Fraunhofer

FEP

FRAUNHOFER-INSTITUT FÜR ELEKTRONENSTRAHL- UND PLASMATECHNIK FEP

ANNUAL REPORT 2012

ANNUAL REPORT
2012

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FOREWORD

1 *Acting Director*
Prof. Dr. Volker Kirchhoff
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Dr. Nicolas Schiller

Dear Readers,

We would like to inform you again about our institute's work last year in this annual report. As always, the financial figures take top priority. As in the last two years, we were able to increase the revenue from industry again by approx. 10 percent. As a result, we have exceeded the 6 million euros mark. The operating budget accounts for a 50 percent share of the revenue from industry. The prospects for next year have also improved again compared to past years. Thus creating the basis for the institute to develop further. At this point, we would like to thank all our industry partners for the confidence shown in us.

With a positive trend in all areas, there was particularly strong growth in the business field of electron beam applications and precision coating. In addition though, we were also able to acquire an industrial contract for over 1 million euro in the field of photovoltaics.

One important prerequisite for the institute to develop further is to create more lab space. The first stage has been achieved with the completion of a new building with an area of approx. 500 m². These new labs are urgently required for the strategic development of the precision coating department. All the permits were obtained in 2012 for the next extension, which will enable the construction of another 500 m² lab complex.

The specialist work is described in detail in the following articles. Our work on solar thermal energy is described in detail under the title „Solar heating – green heat in abundance". The second editorial explains new approaches for coating 3D components. By combining sputtering and evaporation processes, coating qualities are achieved which open up new application fields to us.

The development of our biomedical lab unit is particularly pleasing. This new field of work was built up a few years ago using resources from our institutional funding. Now the first major publically funded projects and several smaller industrial contract projects have been successfully acquired.

A totally new field of work deals with cultural heritage. Together with other Fraunhofer Institutes, Leibniz Society Institutes and the Prussian Cultural Heritage Foundation, Fraunhofer FEP analyzed to what extent new technologies may stop the deterioration of cultural and art treasures and new methods for restoration that can be derived from them. The first workshop showed how much social interest there is in this topic. Dealing with cultural and art treasures plays an important role in the life of a society, particularly in a technology-driven world.

Dear Readers, this annual report can only give you a tiny glimpse into our work. Therefore, we would be particularly delighted if it has sparked your interest and invite you to discuss new electron beam and plasma technology applications with us.

Prof. Dr. Volker Kirchhoff *Dr. Nicolas Schiller*

PROFILE OF THE FRAUNHOFER FEP

As one of the 66 institutes and independent research units of the Fraunhofer-Gesellschaft, Europe's largest applied research organization, the Fraunhofer Institute for Electron Beam and Plasma Technology FEP, based in Dresden, focuses on developing technologies and processes for surface refinement.

Following German reunification, the Fraunhofer FEP was established from work groups of the former Manfred von Ardenne R&D institute in Dresden. Back then as well as today, the Fraunhofer FEP develops and tests electron beam and plasma based technologies and processes for refining surfaces and optimizes them for industrial applications. In collaboration with specialist partners process and plant technologies can be provided to meet the needs of our customers.

Thin film technology is one of our main fields of work. This involves the vacuum coating of sheets, strips, and components made of diverse materials with a variety of layers or layer systems. Many items we use in everyday life require their surfaces to be customized. For example, polymer packaging films are made impermeable by special barrier layers. Metal sheets, which are for example used for facade cladding, are provided with corrosion-resistant and decorative layers. Sun protection films and heat-insulating architectural glass are produced by applying light-filtering layer systems to conventional materials. Furthermore, our applied research work is responsible for special layers used for displays, for forgery-proof labels, and for the mirrors in the newly restored Green Vault in Dresden. For a worldwide market plants coat huge amounts of foil, metal, glass, and polymers. We develop special technologies and pilot plants for making new applications possible and for optimizing existing processes.

Electron beam technology is the second main field of our work. Electron beams are used for the welding and evaporation of metals and for modifying surface and boundary layers. Other applications are the curing of paints and lacquers, improving the properties of plastics, sterilizing medical devices, and germ reduction in seeds. Electron beams are therefore used as a precise tool for a broad range of applications. Products such as thin film solar cells, sensors, microelectronic components, and data media are being produced using technologies developed by the Fraunhofer FEP.
In order to extend the R&D work in thin film technology and electron beam technology we have increased our collaboration with Saxon universities and technical colleges over recent years. As an industry-oriented R&D organization, we provide customized solutions, which are often sophisticated: besides involving an optimized layer system, suitable cleaning and pretreatment methods for the substrate as well as post-treatment steps have to be elaborated.

Key services we provide are the development and optimization of coating sources and processes, scale-up to production quantities, and integration into suitable plant technology and into existing production processes. Cost optimization of the total system has the highest priority here. Due to the cross-sector and key nature of thin film and surface technology, our work is of interest to a wide range of customers.

The most important sectors are mechanical engineering, solar energy, environment and energy, biomedical engineering, optics, sensor technology, and electronics, packaging, architecture, preservation, and agriculture.

We are operating in the following business units:
- Coating of flat substrates
- Coating of flexible products
- Coating of metal sheets and strips
- Electron beam applications
- Coating of components
- Precision coating

The work of all the business units involves the four core technologies of the institute:
- Electron beam technology
- Sputtering technology
- Plasma-activated high-rate deposition
- High-rate PECVD

We are increasingly offering new technologies to customers as „integrated packages", comprising the development and production of innovative key components for coating technology along with the relevant process technology.
We currently have about 8,000 m² of premises. The equipment includes numerous pilot plants for coating, welding, curing, and surface treatment. In addition, the institute has many laboratory plants and a variety of analytical facilities for the characterization of surfaces.

With our qualified employees, excellent equipment, and the involvement in international networks we are in an ideal position to boost innovative products in thin film and electron beam technologies right through to marketability.

More information

www.fep.fraunhofer.de

Mobile website

m.fep.fraunhofer.de

ORGANIZATIONAL STRUCTURE

ORGANIZATIONAL STRUCTURE

General Management

Acting Director **Prof. Dr. Volker Kirchhoff**

Deputy Director **Dr. Nicolas Schiller**

Scientific Assistant Dr. Marita Mehlstäubl

Material characterization
Dr. Olaf Zywitzki

SECRETARIAT / LIBRARY
Annett Nedjalkov / Mandy Schreiber

QUALITY AND TECHNICAL MANAGEMENT
Wolfgang Nedon

MARKETING / PR / CORPORATE COMMUNICATIONS
Annett Arnold

PROTECTIVE RIGHTS
Jörg Kubusch

Administration
Matthias Wünsche

DIVISION ELECTRON BEAM
Prof. Dr. Christoph Metzner

Coating of sheets and metal strips
Prof. Dr. Christoph Metzner
Dr. Jens-Peter Heinß

Electron beam processes
Frank-Holm Rögner
Dr. Gösta Mattausch

DIVISION PLASMA I
Dr. Torsten Kopte

Coating of flat substrates
Dr. Torsten Kopte
Dr. Ullrich Hartung
MEDICAL APPLICATIONS: Dr. habil. Christiane Wetzel

Coating of components
Dr. Heidrun Klostermann
Dr. Fred Fietzke

DIVISION PLASMA II
Dr. Nicolas Schiller

Coating of flexible products
Dr. Nicolas Schiller
Dr. Matthias Fahland

Precision coating
Dr. Peter Frach
DYNAMIC DEPOSITION: Dr. Daniel Glöß
STATIC DEPOSITION: Dr. Hagen Bartzsch

DIVISION SYSTEMS
Matthias Wünsche

DEVELOPMENT OF MECHANICS
Dieter Weiske

DEVELOPMENT OF ELECTRONICS
Dieter Leffler

PROTOTYPING / COOPERATION
Rainer Zeibe / Steffen Kaufmann

INFORMATION TECHNOLOGY
Roberto Wenzel

THE INSTITUTE IN FIGURES

Funding

The institute is able to look back on another remarkable financial year. As a result of successful acquisitions, Fraunhofer FEP was able to generate 6.4 million euros through direct contracts from industry. That corresponds to an increase in revenue of 12 percent compared to last year. Income amounting to 3.6 million euros was achieved from public projects, funded by the federal government and states. The majority of these, amounting to 2.4 million euros, were obtained through publically funded projects together with SMEs supported by the Saxon Ministry of Science and the Fine Arts and the Saxon Ministry for Economic Affairs, Labor and Traffic. The share of external income from projects with business, public and other clients, i.e. third-party funding, was 79 percent and corresponds to a volume of 10 million euros. As a result, we were able to exceed the challenging targets for 2012. The use of institutional funding in the operating budget was 2.6 million euros.

The income achieved during the reporting period can be broken down as follows:

- income from industry (contract research with industry) € 6.4 million
- public funding (contract research funded by the federal government) € 0.6 million
- public funding (contract research funded by the Länder) € 2.4 million
- EU and other funding € 0.6 million

Total expenditure

The total expenses from the operating and investment budget was 14 million euros. 1.5 million euros, thereof 0.7 million euros from the central strategy fund, were invested in equipment technology and infrastructure in the period under review. These investments are used to continue the business units and in particular to complete current research projects and at the same time provide a guarantee for future research work. The personnel expenses share was 7.3 million euros, which corresponds to 58 percent of the operating budget that amounts to 12.6 million euros. Material expenditure was 5.2 million euros.

Workforce

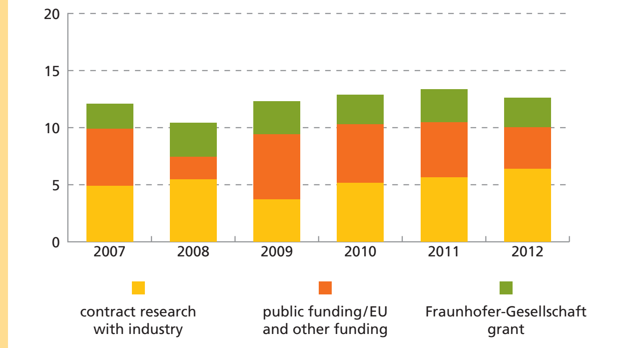
Last year, 133 employees, of these 10 apprentices and another 41 students/interns as well as 77 auxiliary student staff worked at the institute. Of the 62 staff members who were employed as scientists, 8 of them were also working on the doctorate topics. The share of women among the scientists was 15 percent. The educating of young scientists also defined the priorities of our personnel strategy last year. By issuing attractive diploma, Bachelor and doctoral topics, highly motivated scientists were able to successfully acquire their qualifications.

In the area of up-and-coming talent in technology, we also relied on targeted apprenticeships with the respective vocational colleges in 2012. A long-standing partner for the education of physics lab technicians is the Sächsische Bildungsgesellschaft Dresden. Our thanks go to the Dresden Chamber of Industry and Commerce and all the institutions who have contributed to the success of our apprentices and continue to do so.

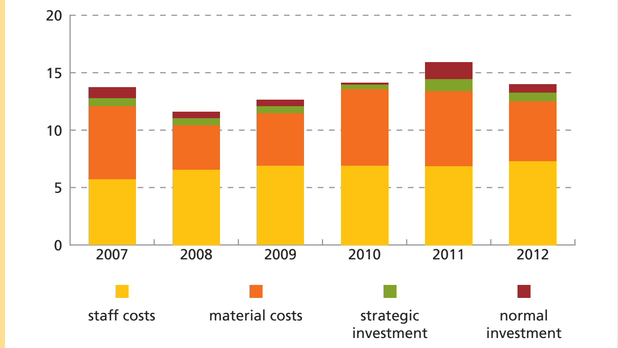
However, we would also like to thank the staff at our institute, who besides their main jobs are always totally committed to personally ensuring the proper training of our future staff. Mr Neumann and Mr Kreusel passed their training qualification examination during the reporting period.

2 new trainees started their apprenticeship at the institute by the end of 2012. There are currently 10 apprentices in training: two BA students, one materials tester, three female physics lab technicians, three male physics lab technicians and one industrial mechanic.

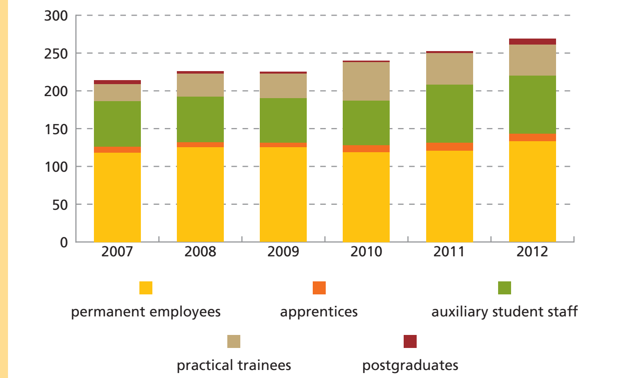
1 Operating budget (in million euros)



2 Investment and total costs (in million euros)



3 Fraunhofer FEP workforce



CONTACT

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INSTITUTE LIFE

Farewell to Matthias Wünsche

Dear Readers,

I would like to take this opportunity to thank my predecessor Mr Matthias Wünsche for all the work he did. In my new role as Head of Administration, I have been left with an institute that is in really good order in terms of organization and finances.

Mr Matthias Wünsche was appointed as Head of Administration at Fraunhofer FEP on 11.01.1996. 15 years of successful work in this role has significantly shaped Fraunhofer FEP. In his role as Head of Systems, he actively contributed to the institute's financial success. System engineering takes on a key role in many projects today.

Under his management, the organizational processes at Fraunhofer FEP were improved and modernized at an early stage so that we were able to meet the challenges of an information society. Collaboration with IT and his „administrators" was particularly important to him.

His conscientious way of working and special understanding for employees' concerns are what distinguished his work at Fraunhofer FEP. His slogan „It will all be alright in the end" was his own mission and vision at the same time. His actions were always defined by achieving the best outcome for our institute and its staff.

Dear Matthias, we were in the same boat on more than one occasion, not just symbolically, and you showed us that the team, oarsman and cox can be one unit. Even in troubled waters you always kept calm and steered our boat back on course. As a successful rower you knew that although you can get ahead faster with the current, a loss of depth could be the consequence . You were always a manager we could trust.

We wish you success and good luck always.

Your Fraunhofer FEP team

Fraunhofer promotes initiatives to reconcile work and family

Reconciling work and family is a particularly important issue for the Fraunhofer-Gesellschaft and part of its corporate philosophy. Above all, we would like to make the return to working life as smooth as possible for our staff, specifically scientists, after starting a family. That is why there has been a cooperation agreement for several years between Fraunhofer FEP together with Fraunhofer IWS, IKTS and IFAM and the Thüringer Sozialakademie gGmbH childcare facilities „Seidnitzer Krümel" and „Stadtmäuse" for the right to 25 childcare places.

