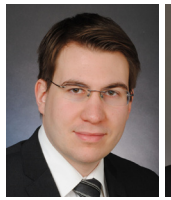
A total of 22 speakers, including 15 external and following 7 PhD students of the TFT group at KIT:

Dipl.-Ing. Stefan Jaiser graduated in Process Engineering from KIT in 2011. Already during his studies he started to specialize on thin-film-related topics when researching OPV processing during a stay at the HOLST Centre in Eindhoven. Within the scope of his research at the TFT group he primarily illuminates the film solidification mechanism of convectively dried lithium-ion battery electrodes. His work pursues the creation of a fundamental understanding of the underlying drying processes to provide a basis for the improvement of state-of-the-art and development of disruptive drying processes. His work was honored with the ECS award at the 2015 European Coating Symposium. Mr. Jaiser is expected to receive his PhD in 2016.

Dipl.-Ing. Anna-Lena Riegel completed her studies in Chemical Process Engineering at KIT in 2012, majoring in Thermal Process Engineering and Technical Thermodynamics. She conducted her diploma thesis as a Solvay scholarship student at the University of British Columbia in Vancouver where she investigated the formation of polymer stabilized nanoparticles for drugs applications. Further, a scholarship was granted her by the German National Academic Foundation during her studies. Since 2013 she is working as research assistant at the KIT/TFT. In her PhD she focuses on processing biosensor solutions, in particular on their special treatment during coating and drying due to sensitive components, on their sorption behavior as well as on the development of novel biosensor solutions containing conductive polymers.

Dipl.-Ing. Sebastian Raupp completed his studies in Chemical Process Engineering at KIT in 2012, majoring in Technical Thermodynamics and Thermal Process Engineering. He was a scholarship holder of the foundation of the German Economy while studying at KIT and at the Royal Institute of Technology (KTH) in Stockholm. At graduation, he was awarded with the Hans Rumpf and Emil Kirschbaum price for his excellent achievements in his studies. Since 2013 he is working as research assistant at the KIT/TFT. In his PhD he works on solution processing of organic electronics including fundamental research on diffusion and drying processes in thin multilayer films. Mr. Raupp is expected to finish his PhD in summer 2017.

Workshop speakers and instructors



Ralf Diehm (since 2014)

T. Fritzensmeier (since 2015)

Jochen Eser (since 2015)

Max Tönsmann (since 2015)