By setting up a parent-child office at Fraunhofer FEP, we now have the option of parents being able to bring their children to work, when the usual childcare arrangements are not possible. A parking space has also been provided on the campus site for parents who use the parent-child office.

The establishment of the parent-child office was made possible by financial support from the Fraunhofer-Gesellschaft's „Funding program to support institute measures to reconcile work and family". The Fraunhofer-Gesellschaft provides annual funding totaling 250,000 euros for these kinds of institute-related measures.

The parent-child office was officially opened on July 17, 2012.

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OUR ADVISORY BOARD

The 23rd Fraunhofer FEP advisory board meeting took place on May 22, 2012.

The Fraunhofer FEP trustees, representatives from business, politics and science, met in Dresden to obtain a summary of the institute's work last year and to derive the future strategic focuses together with the institute's staff.

Dr. Feldhütter, representing the Fraunhofer Society Executive Board, reported on business, political and thematic developments within the Fraunhofer-Gesellschaft. In his talk, Dr. Feldhütter referred to the two successful networking instruments within the Fraunhofer-Gesellschaft, the „regional innovation clusters" and „systems research". In doing so, he addressed the focuses of the systems research „electromobility", the Fraunhofer „Morgenstadt" and „Märkte von übermorgen" initiatives with the current focus on the Fraunhofer FEP „Steri-Health" project.

The institute's management provided the trustees with a summary of the institute's economic situation as well as new projects and developments since the advisory board meeting last year. In his lecture on „Electron treatment of seeds, new impetus for an old topic", Frank-Holm Rögner presented the current work and new partnerships, alongside an outline of the history.

In a second lecture on „Development focuses for 3D coating", Dr. Heidrun Klostermann provided insight into the current work in her department and reported on the „Future of component coating" strategic workshop carried out in 2011.

At this point, our thanks go to all the trustees, who constantly contribute to the institute's successful direction with their commitment and valuable comments and suggestions.

Members of the Advisory Board

Dr. Ulrich Engel	Chairman of Advisory Board
RD'in Dr. Annerose Beck	Saxon State Ministry of Science and the Arts, Head of Division Federal-State-Research Institutions
Prof. Dr. Lukas Eng	Dresden University of Technology, Institute for Applied Photonics, Director
Prof. Dr. Richard Funk	Dresden University of Technology, Faculty of Medicine, Institute for Anatomy, Dean
Prof. Dr. Gerald Gerlach	Dresden University of Technology, Faculty of Electrical Engineering and Information Technology, Institute for Solid-State Electronics, Director
Prof. Dr. Gert Heinrich	Leibniz-Institute for Polymer Research Dresden e. V., Head of Institute of Polymer Materials
Prof. Dr. Dieter O. Junkers	Clausthal University of Technology
Nicole Kraheck	Federal Ministry of Education and Research, Department 513
Ralf Kretzschmar	hollomet GmbH, Managing Director
Dr. Harald Küster	ALANOD Aluminium-Veredlung GmbH & Co. KG, Head of Research and Development
Dr. Klaus Michael	Heraeus Sensor Technology GmbH, Manager Business Development
Peter G. Nothnagel	Saxony Economic Development Corporation GmbH, Managing Director
Dr. Jan-Peter Osing	AMG Coating Technologies GmbH, Senior Advisor
Dr. Dietmar Roth	Roth & Rau AG, Wüstenbrand, Management
Robin Schild	VON ARDENNE Anlagentechnik GmbH, Managing Director
Dr. Michael Steinhorst	Tata Steel Europe, Director Product Development, Technology, Application
Dr. Hermann Stumpp	LOI Thermprocess GmbH, Chairman LOI Italimpianti Group
Christoph Teetz	MTU Friedrichshafen GmbH, Vice President Predevelopment & Analytics

Guest members

Dr. Hans-Otto Feldhütter	Fraunhofer-Gesellschaft, Division Director Research
Dr. Patrick Hoyer	Fraunhofer-Gesellschaft, Institute Liaison
Dr. Hans-Ulrich Wiese	Former Board Member of the Fraunhofer-Gesellschaft

COLLABORATION AND MEMBERSHIPS

Thin film technology is used in a number of rapidly developing markets. We collaborate with both national and international partners in order to improve the competitive position of our customers and our institute and to promote successful development work.

Industry partners

Fraunhofer FEP collaborated in 2012 with approx. 50 national and international industrial partners.

Research partners

- University of Virginia USA
- Beijing Institute of Aeronautical Materials
- National Institute for Materials Science Japan
- Korean Institute of Industrial Technology

Fraunhofer cooperations

- Fraunhofer Group for Light & Surfaces
- Fraunhofer Battery Alliance
- Fraunhofer Photocatalysis Alliance
- Fraunhofer Polymer Surfaces Alliance POLO
- Fraunhofer Cleaning Technology Alliance
- Research Alliance Cultural Heritage

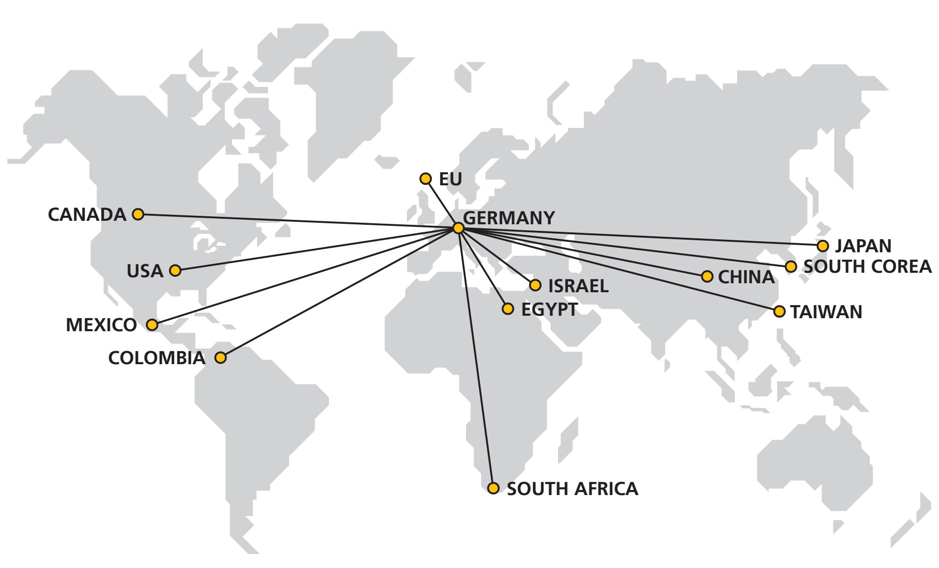
Academic cooperations

- Technische Universität Dresden – Institut für Festkörperelektronik
- Westsächsische Hochschule Zwickau
- Hochschule für Technik und Wirtschaft Dresden (HTWD)

Memberships

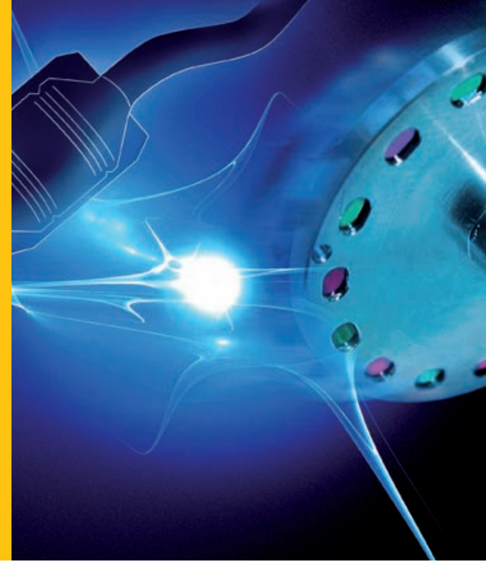
- EFDS Europäische Forschungsgesellschaft Dünne Schichten e. V.
- Organic Electronics Saxony e. V. (OES)
- Silicon Saxony e. V.
- Dresden Concept
- AMA Fachverband für Sensorik e. V.
- Bundesverband mittelständische Wirtschaft (BVMW)
- Deutsche Gesellschaft für Galvano- und Oberflächentechnik e. V. (DGO)
- Kompetenznetz Industrielle Plasma-Oberflächentechnik INPLAS e. V.
- Kompetenzzentrum Maschinenbau Chemnitz/Sachsen e. V. (KMC)
- Netzwerk »Dresden – Stadt der Wissenschaft«
- Verband der Elektrotechnik – Bezirksverein Dresden e. V. (VDE)
- Verband deutscher Maschinen- und Anlagenbau e. V. (VDMA)
- IVAM e. V. Fachverband für Mikrotechnik
- International Council for Coatings on Glass ICCG e. V.

1 Worldwide Partners of Fraunhofer FEP










FRAUNHOFER GROUP FOR LIGHT & SURFACES

Competence by networking

Six Fraunhofer institutes cooperate in the Fraunhofer Group Light & Surfaces. Co-ordinated competences allow quick and flexible alignment of research work on the requirements of different fields of application to answer actual and future challenges, especially in the fields of energy, environment, production, information and security. This market-oriented approach ensures an even wider range of services and creates synergetic effects for the benefit of our customers.

Core competences of the group

- surface and coating functionalization
- laser-based manufacturing processes
- laser development and nonlinear optics
- materials in optics and photonics
- microassembly and system integration
- micro and nano technology
- carbon technology
- measurement methods and characterization
- ultra precision engineering
- material technology
- plasma and electron beam sources

Contact

Group Chairman	Group Assistant
Prof. Dr. Andreas Tünnermann	Susan Oxfart
Phone +49 3641 807-201	Phone +49 3641 807-207

www.light-and-surfaces.fraunhofer.de

Fraunhofer Institute for Electron Beam and Plasma Technology FEP

Electron beam technology, sputtering technology, plasma-activated high-rate deposition and high-rate PECVD are the core areas of expertise of Fraunhofer FEP. The business units include vacuum coating, surface modification and treatment with electrons and plasmas. Besides developing layer systems, products and technologies, another main area of work is the scale-up of technologies for coating and treatment of large areas at high productivity.

www.fep.fraunhofer.de

Fraunhofer Institute for Laser Technology ILT

With more than 350 patents since 1985 the Fraunhofer Institute for Laser Technology ILT develops innovative laser beam sources, laser technologies, and laser systems for its partners from the industry. Our technology areas cover the following topics: laser and optics, medical technology and biophotonics, laser measurement technology and laser materials processing. This includes laser cutting, caving, drilling, welding and soldering as well as surface treatment, micro processing and rapid manufacturing. Furthermore, the Fraunhofer ILT is engaged in laser plant technology, process control, modeling as well as in the entire system technology.

www.ilt.fraunhofer.de

Fraunhofer Institute for Applied Optics and Precision Engineering IOF

The Fraunhofer IOF develops solutions with light to cope foremost challenges for the future in the areas energy and environment, information and security, as well as health care and medical technology.
The competences comprise the entire process chain starting with optics and mechanics design via the development of manufacturing processes for optical and mechanical components and processes of system integration up to the manufacturing of prototypes. Focus of research is put on multifunctional optical coatings, micro- and nano- optics, solid state light sources, optical measurement systems, and opto-mechanical precision systems.

www.iof.fraunhofer.de

Fraunhofer Institute for Physical Measurement Techniques IPM

Fraunhofer IPM develops and builds optical sensor and imaging systems. These mostly laser-based systems combine optical, mechanical, electronic and software components to create perfect solutions of robust design that are individually tailored to suit the conditions at the site of deployment. In the field of thermoelectrics, the institute has extensive know-how in materials research, simulation, and systems. Fraunhofer IPM also specializes in thin-film technologies for application in the production of materials, manufacturing processes and systems.

www.ipm.fraunhofer.de

Fraunhofer Institute for Surface Engineering and Thin Films IST

As an industry oriented R&D service center, the Fraunhofer IST is pooling competencies in the areas film deposition, coating application, film characterization, and surface analysis. Scientists, engineers, and technicians are busily working to provide various types of surfaces with new or improved functions and, as a result, help create innovative marketable products. The institute's business segments are: mechanical and automotive engineering, aerospace, tools, energy, glass and facade, optics, information and communication, life science and ecology.

www.ist.fraunhofer.de

Fraunhofer Institute for Material and Beam Technology IWS

The Fraunhofer Institute for Material and Beam Technology is known for its innovations in the business areas joining and cutting as well as in the surface and coating technology. Our special feature is the expertise of our scientists in combining the profound know-how in materials engineering with the extensive experience in developing system technologies. Every year, numerous solution systems have been developed and have found their way into industrial applications.

www.iws.fraunhofer.de

THE FRAUNHOFER-GESELLSCHAFT

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 66 institutes and independent research units. The majority of the more than 22,000 staff are qualified scientists and engineers, who work with an annual research budget of 1.9 billion euros. Of this sum, more than 1.6 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

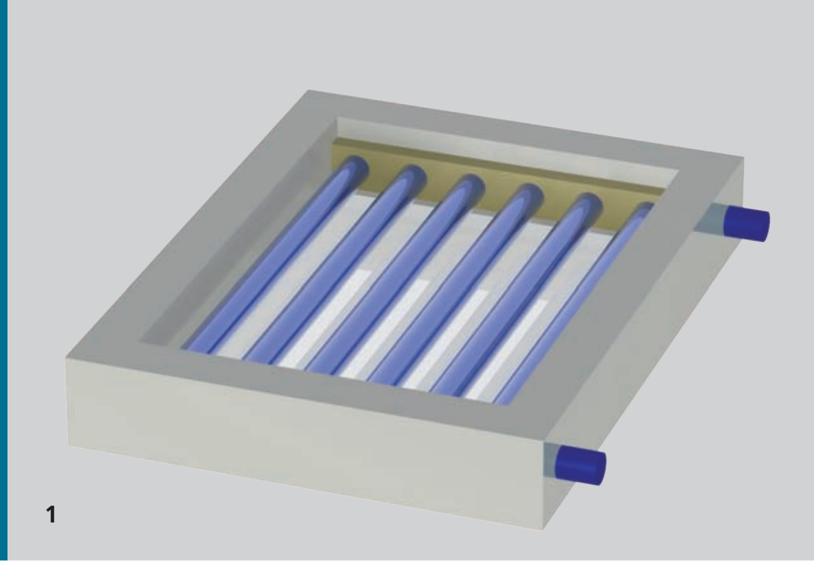
As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

1 *Fraunhofer Institutes and Research Establishments in Germany*

RESEARCH NEWS

RESEARCH NEWS



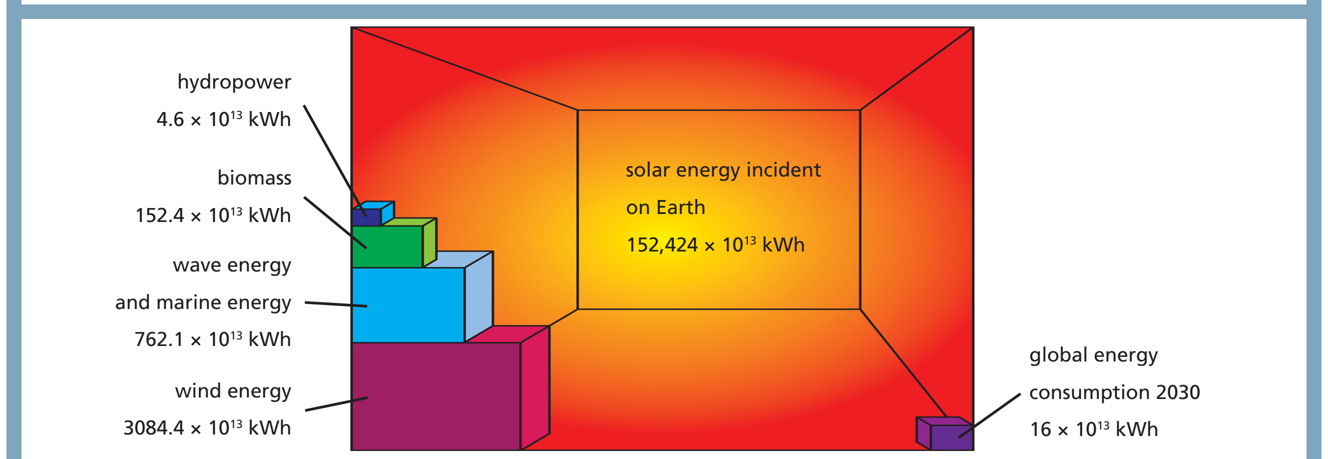
SOLAR HEATING – GREEN HEAT IN ABUNDANCE

In order to solve the global energy and climate problems, it is imperative to use renewable energy in a sustainable way. The utilization of wind energy and solar energy are what everybody is talking about, yet solar heating also offers huge potential to become a cornerstone of energy provision.

Self-powered solar heating/cooling of buildings

Solar energy is by far the largest source of renewable energy (see Fig. 3).
The largest consumption of fossil fuels in Germany today is for heating buildings, followed by electricity generation and transport.[1] Direct conversion of sunlight into heat could save large amounts of fossil energy. This type of energy utilization is generally termed solar heating. A prerequisite for this is firstly efficient conversion of sunlight into usable heat energy using optimized solar collectors, and secondly a low-loss means of storing heat, possibly for an entire year. Namely, heat energy stored during the summer is used in the winter for heating buildings. Zeolites can be used for this purpose. Zeolites are silicate minerals which in their base state contain a lot of water. They have an extremely large internal surface that can store heat quasi loss-free by pure chemical means. A zeolite storage system of a few cubic meters suffices to store the energy required to heat a home for the winter months. The charging of a zeolite storage system, namely the dehydration, requires, however, temperatures of ca. 200°C. Conventional solar collectors operated with water as the heat transport medium cannot provide this. Instead, a new class of solar collectors are required that are designed to allow the high temperatures of the heat carrier medium. These also enable the operation of thermally driven cooling units and hence the solar cooling of buildings in the summer months. The whole system for self-powered solar heating/cooling of buildings is schematically shown in Figure 4.

3 *Renewable energies and global energy consumption*[2]



The following elements are required for this system:

- High-performance solar collectors with high efficiency at operating temperatures up to 200°C
- Zeolite storage systems having long-term stability and a suitable storage capacity
- Energy management for the whole system

Fraunhofer FEP started a collaborative R&D project back in 2011 on high-performance solar collectors having high efficiency at operating temperatures of up to 200°C. Partnerships

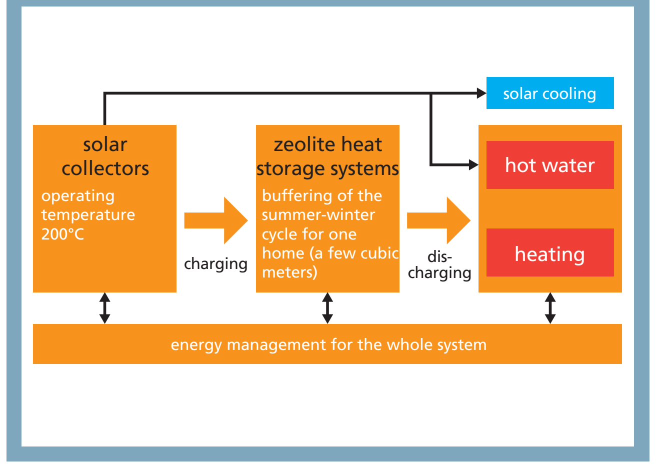
[1] *Arbeitsgemeinschaft Energiebilanzen: Auswertungstabellen zur Energiebilanz der Bundesrepublik Deutschland 1990-2010, Stand 07/2011*

[2] *Eurec Agency / Eurosolar WIP: Power for the World – A Common Concept*

1 *Scheme of a solar collector*

2 *Zeolites*

4 *Self-powered solar heating / cooling of buildings*



were struck up at that time to accelerate work on increasing the long-term stability of the zeolite heat storage systems.

Solar collectors with high efficiency at operating temperatures of up to 200°C

Regarding thermal solar collectors, various systems are commercially available. Vacuum tube collectors achieve the highest efficiency of ca. 95 percent. These systems generally have a metal inner tube that is coated with an absorber layer. There is a vacuum between the inner tube and a partially mirrored outer tube to prevent losses due to heat conduction and convection. The working temperature of conventional solar collectors is ca. 80°C.

Concerning the working temperature of up to 200°C, two fundamental problems arise:

- The combination of a metallic inner tube and glass outer tube leads to metal-glass joints and these must be permanently sealed in order to preserve the vacuum. The very different thermal expansion properties of metals and glass mean that this can be problematic for frequent temperature changes of 200°C and more.
- Radiation losses of wavelength-selective absorbers play no notable role at an operating temperature of 80°C. They are, however, many times higher at a working temperature of 200°C due to their proportionality to the 4th power of the temperature and lead to a reduction in the efficiency.

To overcome these problems, it is planned to develop a novel concept. The high-performance solar collector shown in Figure 6 consists of three concentric glass tubes, and so avoids the use of metal tubes. This thus avoids the problems associated with metal-glass joints.
The inner tube is coated with the absorber layer system. Features of this layer system are its high degree of solar absorption and low degree of emission. The degree of absorption determines the fraction of light that is absorbed and converted into heat in the described layer system. The degree of emission describes the radiation loss due to the high temperature of the absorber. The target is for the absorber layer system to have a degree of absorption of 95 percent and a degree of emission of less than 10 percent at temperatures of 200°C.

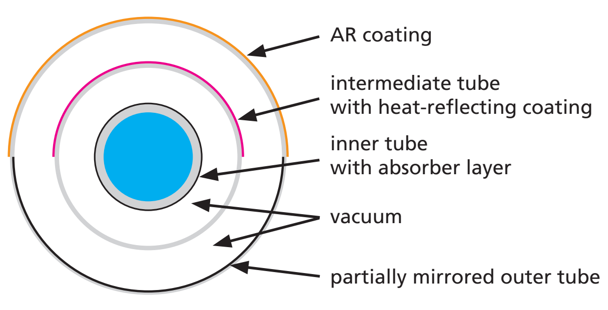
The absorber layer system essentially consists of three single layers:

- IR reflector layer to reduce radiation losses (low degree of emission)
- Selective absorbing layer to absorb the incident radiation
- Anti-reflection layer

A special feature of the concept is the intermediate tube. This fulfills the task of a heat reflector, whereby the radiation losses are considerably reduced at the desired operating temperature of up to 200°C. For this purpose it is coated with a heat-reflecting layer system, similar to the low-E layer systems used for coating architectural glass. An anti-reflection coating can also be applied to the outer tube in order to minimize reflection losses. All coatings must meet high requirements regarding adhesion strength and thermal stability. The functional layer systems are being developed at Fraunhofer FEP, initially on flat glass substrates. They are being characterized according to the requirements regarding the materials used, their specific properties and robustness. A further focus of the work of Fraunhofer FEP is transferring the coating processes to the 3-dimensional tube geometry. The next step here is for Fraunhofer FEP to transfer the coating technologies to glass tubes. The aim is to preserve the functional properties of the layer systems. At our project partner, the machine construction company Götz Lamm & Co. OHG Metalltechnik, Großenhain, an experimental plant is being constructed for coating the individual tubes necessary for the collector. It is being designed for a tube length of 800 mm in the first instance. The resulting semi-finished products will be joined together by the glassblower Horst Müller in Berlin to form a collector. This prototype will then be characterized by an accredited test laboratory.

The work of Fraunhofer FEP on the absorber layer system is essentially finished, while the studies on the heat reflector and anti-reflection layer systems have started. The experimental plant is currently being built and will be commissioned at the beginning of 2013.

6 *Schematic representation of the collector concept*



The project was funded by the European Union and the Free State of Saxony.
Funding reference: 10007/2533

5 *Pilot scale in-line sputter plant ILA 900*

Europa fördert Sachsen.
EFRE
Europäischer Fonds für regionale Entwicklung
Gefördert aus Mitteln der Europäischen Union

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COMPONENT COATING TO MINIMIZE RAW MATERIAL USAGE

Complex surfaces, sensitive materials, and yet very high demands on functionality - the coating of non-standard substrates is very challenging. New combinations of technologies are required in order to open up opportunities for the economically viable vacuum coating of mass-produced components.

The optimum usage of resources is imperative in the 21st century. The onward march of globalization and rapid industrialization has brought resource availability and management to the attention of society. Regulations of the European Union promote the sustainable use of strategic materials and primary energy sources in order to limit the emission of substances that are harmful to the environment. Reaching these goals requires altered consumer behavior on the one hand and new and innovative production processes and product qualities on the other. Germany occupies a key position here because manufacturing industry in Germany makes up a third of the economy, has a strong position on a comparative European basis, and can take on a pioneering role internationally.

Key manufacturing sectors in Germany are the car manufacturing industry, the metal processing industry, and machine construction. These and other sectors are actively involved in minimizing the use of raw materials - on the one hand for economic reasons and on the other hand to maintain their market position with resource-saving products. They also strive to do this out of a responsibility to society and the environment.

Vacuum coating has for some time played a role in these developments. Due to ever stricter regulations, vacuum coating is gaining further importance. In some areas of consumer goods production PVD and CVD are established methods for functionalizing and improving the functionality of products. Examples are the metallization of plastic components such as decorative and operating elements, lamp reflectors, and housings for electronics. Protective layers applied by PVD methods protect fasteners on aircraft against corrosion, with safety standards being particularly high here. Low-friction layers on components reduce losses in drive and transmission systems. Abrasion-resistant layers allow highly efficient machining processes to be carried out, including on new, highly resistant, high-strength materials.

The demand for function optimization via coating is also increasing. Process developers are constantly confronted by new requirements regarding the materials to be coated, the complexity of specifications, and cost efficiency. New efficient coatings, comprising for example thick multimaterial layer systems having specific structures and functions, also need efficient and reliable coating processes to be developed. The Fraunhofer FEP has set itself this challenge and is developing combined methods which bring together aspects of electron beam technology and plasma technology.

Besides the process-related challenges, the coating of 3D objects requires suitable substrate movement in order to apply uniform layers to the components and requires concepts for monitoring the substrate temperature. Depending on the substrate material and coating material, key parameters for an effective coating process are maintenance of strict temperature limits to avoid substrate damage and in some cases controlled heating to achieve a specific morphology or phase.

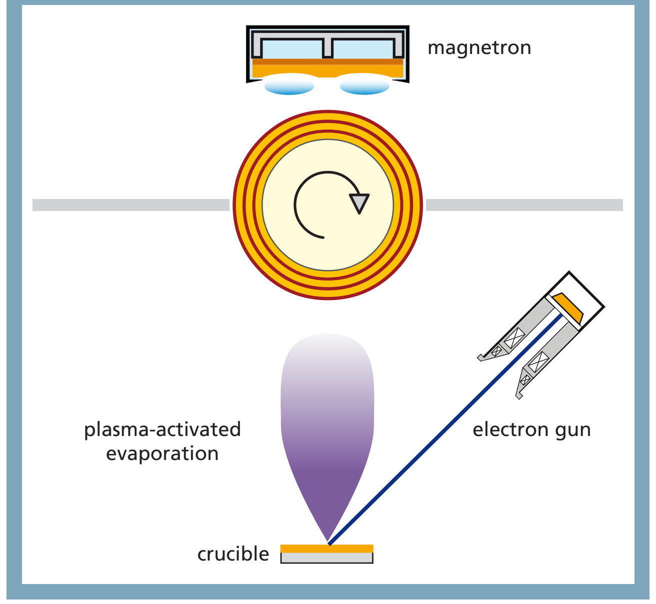
Using new combined vacuum methods, the Coating of Components business unit of the Fraunhofer FEP now also offers alternatives to chemical methods in areas where regulations on work safety and environmental protection make their use increasingly unprofitable or difficult. The Coating of Components business unit continues its work on the functionalization of small components (bulk goods). Besides corrosion protection via multilayers deposited via PVD, the aim is to realize other functionalities on small components, for example low-friction carbon-based layers deposited via PECVD at very high rates (see the article on page 108 by Dr. B. Zimmermann). Reduced friction loss on many small parts can result, for example, in improved efficiency of drive systems and hence lower usage of resources.

For larger components the Fraunhofer FEP wants to create a platform for combination-coating using magnetron sputtering, electron beam high-rate deposition, and PECVD. For coating metal strips, high-rate electron beam deposition has been shown to produce layers with unique combinations of properties which cannot be economically realized using other methods. The equipment required to open up this technology for 3D coating is a short cycle unit in which the components are fed via a load lock into the process chamber without breaking the vacuum and the rotating components – a prerequisite for 3D parts – are then subjected to coating processes either sequentially or in parallel.

The combinations of processes under development will open up new freedom for the layer compositions which has hitherto not been possible using traditional vacuum coating processes for coating 3D components. These compositions will include dielectric materials not possible using arc evaporation, and also thick layers of the order of 100 µm which cannot be economically applied by either sputtering or arc evaporation. In general the work will concern layer systems which can only be applied in an uninterrupted process by a combination of different technologies. These include, for example, systems of the type M - MC - MC_xN_y - C_xN_y whose layers with their individual functionalities are vital for good overall performance. Multiphase layers, having oxidic components that only become effective in different exposure situations, can also be prepared using suitable hybrid processes. This means that new substrate / functional surface combinations will be possible, helping to bring together apparently opposing features such as lightweight, improved performance, and abrasion-resistance in, for example, components of combustion engines.

The development platform that has been described for small components and substrates up to a typical size of 300 mm, and in some cases even larger, will also be used by the Coating of Components business unit to enhance the know-how of the Fraunhofer FEP in its core areas of expertise and for coating non-standard substrates. Together with industrial partners the Fraunhofer FEP will thus contribute to optimization of resource usage for industrial production and at the same time the manufacture of resource-saving products.

1 *Combined methods for depositing multimaterial layers*



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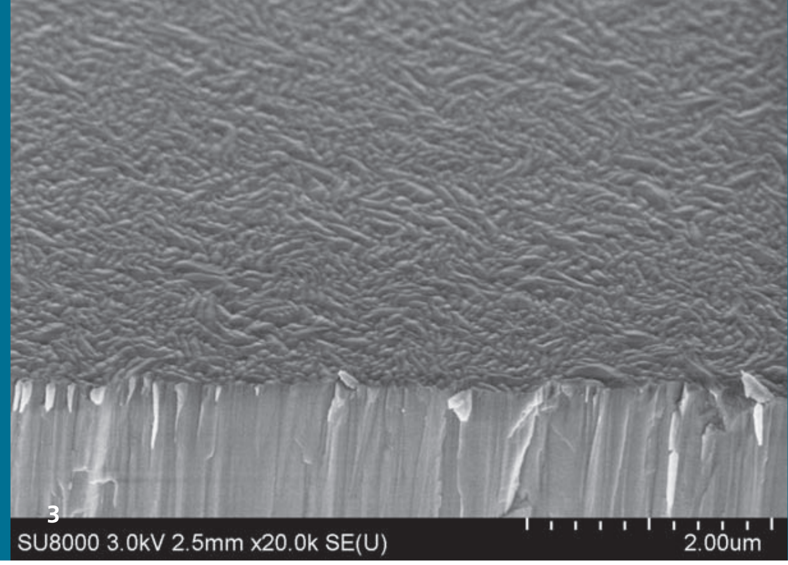
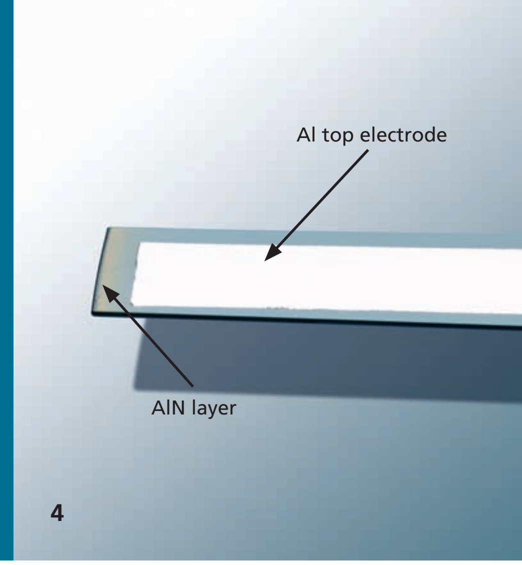




MAGNETRON SPUTTERING OF PIEZOELECTRIC ALUMINUM NITRIDE THIN FILMS

Piezoelectric thin films are used, for example, for MEMS[1], SAW[2] / BAW[3] elements, for ultrasound generation, and for energy harvesting (micro energy generation). Aluminum nitride (AlN) is a highly promising material for these layers.

Piezoelectric materials are materials that undergo deformation when an electrical voltage is applied or give rise to charge separation when a mechanical force is applied. A commonly used parameter for characterizing piezoelectric materials is the piezocoefficient d_{33} (change in length parallel to the electrical field; units: pm/V or pC/N), with a high value indicating better piezoelectric behavior. The most common material for piezoelectric applications, lead-zirconate-titanate (PZT), can have several hundred pC/N.

An alternative material is aluminum nitride. Due to its wurtzite crystal structure it possesses piezoelectric properties. AlN has a number of advantages over PZT. Two examples are the fact that it is lead-free (EU directive RoHS) and the fact that the deposition of AlN is compatible with commonly used microelectronic processes. Literature values for the d_{33} piezocoefficient of AlN are in the 5 to 7 pC/N range. At Fraunhofer FEP we are able to deposit layers having piezocoefficients of up to 9 pC/N at moderate film stress (Fig. 5). The layer deposition is carried out by reactive magnetron sputtering of aluminum targets in an argon-nitrogen atmosphere. The deposition processes were performed in a stationary coating system with a double ring magnetron (DRM 400, Fig. 1). By superimposing the discharges of both targets it is possible to deposit very homogeneous layers across a diameter of up to 200 mm at high coating rates (Fig. 6).

One main application of AlN is for ultrasonic transducers. Besides single element transducers, the phased array technology should be mentioned: Time-delayed activation of small transducer elements allows electronic deflection and focusing of the ultrasonic pulse into different regions of the material, without having to change the sensor position. Collaborative work is being undertaken with the Fraunhofer IZFP to develop phased array sensors with thin AlN layers.

In conjunction with TU Dresden and the University of Oulu (Finland) studies have been carried out on energy harvesting using AlN thin films on silicon (Si) strips (Fig. 4). Although their design is not yet optimized, the cantilevers in resonance showed energy densities of up to 20 $mW/g \times cm^{-3}$ and a generated power of up to 270 µW. Key future areas of work will be to increase the layer thickness and optimize the design. This will make it possible, for example, to have a more compact system, to increase the generated voltage, and to adapt the resonance frequency for the specific application.

Reactive co-sputtering of aluminum and scandium targets has allowed aluminum scandium nitride ($Al_xSc_{1-x}N$) layers with variable Al:Sc ratio to be deposited. Compared to pure AlN these layers have considerably higher d_{33} piezocoefficients of up to 30 pC/N for similar coating rates and moderate film stress (Fig. 5).

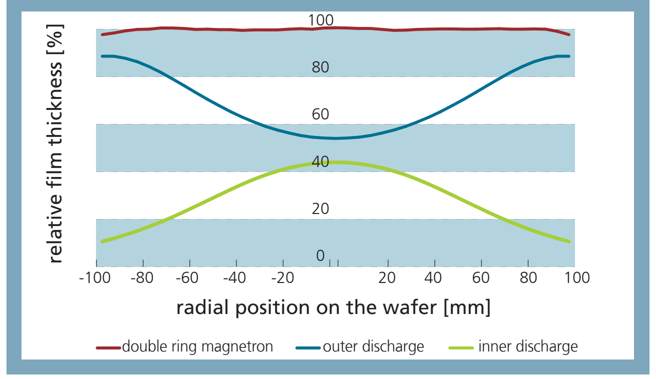
[1] MEMS: micro-electro-mechanical systems
[2] SAW: surface acoustic wave
[3] BAW: bulk acoustic wave

1 Double ring magnetron DRM 400
2 Cluster 300 experimental plant for stationary magnetron sputtering
3 SEM micrograph of an AlN layer
4 AlN thin film on silicon cantilever for energy harvesting

5 Comparison of AlN and $Al_xSc_{1-x}N$ layers

	AlN	$Al_xSc_{1-x}N$
layer thickness [µm]	10	10
max. d_{33} [pC/N]	9	30
deposition rate [nm/min]	100 … 200	100 … 140
film stress [MPa]	-300	-300

6 Layer thickness distribution of the DRM 400



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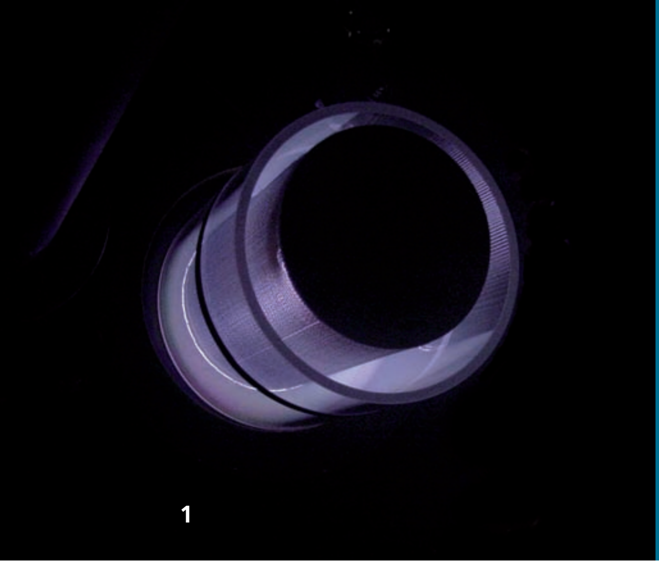

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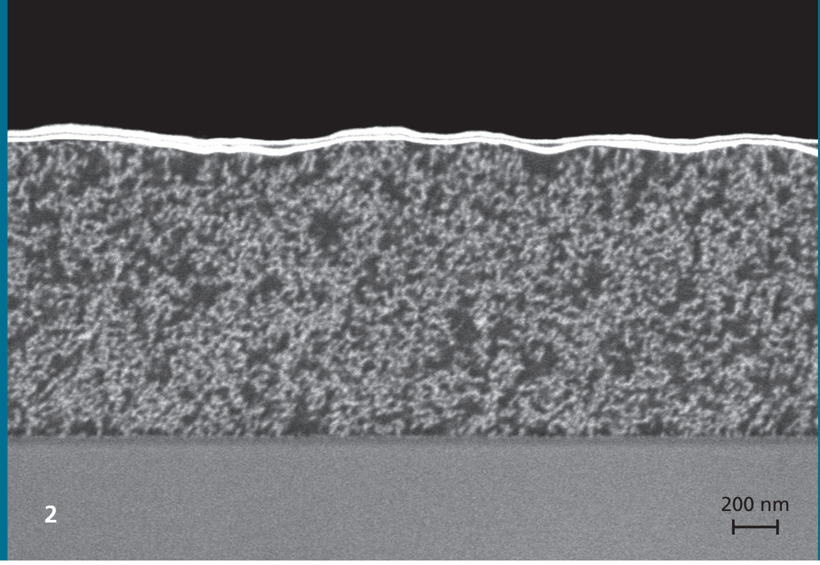

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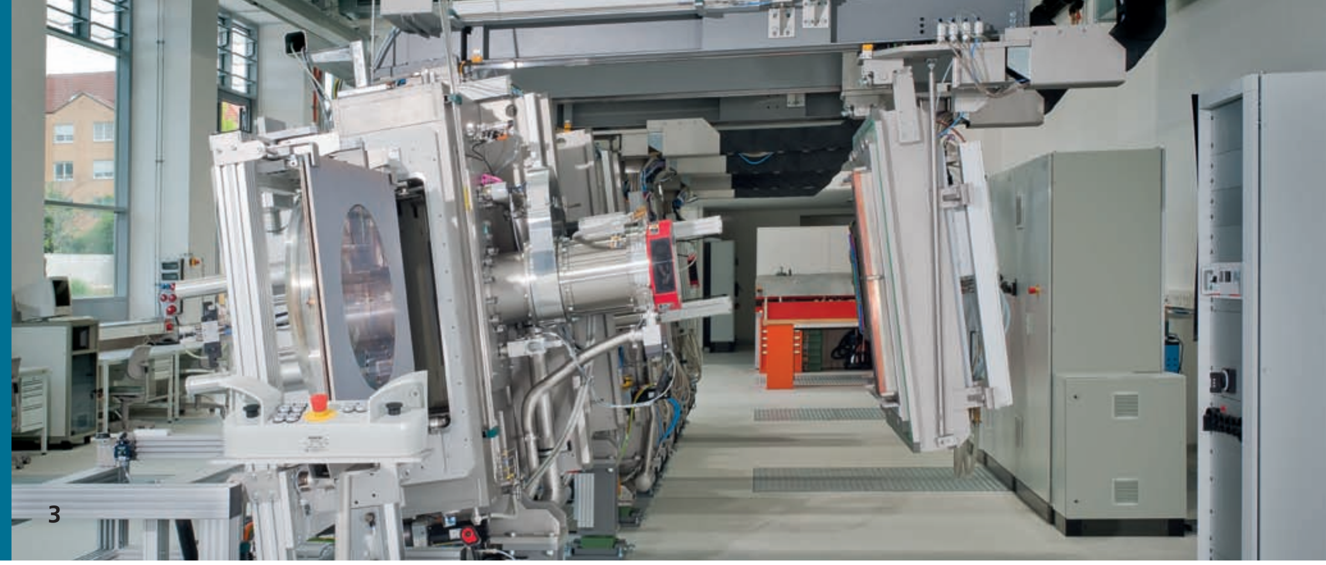


3

LOW PRESSURE PLASMA TREATMENT FOR CURING HYBRID LAYER SYSTEMS

The Fraunhofer FEP has carried out studies on the use of low pressure plasma treatment as an alternative method for curing wet polymer layers. Hybrid layer systems were employed as the layer materials because these merge various properties of the organic and inorganic base materials.

Novel, inorganic-organic hybrid polymers have the advantage over conventional, usually pure organic polymers that they merge a variety of functionalities and properties of their organic and inorganic base components. This creates new overall properties, which the base materials alone do not possess. Such hybrid polymers are used, amongst other things, as non-stick layers, diffusion barriers, dental materials, and for mechanical protection.

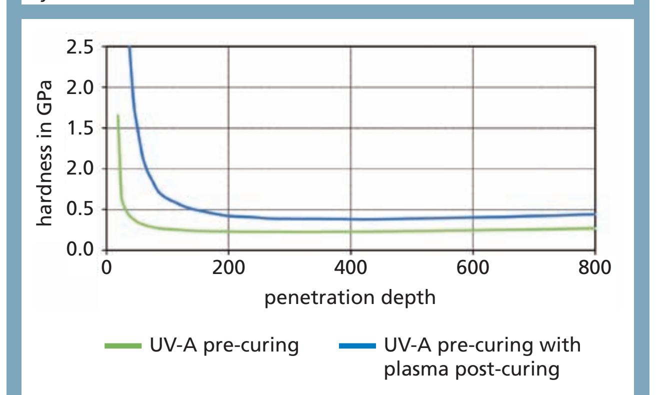
In order to meet the complex requirements of multifunctional surfaces, the various properties of the individual materials must be merged. The inorganic-organic hybrid polymers (ORMOCER®s) manufactured at the Fraunhofer Institute for Silicate Research ISC are a successful way of achieving this. Their manufacture involves the crosslinking of inorganic compounds with organic polymer units at the molecular level. An organo-functionalized support material (siloxane structure) serves as the base structure for the sol-gel systems. Inorganic-oxidic networks serve as a second component to increase the chemical and thermal stability and the layer hardness. Organic polymer chains are incorporated as the third component, and these are responsible for most of the polymerization during the curing of the layer system.

UV curing and thermal curing are established methods for curing sol-gel layer systems. Projects underway at the Fraunhofer FEP are exploring for the first time the use of a low pressure plasma as a curing method for novel applications. A Plasmatreater was employed as a plasma source. This is used as standard for substrate pre-treatment in PVD coating processes. In particular, ion bombardment during plasma curing leads to the formation of free radicals in the layer. These result in more stable crosslinking of the hybrid polymers. FT-IR analysis indicated the degradation of double bonds (C=C) and the formation of SiO_x bonds. To measure the layer hardness, the plasma-treated layers were tested using the nanoindentation method, which allows the hardness to be measured as a function of depth. Significantly elevated hardness was found at the surface (Fig. 4).

One goal of the studies was to provide the plasma-curable hybrid polymers with photocatalytic activity, for example, in order to provide antibacterial properties. To achieve this, photocatalytically active titanium dioxide nanoparticles were embedded in the hybrid polymers. A positive side-effect of the plasma treatment here is the simultaneous etching effect which partially exposes the nanoparticles that are embedded in the polymer layer, so fully opening up their photocatalytic effect. The photocatalytic effect of the layer systems was demonstrated by the decomposition of methylene blue on exposure to UV-A light (1 mW/cm²). The TiO_2 nanoparticle containing hybrid polymer layers have a greater photocatalytic effect than commercially available glass coatings.

The advantages of plasma curing over thermal curing are the shorter process times and lower thermal loads on the substrates. A benefit over UV curing is that there is no need for UV initiators. Potential uses for the plasma curing of hybrid polymers are coatings for metal surfaces and, in particular plastic surfaces, with the increased surface hardness providing improved scratch protection. Possible applications for the photocatalytic layers are antibacterial or easy-to-clean surfaces for medical products and for environmental monitoring.

4 *Layer hardness as a function of penetration depth measured by nanoindentation*



Funding:
Federal Ministry of Education and Research

Project:
»Innovative plasma technology for generating photocatalytically active hybrid layers« (PlasKat), Funding reference: 13N9313

»Innovative gradient layers with nanoscale hybrid polymers« (InGrad), Funding reference: 03X0099D

1 *Internal treatment with Plasmatreater*

2 *TEM micrograph: Plasma-cured layer with homogeneously incorporated TiO_2 nanoparticles (© Fraunhofer ISC)*

3 *Precision coating plant – PreSensLine*

Federal Ministry of Education and Research

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LIGHTWEIGHT PHOTOVOLTAIC

The solar industry, a leading sector of German industry, is undergoing radical change and needs to reinvent itself. Fundamental innovations are necessary due to the enormous cost pressure being put on the market by, in particular, Asian solar module manufacturers. A collaborative internal Fraunhofer project is carrying out valuable preliminary development work on novel, lightweight solar modules.

Solar modules are indispensable components for generating renewable energy. Currently the most powerful modules have efficiencies of about 20 percent by using solar cells made of crystalline silicon wafers. The typical structure of such a solar module consists firstly of a front glass that provides mechanical support and protection. Below this the actual solar cell is embedded in an elastic polymer material. The back of the module is encapsulated by a film that is impermeable to light and vapors. The complete encapsulation of solar cells is necessary in order to prevent deterioration caused by the effects of atmospheric gases and vapors. This allows service lives of more than 20 years to be achieved.

The front glass means that a typical solar module weighs about 20 kilograms. The aim of the collaborative project within the Fraunhofer-Gesellschaft is to drastically reduce the weight by half. The approach being adopted is to replace the glass at the front by a polymer film. The mechanical stability is provided by a support system on the back. Advanced fiber reinforced materials, like those used in the car manufacturing industry, are used for this.

As well as the novel lighter solar module design, the efficiency of the individual solar cells is being drastically increased using new concepts. For example, all the electrodes and light-impermeable contacts are positioned on the back sides of the wafer-based solar cells. This allows a larger area of the solar cells to be irradiated by sunlight. The efficiency of the solar cells and hence, of the total module is thus enhanced.

The final result is a solar module having greater efficiency and only half the weight. Due to the lower weight, the solar modules can, for example, be installed on factory roofs. Factory roofs are often constructed cost-effectively and designed for the expected snow loads. An additional mounting assembly for conventional solar modules was not possible due to the high additional weight. The new lighter solar modules have an advantage in this regard. Roof areas across Europe provide an opportunity for solar modules that must no longer be unused.

The joint internal project involves the Fraunhofer ISE, IFAM, IZM, and FEP. In addition to the technological work developing a new generation of lightweight solar modules, much attention is being put on the cost aspect. Using efficient production methods and favorable-cost materials, a realistic concept has already been developed within the first half of the project. The concept allows manufacture of lightweight modules for the same cost as present day conventional solar modules. Further optimization will allow new price ranges to be achieved which will help German solar module manufacturers to once again become market leaders.

The Fraunhofer FEP is playing a leading role in the project developing the front film. Our 20 years of experience in the improvement of polymer films is being used here to prepare favorable-cost substrate materials having the necessary optical properties. In addition, the know-how we have acquired from 10 years' work on the encapsulation of sensitive, electronic components is being used to coat the substrate films with a barrier layer to prevent the penetration of atmospheric gases and vapors.

Project funding:
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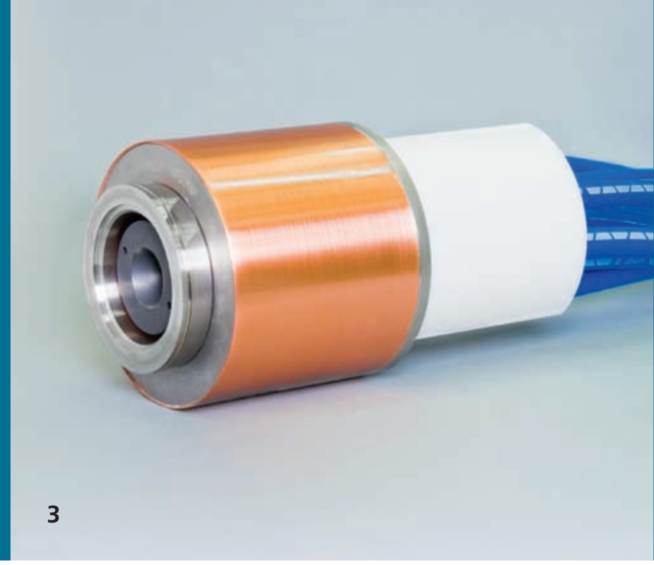

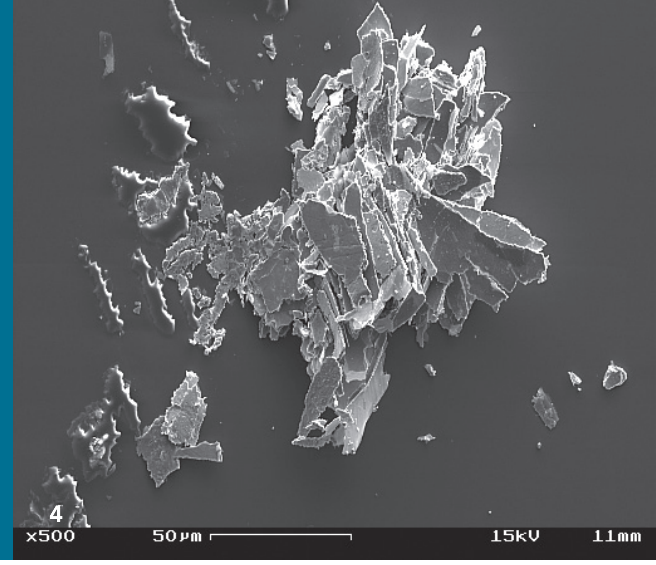

10 YEARS OF FRAUNHOFER CLEANING TECHNOLOGY ALLIANCE – FRAUNHOFER FEP HAS BEEN INVOLVED SINCE THE START!

The cleaning of surfaces in all sectors of industry is a necessary part of the production chain. However, there is virtually no research institution in Germany or wider afield which focuses on this topic.

Even within the Fraunhofer-Gesellschaft there is no institute exclusively devoted to cleaning technology. However, in many Fraunhofer institutes there are work groups which, depending on the area of technology, necessarily have to involve themselves with the cleaning of surfaces. For example, this may be a pre-treatment step prior to a coating process, a cleaning step prior to joining substrates, or minimization of particle contamination in the microelectronics sector. This is the background to why 8 Fraunhofer institutes decided to found the Fraunhofer Cleaning Technology Alliance (FAR) ten years ago on 5th December 2002. The founding members were Fraunhofer FEP, ICT, IGB, ILT, IPA, IPK, IST, and IWS. Fraunhofer FEP recognized early on that the bringing together of expertise in this interdisciplinary area was essential not only for our own technological needs but also for marketing cleaning technology know-how.

What has been achieved in these 10 years?

A new industrial fair in the area of industrial parts and surface cleaning, parts2clean, started up at virtually the same time as the foundation of the Fraunhofer Cleaning technology Alliance. The organizer, FairXperts, sought a technical partner and the founding members of FAR were chosen. A lasting partnership has developed and the technical forum organized by FAR forms an ever growing aspect of the parts2clean fair. This year the technical forum was held in two languages (German/English) so giving the forum an international dimension. The joint stand of the FAR institutes remains the main focus of FAR at the parts2clean fair.

A joint market survey carried out by FAR in 2007 clearly highlighted that there was a considerable knowledge deficit in the area of cleaning technology, with no training courses in Germany and hardly any options for follow-up training. The member institutes of FAR therefore developed a comprehensive and systematic 3-day training program covering the principles of cleaning technology to provide assistance to industry with their cleaning tasks. Much positive feedback from participants and the number of confirmed bookings for the fifth seminar on the principles of cleaning technology at Fraunhofer FEP in April 2013 are testament to the success of this program. That the seminar was included this year in the portfolio of the Fraunhofer Academy is additional recognition of its excellent quality.

Naturally, the portfolio of Fraunhofer FEP in the area of cleaning technology has expanded over this time period. Classical topics, which originate from the technology portfolio of the institute, are the low pressure plasma-etching processes for surface preparation prior to vacuum coating. High-rate coating processes require highly effective cleaning processes. That is why our developments included a hollow cathode arc discharge source (Fig. 3) which achieves these high etching rates and can be used in a versatile way.

The cleaning step prior to vacuum treatment also has a major influence on the coating quality. These classic, mostly liquid-based ultra-fine cleaning processes were originally the reason for involvement in FAR. In the meantime, the expertise that has been acquired in the area of process analysis and optimization, process media care, surface analysis, failure analysis, and quality assurance has been successfully used for customers from a wide range of industries.

Another area of cleaning technology concerns disinfection and sterilization processes for industries where hygiene is important, for example the food and packaging industries, pharmaceutical production, and medical technology. Great attention is put on cleanliness in these sensitive areas. Fraunhofer FEP is successfully using electron treatment as an effective, rapid, eco-friendly, and gentle cleaning method to provide innovative solutions for many current cleaning problems.

In summary it can be stated that the excellent collaboration within FAR has allowed effective interdisciplinary developments to be made in the area of cleaning technology. FAR has become established, both internally and externally, as a competence center for industrial cleaning technology and this has allowed access to a wide range of industries. Fraunhofer FEP will continue to actively shape future developments in the area of cleaning technology.

1 *Booth at the parts2clean*
2 *Training programme cleaning technology*
3 *Powerful plasma source for surface pre-treatment*
4 *SEM micrograph for the analysis of contamination*

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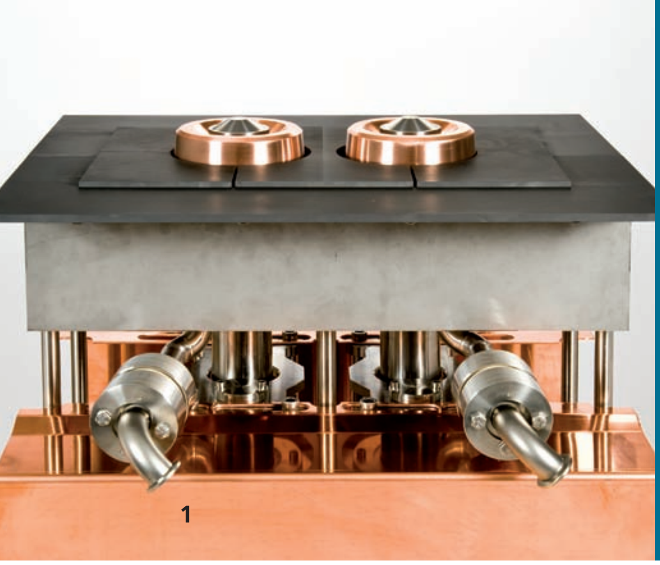
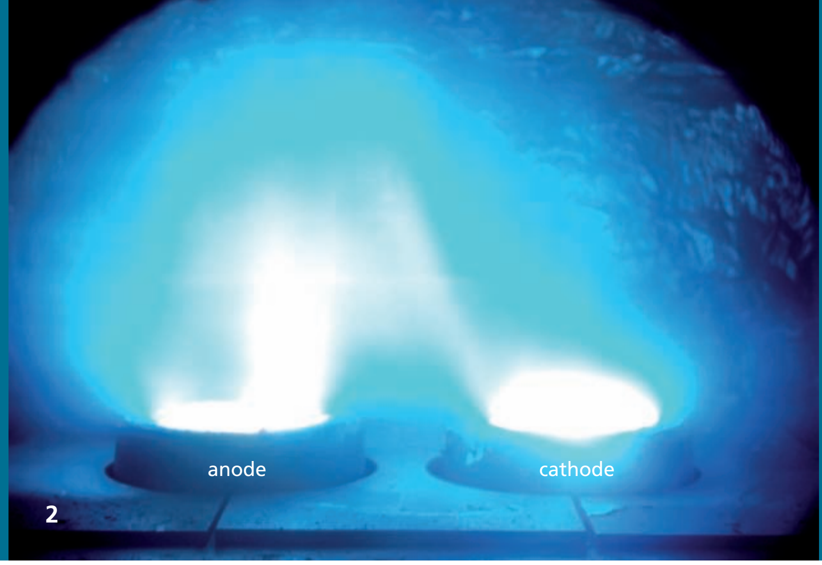
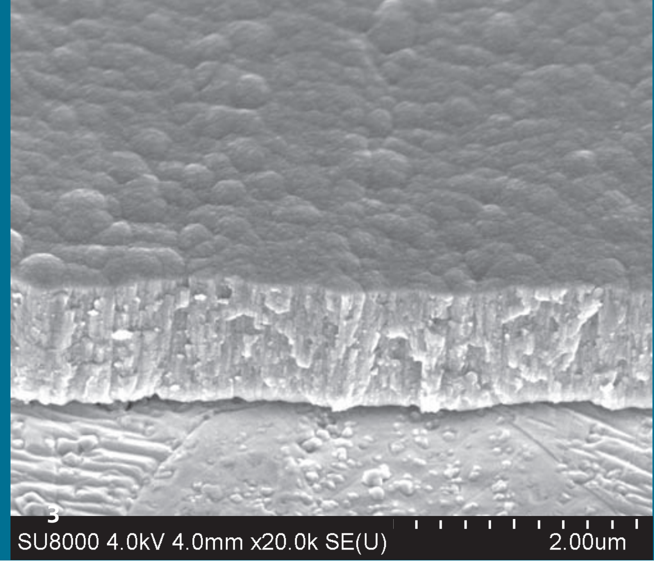
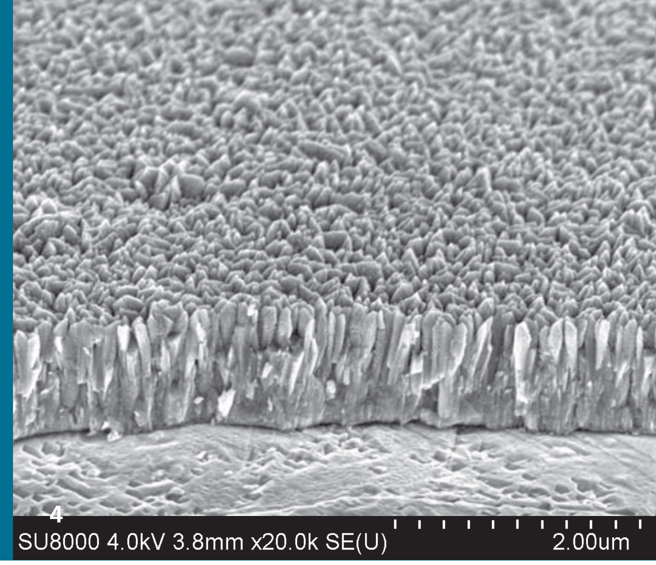








LONG-TERM STABLE PLASMA PROCESS FOR HIGH-RATE VAPOR DEPOSITION USING A DUAL CRUCIBLE

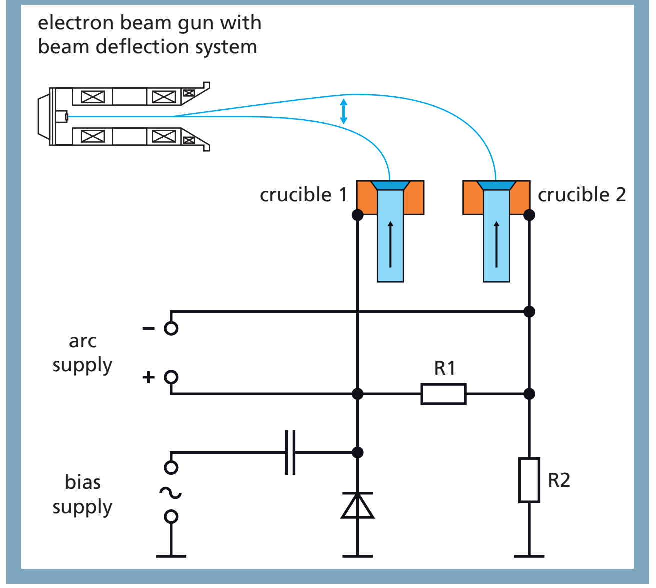
Thin titanium dioxide coatings are important for the optical refinement of surfaces and can even have photocatalytic effects. The introduction of a dual crucible for the SAD process means that Fraunhofer FEP now has a powerful plasma process for high-rate vapor deposition with long-term stability.

A high coating rate is needed when large quantities of material have to be applied as a layer material in an economical way, for example the coating of very large surfaces or the application of relatively thick layers. Electron beam evaporation is the ideal vacuum process for achieving the high coating rate requirements, even for high melting point materials that are difficult to evaporate. Combination with a powerful plasma process is often essential in situations where coatings of high melting point materials must meet specific quality criteria regarding their properties, density, and layer microstructure.

The so-called SAD process (Spotless arc Activated Deposition), developed by the Fraunhofer FEP in the 1990s, combines electron beam evaporation with a diffuse arc discharge which burns in the metal vapor of a hot, evaporating cathode. A diffuse type of vacuum arc discharge arises when the cathode temperature is high enough to allow a sufficiently high current density of thermionic electron emission. This plasma process allows dense metal layers to be applied at coating rates of about 1 µm/s or reactively deposited compound layers at coating rates of up to 0.1 µm/s. Droplet-free, highly transparent oxide layers can also be produced in this way.
The benefits of the method really come to the fore for the manufacture of titanium dioxide (TiO_2) layers. Whether the layers are amorphous or crystalline TiO_2 is determined by the choice of process parameters. The high optical refractive index of the layers (2.3 to 2.5 at 550 nm) is suitable for the manufacture of highly reflective surfaces, for example as required in the solar industry. The high refractive index produces intense interference colors and powerful decorative effects. The crystalline coatings, and in particular the anatase type, have significant photocatalytic and superhydrophilic properties after irradiation with UV light and can be used to keep external surfaces clean (e.g. building facades).

A key improvement to the process was achieved by developing a novel process variant with a dual crucible. Two electrically insulated, water-cooled copper crucibles, each equipped with motor-driven material feed (rod feed from below), form the evaporator unit. The hot, evaporating surfaces of the two metal melts act as electrodes for the diffuse arc discharge. Tests over a period of 100 hours, during which more than 40 kg titanium was evaporated, demonstrated that the electrodes maintained their full functionality for the arc discharge.
The stability over such a long time period is an important prerequisite for industrial use. The earlier limitations regarding the process stability, namely the gradual depositing of oxide layers on a water-cooled anode, have thus been overcome.
For homogeneous coating of broad strip materials at least two dual crucibles are necessary.

5 *Schematic representation of the SAD process with the dual crucible*



The studies on the dual crucible were carried out in a joint project with VON ARDENNE Anlagentechnik GmbH.

The project was funded by the European Union and the Free State of Saxony.
Funding reference: 14274I2473

1 *A dual crucible developed at the Fraunhofer FEP*
2 *Plasma of the diffuse arc discharge during the evaporation of titanium from the dual crucible*
3 *SEM image of a ca. 1 µm thick, amorphous, TiO_2 layer in cross fracture*
4 *SEM image of a ca. 1 µm thick, crystalline, TiO_2 layer (anatase) in cross fracture*

Gefördert aus Mitteln der Europäischen Union
Europa fördert Sachsen. EFRE Europäischer Fonds für regionale Entwicklung

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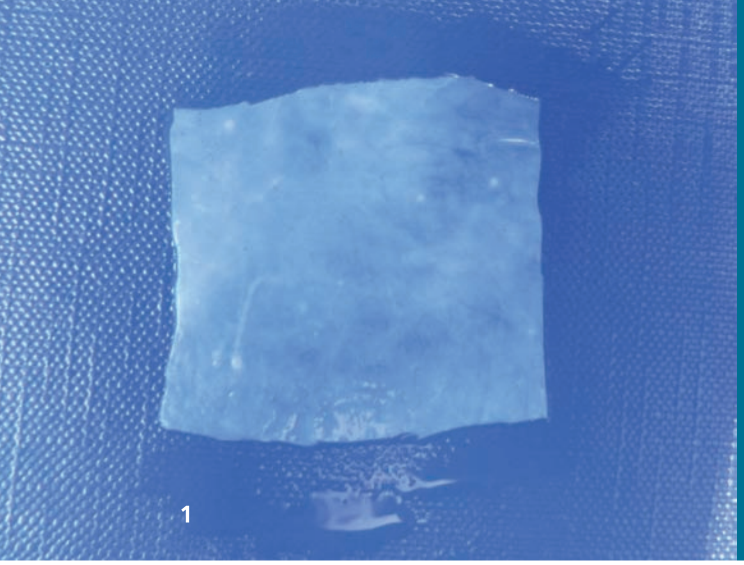
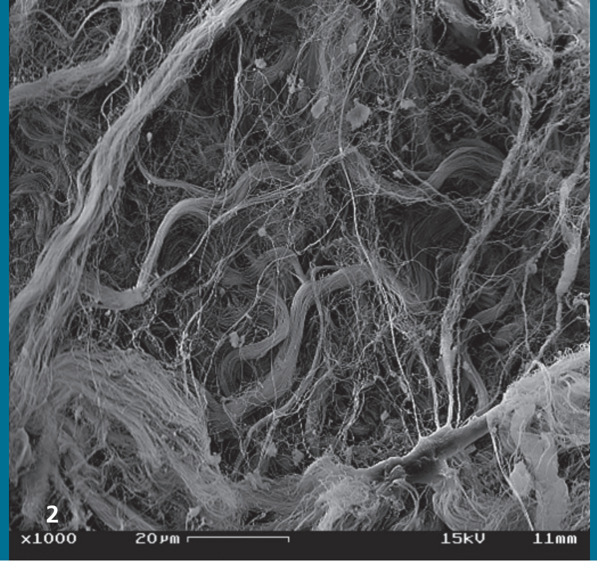




MODIFICATION OF BIOLOGICAL MATERIAL WITH ELECTRON BEAMS

As part of a foundation scholarship, fundamental studies are being carried out at Fraunhofer FEP on the potential of the non-thermal electron beam technology for the modification and sterilization of biological material.

Porcine pericardium tissue was chosen as the model biological material. The pericardial tissue can be stabilized by transverse crosslinking of the long-chained collagen molecules and can then be used for implants. The standard technique involves chemical crosslinking with glutaraldehyde.

Collagen-containing materials, such as porcine heart valves and the bovine pericardium, crosslinked in this way are already used as replacement heart valves or pericardial patches for enlarging the pericardium after open heart surgery. Compared to synthetic materials they have improved biocompatibility and hence require no anticoagulation therapy. However, the crosslinking with glutaraldehyde is responsible for the calcification of replacement heart valves made of biological material. The result is that after ca. 10 to 15 years the replacement heart valve fails. For this reason, only older patients are given replacement heart valves made of biological material. Younger patients are rather given mechanical heart valve implants plus the associated anticoagulation therapy.

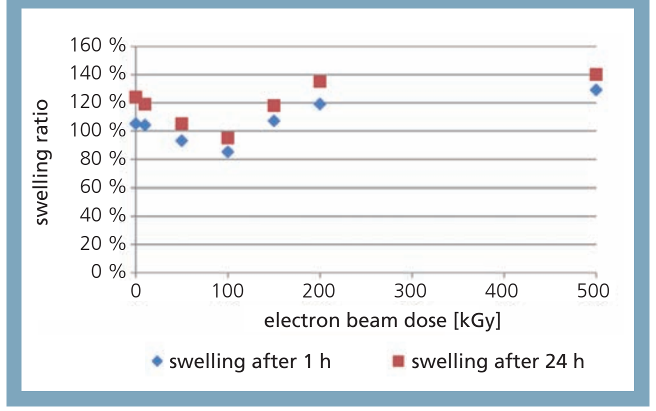
A few alternative approaches are described in the literature: The use of other crosslinking substances and the suppression of hydroxyapatite formation and calcium diffusion. The use of electron beams is also a very promising approach. The ability of electron beams to cleave chemical bonds and facilitate crosslinking between individual molecules makes electron beams ideal for this application. In particular non-thermal electron beam technology, which Fraunhofer FEP uses on its REAMODE plant, allows materials to be modified under normal pressure and at room temperature. This thus allows sensitive biological materials to be treated. There are already single publications in the literature describing the general application of electron beams on collagen which indicate a successful realization of our project.

Indeed, our initial results on electron beam treated porcine pericardium are highly promising. For example, the swelling of the biological material was reduced after treatment with electron beam doses of up to 100 kGy (Fig. 5), and in the literature this is attributed to crosslinking of the collagen molecules [1]. After electron beam treatment with 1000 kGy the tissue is too brittle to carry out further analyses. At high electron beam doses, chain degradation dominates over the crosslinking. The region beyond 25 kGy is of particular interest for medical applications and especially for implants: A major advantage of electron beam treatment is that specimens are simultaneously sterilized because undesirable germs are killed. For sterilization with ionizing beams a minimum dose of 25 kGy is required by law.

The focus of the work within the framework of the foundation scholarship is to determine the optimum electron beam parameters for collagen crosslinking in the biological tissue which guarantee its flexibility, mechanical strength, biocompatibility, and sterility. Electron beam treatment using the REAMODE plant allows many parameters to be varied, evaluated, and optimized for specific applications. In addition to the electron beam dose, other parameters that can be varied include the gas atmosphere (ambient air, inert gas, reactive gas), the substrate temperature, the electron density, and the electron energy, with the latter determining the depth of penetration of the electrons into the material.

The studies within the foundation scholarship will form the basis for further application-related projects.

5 *Swelling of electron beam treated pericardium specimens after 1 h and 24 h*



[1] *Charulatha, V.; Rajaram, A. (2003), Biomaterials 24:759-767*

1 *Pericardium specimen*
2 *SEM micrograph of the pericardium (1000 times magnification)*
3 *REAMODE – experimental plant for modifying organic materials using accelerated electrons*
4 *Bioprosthetic heart valve*

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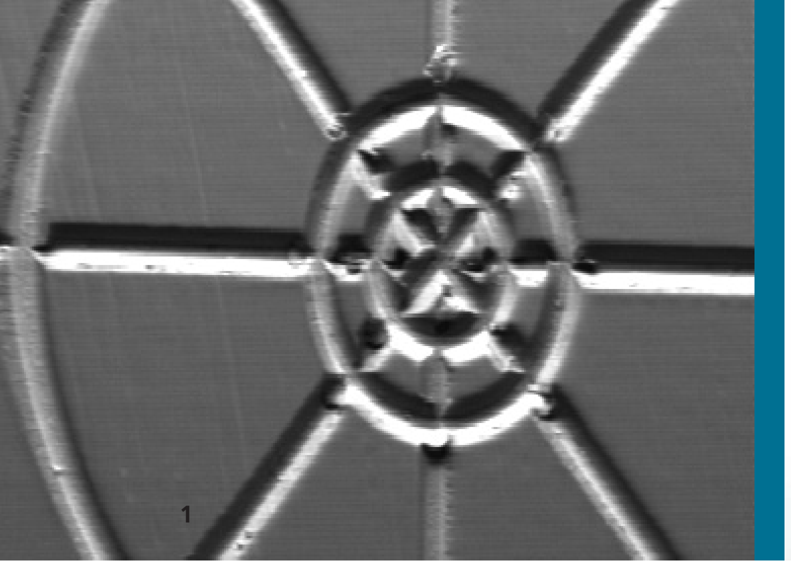

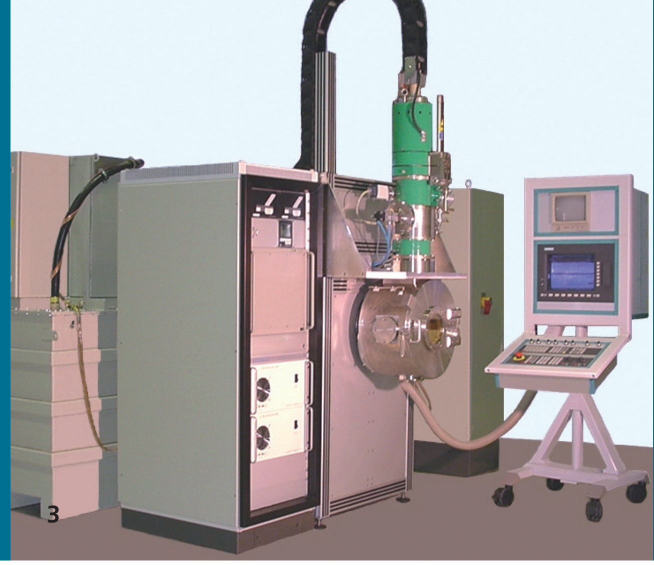

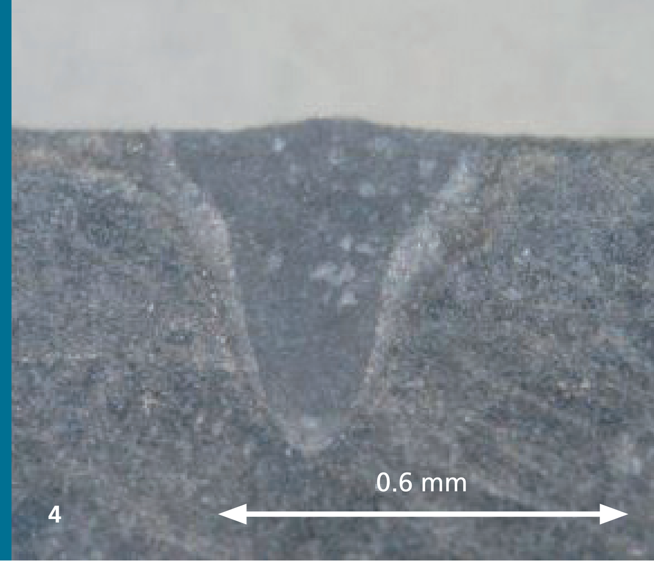

IMPROVED QUALITY ASSURANCE FOR ELECTRON BEAM WELDING

A monitoring technique developed by the Fraunhofer FEP makes electron beam welding plants easier to operate and offers new opportunities for quality assurance.

In recent years electron beam technology has moved away from the mystique of special plants to integrated production stations. From the viewpoint of automation and operation, however, there are still many problems to be overcome and the Fraunhofer FEP is working on a number of promising approaches and developments.

For a high-quality use of an electron beam it is vital that its effectiveness, namely the power density distribution, its focal plane, and the position on the work piece, can be adequately accurately set.

Utilization of the electrons backscattered from the work piece has proven to be useful for detecting relevant beam parameters. The resulting backscattered electron images (Fig. 1) are comparable to SEM (scanning electron microscope) images. The special feature of this new method is the fact that the original welding beam current can now be used to generate the images instead of the much lower observing beam currents. This allows improved positioning accuracy for the beam, because beam current dependent error variables (e.g. centering) are now irrelevant. However, in order to minimize thermal effects on the work piece, the energy input for generating the image must be reduced to a minimum. This can be realized by extremely short observation times.

Using a self-developed, rapid, beam current control system and a suitable programmable rapid beam guidance system, the surface of a work piece can be observed in a snapshot way as a backscattered electron image (Fig. 1). The dynamics result from a novel control concept, which utilizes the dependence of the beam current on the Wehnelt voltage, meaning that in advance a Wehnelt voltage value can be predicted, the voltage can be quickly increased to this, and then finely adjusted. For standard welding power sources, the Wehnelt voltage is the control parameter for the beam current. In the total beam current range, current rise times of less than 10 ms can be realized and hence lower energy input into the work piece.

Such images of a fixed specimen relative to the electron beam generator allow the beam parameters to be evaluated using recently developed, customized image analysis software. Using the image of a specimen shown in Figure 2, statements can be made about beam parameters such as mechanical centering, focusing of the electromagnetic lens, beam current, and accelerating voltage.
Using this method, it is now possible to monitor technologically important beam parameters under joining conditions. A correction can be made if the beam parameters drift outside a set parameter window. Due to this readjustment inadequate welding results can be prevented.

The image generation technology can also be used for automated beam positioning on the work piece with minimum energy input. This opens up new fields of application for the precise joining of heat-sensitive work pieces, such as sensors (Fig. 4). These base functionalities have been brought together in a prototype and will form the basis for a future beam adjustment and diagnosis system for quality assurance in electron beam welding.

The project results also provide the conditions for making electron beam welding equipment easy to operate by personnel without complex additional training.

The project was funded by the European Union and the Free State of Saxony.
Funding reference: 13530/2310

1 *Backscattered electron image of a test specimen*

2 *Test specimen for the back-scattered electron images*

3 *Electron beam precision welding unit*

4 *Optical micrograph of a welded seam of an ultrasonic sensor*

Gefördert aus Mitteln der Europäischen Union
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Europäischer Fonds für regionale Entwicklung

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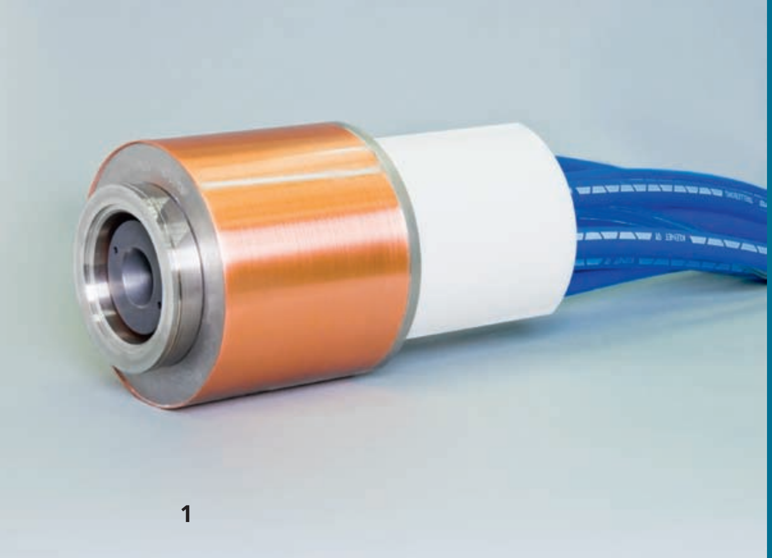

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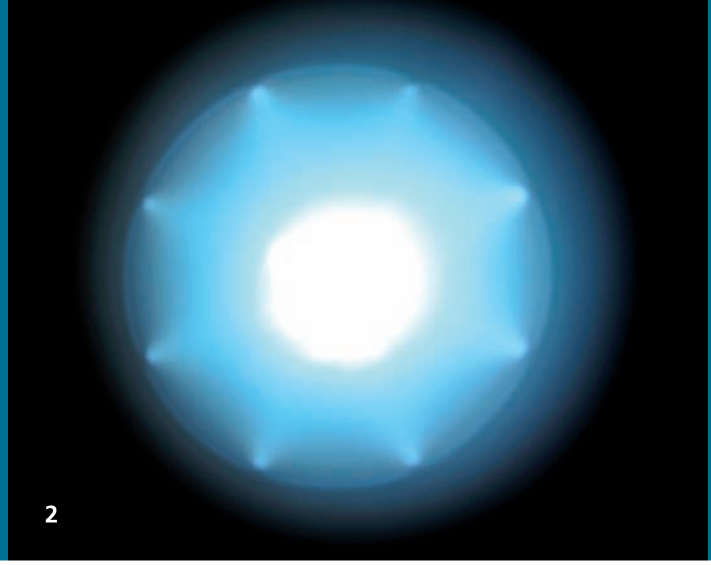

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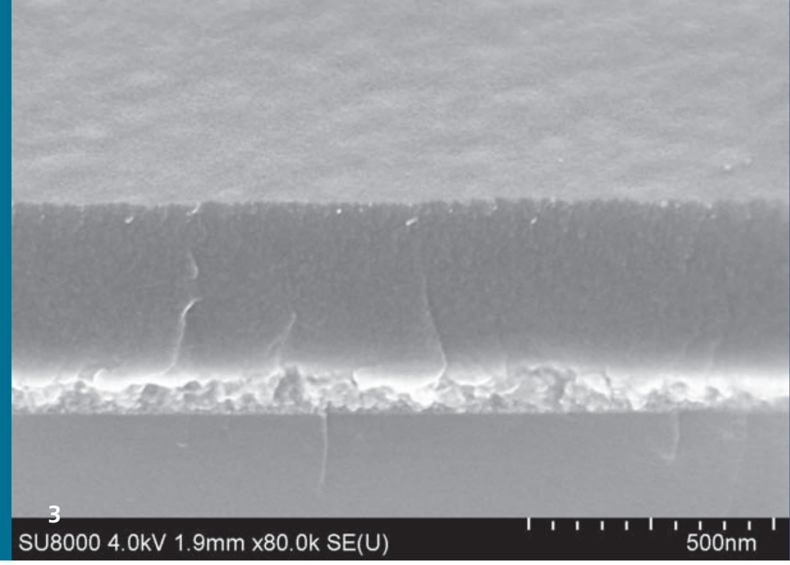

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HIGH-RATE PECVD DEPOSITION OF AMORPHOUS CARBON LAYERS USING THE LAVOPLAS PLASMA SOURCE

Layers of amorphous carbon for tribological applications can be deposited at favorable cost and at high rates of up to 1000 nm/min using the newly developed arcPECVD process of Fraunhofer FEP which uses the LAVOPLAS plasma source.

Amorphous hydrogenated carbon films (a-C:H layers) are already used as functional layers for a variety of applications. They are especially applied as tribological layers (scratch protection, friction reduction). In science and industry, favorable-cost technologies are constantly being sought for high-rate deposition of amorphous carbon layers.

The standard industrial method for depositing a-C:H layers involves PECVD processes (Plasma Enhanced Chemical Vapor Deposition) whereby the plasma is excited via alternating electric fields in the radio frequency range (RF). Advantages are the simplicity and low-cost of the technology, however, the disadvantage is the low deposition rate. Other methods such as arc evaporation processes or PECVD via electron cyclotron resonance excitation give considerably harder layers. However, the equipment required is much more expensive and the cost is usually only viable for demanding niche applications.

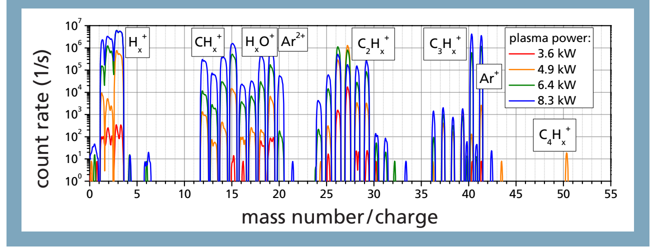
With LAVOPLAS (Large Volume Plasma Source) Fraunhofer FEP developed a plasma source which is based on a magnetically enhanced hollow cathode arc discharge, and produces long-range, homogeneous, and dense plasmas. Its compact and robust structure, no need for additional hardware components in the vacuum chamber, very low gas throughput, and also high power up to over 20 kW makes the source ideal for industrial use. Applications hitherto include substrate pre-treatment, plasma-activated high-rate deposition of barrier and corrosion protection layers, and plasma-assisted magnetron sputtering of abrasion-resistant layers.

The hollow cathode arc PECVD process (arcPECVD) was developed as a further application of this plasma source. Here, the reactive gas acetylene is injected via a nozzle system into the near-source plasma where, due to the high charge carrier energies and densities, it is very effectively excited, ionized, and dissociated. Using mass spectrometry, high concentrations of both ionized acetylene ions and dissociation products, right down to individual carbon and hydrogen ions, have been detected. Carbon-hydrogen clusters were also produced as a result of plasma-polymerization.

The carbon-containing species generated in the plasma deposit on the substrate and form the a-C:H layer. Very high coating rates were achieved of up to 1000 nm/min for stationary coating and these rates are vastly superior to the rates for conventional RF-PECVD processes. The nature and properties of the layers can be varied by customizing the ion energies via a bias to the substrate or by using substrate cooling. The spectrum ranges from ductile polymer-like layers, having a high hydrogen fraction, to graphite-like layers with low hydrogen concentrations, right through to very smooth and homogeneous layers of high hardness (18 GPa). The latter are of most interest for the application under study here. They have similar properties to published values for diamond-like carbon layers (DLC) produced using established RF-PECVD technology.

The arcPECVD process can be adapted to specific layer and customer requirements. The first experiments coating free-flowing substrates in a drum were highly promising. In addition, the arcPECVD process is being used with other starting materials, for example hexamethyldisiloxane (HMDSO), for the high-rate coating of polymer films with silicon-based permeation barrier layers.

4 *Mass spectrum of the argon-acetylene plasma*



5 *Comparison of selected layer properties for the three a-C:H types*

a-C:H layer type	hardness (GPa)	hydrogen content (at.-%)	sp³ fraction (%)
polymer-like	7.8	42	40
diamond-like	18.2	31	25
graphite-like	6.1	18	20

1 *The hollow cathode arc plasma source LAVOPLAS*

2 *Front view of the LAVOPLAS plasma source with circularly arranged acetylene nozzles during operation*

3 *SEM micrograph of a hard diamond-like a-C:H layer*

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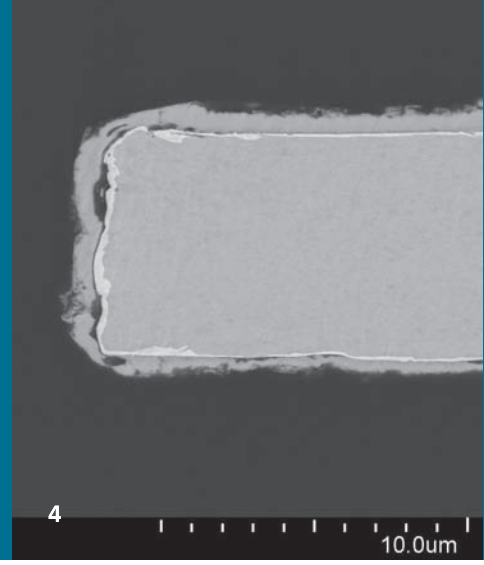

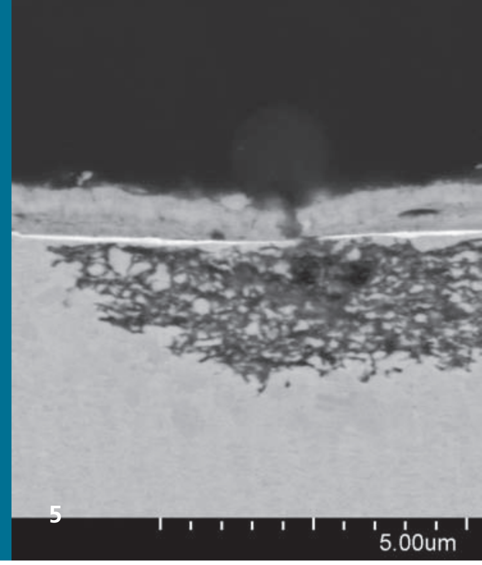

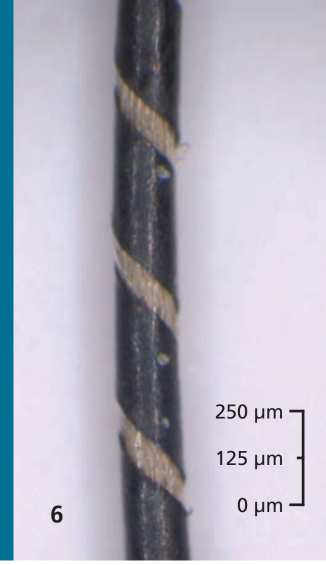

STUDIES ON GOLD FABRICS FROM THE TIME OF AUGUSTUS THE STRONG

Following the studies on tin amalgam mirrors in the Historical Green Vault (Grünes Gewölbe) in Dresden Royal Palace, the Fraunhofer FEP is now involved in another interesting project on the preservation of cultural heritage. This involves analytical studies on gold fabrics from parade garments from the time of Augustus the Strong (1670 – 1733).

Gold fabrics were used in the Baroque period in textiles for manufacturing ornate princely garments and for decorating princely parade halls. Due to dynastic occasions such as the coronation of Augustus the Strong in 1697 in Krakow and the marriage of the Electoral Prince of Saxony in 1719 in Dresden, the wealth of parade textiles rose to a level not seen before.

The main item of Roman coronation regalia of Augustus the Strong in 1697, which is now in the Dresden Armory, is a coronation mantle of royal blue, gold-stitched silk velvet which combines sumptuousness with technical innovation and perfection (Fig. 1). The parade gown of Augustus from 1719 consists entirely of gold fabric with gold embroidery (Fig. 2). This fabric comprises gilded silver thread spun on silk (Fig. 3).

The studies at the Fraunhofer FEP are analyzing, amongst other things, the thickness of the gold coating, the purity of the gold, and the chemical composition of the silver. The microstructure of the metal threads and different types of occuring corrosion were analyzed. For example, the thickness and composition of the often visible external dark layers of corrosion will be measured (Fig. 6). Another aim was to determine whether the original gold coating can still be detected under these layers of corrosion.

The project work is being undertaken in collaboration with experts in heritage conservation, restorers, art historians at the armory of the Staatliche Kunstsammlungen Dresden (SKD), and the Büro für Denkmalpflege Dr. Schneider & Küster in Leipzig. The results make an important contribution to the appraisal and ranking, from the viewpoint of art history and technology, of different workshops, for example in France, Italy, and Saxony. The accurate reconstruction of parage garments for museum usage by Dresden Royal Palace was linked to the project.

This very challenging work, including the metallographic preparation, was undertaken using the cross-section ion preparation technique that is available at the Fraunhofer FEP. This allows the preparation of ion-polished samples of the whole cross-section of the metal threads (ca. 300 µm × 10 µm). These samples were then imaged using a scanning electron microscope and analyzed by EDS (energy dispersive x-ray spectroscopy).

The results show that the silver threads have a relatively homogeneous layer of gold (80 to 150 nm thick) which could still be detected below the layers of corrosion (Fig. 4). The samples tested up until now have shown that the gold purity is very high at 23 carats (the rest is silver). There are small differences in the copper content of the silver. Part of the copper in the silver has oxidized to copper oxide due to internal oxidation, and due to its brittleness this makes deformation more difficult when fine drawing and flattening the wire.

Regarding the corrosion phenomena, dense corrosion layers of thickness up to 2 µm thick and largely composed of silver sulfide (Ag_2S) were detected. To form these corrosion layers the silver must first diffuse through the thin gold layer. In the presence of sulfur anions the silver reacts to form silver sulfide, the main corrosion product. Only small amounts of silver oxide (Ag_2O) and silver chloride (AgCl) were detected. At voids or cracks in the gold layer, pitting corrosion can occur due to the difference in electrochemical potential to the silver (Fig. 5). This then propagates very quickly inwards. There is a very high risk of this type of corrosion when valuable objects are being exhibited. This must be avoided by close monitoring of the room climate at all times.

The results obtained up until now show that systematic SEM studies on gold threads provide key information for the restoration, ranking from an art history viewpoint, reconstruction, and exhibiting of parade garments. It is intended to continue these studies on other objects in the near future.

1 Roman coronation regalia of Augustus the Strong at the coronation as the Polish king in 1697 in Krakow (© Staatliche Kunstsammlungen Dresden, Jürgen Karpinski)

2 Parade gown of Augustus the Strong for the marriage celebrations in 1719 in Dresden (revised 1733) (© Staatliche Kunstsammlungen Dresden, Jürgen Karpinski)

3 Gold fabric made of silk and gilded silver thread showing little corrosion

4 Ion-polished cross-section of a gilded silver thread having a ca. 100 nm thick gold layer (light) and ca. 1 µm thick corrosion layer of mostly silver sulfide (dark)

5 Ion-polished cross-section of a gilded silver thread with visible pitting corrosion

6 Gold fabric made of silk and gilded silver thread with a corrosion layer of silver sulfide

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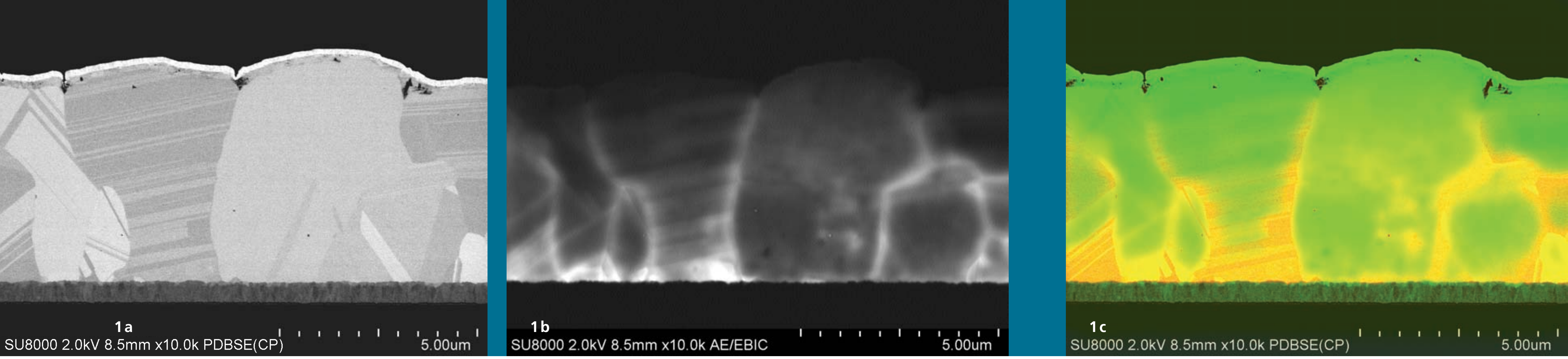


HIGH RESOLUTION EBIC STUDIES ON CdTe THIN FILM SOLAR CELLS

High resolution electron beam induced conductivity (EBIC) studies allow evaluation of the effect of chlorine activation on CdTe thin film solar cells.

One of the most important steps in the manufacturing of polycrystalline CdTe thin film solar cells is chlorine activation which is vital for realizing high cell efficiencies. The resulting complex changes to the structure and properties are still not fully understood and are therefore a topic of scientific debate. Recrystallization, grain growth, and interdiffusion processes between the CdS and CdTe can occur during the chlorine activation and this affects the efficiency of the solar cell. A further important effect of chlorine activation is the influence on doping and the point defect structure of CdTe.

A promising method for studying p-n junctions is measurement of the electron beam induced current (EBIC) in a scanning electron microscope (SEM). Here, the EBIC signal is recorded simultaneously as the microscope image with secondary or backscattered electrons. Due to the electron beam, electron-hole pairs are generated in the CdTe absorber layer which can be separated by the electric field of the p-n junction of the solar cell and so contribute to the electron beam induced current. In contrast, recombination of the generated charge carriers causes a lower EBIC signal and reduction of the efficiency.

For the EBIC studies being carried out here, polished cross-sections of the complete solar cells were prepared by ion preparation. These were then analyzed by field emission scanning electron microscopy (FE-SEM). The ion preparation allows high resolution imaging of the microstructure in crystal orientation contrast and material contrast. Via additional electrical connection of the front and back contact of the solar cell with a high sensitivity amplifier, the current induced by the electron beam can be measured (Fig. 2).

In order to achieve high lateral resolution of the EBIC signal, a relatively low acceleration voltage of 2 keV was used for the electron beam, with an estimated electron range of about 25 nm. The EBIC results show that after the activation treatment, the regions within the CdTe absorber layer near to grain boundaries have a considerably higher EBIC signal than the center of the crystallites (Fig. 1a to c). A higher EBIC signal was also detected near twin boundaries and on small CdTe crystallites at the p-n junction.

The results show that the chlorine activation process mostly affects regions near grain boundaries and the boundary of the p-n junction between n-conducting CdS and p-conducting CdTe. This can be explained by the much more rapid grain boundary diffusion compared to the chlorine volume diffusion.

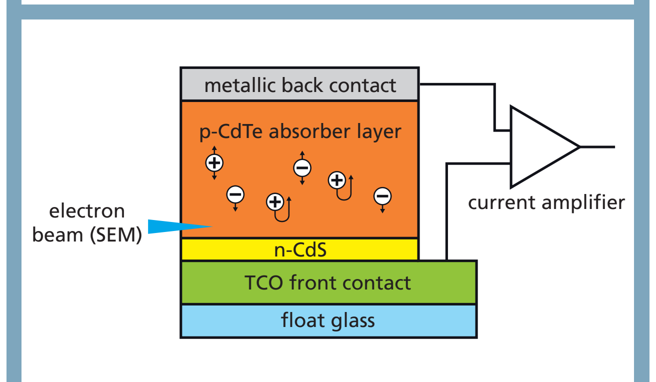
Further systematic EBIC studies in the near future should help to further optimize the chlorine activation step and improve our understanding of these complex processes.

CdTe: Cadmium telluride
CdS: Cadmium sulfide

The project was funded by the European Union and the Free State of Saxony.
Funding reference: 14549/2533

1 *High resolution FE-SEM images of the cross-section of a CdTe thin film solar cell*
a) *Imaging with backscattered electrons (BSE)*
b) *The same position as in a) imaged using the signal of the electron beam induced conductivity (EBIC)*
c) *Superposition of the BSE signal (green) and the EBIC signal (orange)*

2 *Structure of a CdTe thin film solar cell*



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HIGHLIGHTS

HIGHLIGHTS




FOUR YEARS CULTURAL HERITAGE ALLIANCE – A SUMMARY OF THE CONTRIBUTION OF FRAUNHOFER FEP

A Fraunhofer-funded collaborative project entitled „Plasma technology – an innovative technology for conserving and restoring cultural objects“ gave the Cultural Heritage Alliance the opportunity to shape and establish itself and present its work to the public.

The Cultural Heritage Alliance was founded in 2008 by the Fraunhofer-Gesellschaft, the Leibniz Association, and the Prussian Cultural Heritage Foundation. On 26th July 2012 the results of the first joint project „Plasma technology – an innovative technology for conserving and restoring cultural objects“ were presented at a symposium held at Fraunhofer FEP. The symposium was attended by about 80 people from the worlds of science and the humanities, arts and culture, politics, and the media.
The project leaders of Fraunhofer IGB, Fraunhofer IST, and Fraunhofer FEP outlined a large range of applications of atmospheric and low pressure plasma for cleaning, conserving, and restoring cultural objects such as archaeological metal finds, silver objects, silk-silver thread, textiles, and leatherwork right through to plastics and paper sheets. In addition, project leaders from the Fraunhofer IBP, Fraunhofer FEP, and Fraunhofer IWS presented work on the sustainable restoration of museums, sensor technology for monitoring corrosive environmental conditions, and an innovative method for studying and visualizing hidden murals. All the results and technological processes could be appraised in an accompanying exhibition.

The afternoon session was attended by the Saxon State Minister for Science and Art, Professor Sabine von Schorlemer. In her opening address she called for the Staatliche Kunstsammlungen Dresden (SKD) and the Saxon State and University Library Dresden (SLUB) to be included as associate partners in the Cultural Heritage Alliance. The speakers from the Alliance indicated that conservation research in Germany is severely threatened and better collaboration within the EU between the sciences, humanities, politics, and industry is urgently required.

Examples of effective interdisciplinary collaboration in Saxony were presented by the Head Curator of the Armories of SKD and a freelance art historian in talks about studies on ornate textiles in the armories of the SKD. They described new ways for researching provenance in the European context, based on material science work of Fraunhofer FEP. The method permits comparison of „submicrostructures“ in textiles and allows the origin of a fabric to be described scientifically and not only on style aspects. The chairman of the Förderverein Lingnerschloss e. V. described how, with the involvement of society and imagination, it is possible to raise private capital for restoration purposes, to generate returns, and to hence augment the limited public funds.

The symposium served to draw the attention of other professional circles, politicians, and the public to the Cultural Heritage Alliance as a results-oriented body. The Alliance came over as an interdisciplinary body for matters relating to the conservation of cultural heritage and as a forthright representative of the concerns and interests of scientists, artists, restorers, and craftsmen on these matters towards politicians, industry, and foundation associations in a European context.

New opportunities for collaboration between Fraunhofer FEP and SKD arose as a direct result of the presentations about paper analysis and paper restoration. Together with the restoration workshop of the Copper Engravings Gallery of the SKD, and with the participation of the Berlin State Library, the topic of long-term damage to graphic works by passe-partouts will be studied. The SLUB is also interested in the sustainable stabilization of wood pulp containing papers and books that are in danger of disintegrating by using electron beams to crosslink monomers. The symposium opened the way for new potential project partners. In the meantime, further important project partners have been gained and the first sources of funding have been accessed.

Fraunhofer FEP makes a key contribution to the Cultural Heritage Alliance and at the same time benefits from the complemental expertise it gains in innovative technological developments in pertinent fields.

Website of the Alliance

www.forschungsallianz-kulturerbe.de

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FRAUNHOFER LOUNGE

Also in 2012 the successful series of evening talks, the Fraunhofer Lounge, could be continued. In fact, March 2012 saw the holding of the 10th Fraunhofer Lounge. Regularly since 2008 guests from the worlds of politics, science, and industry plus employees of the institute listen to invited speakers and then exchange ideas and debate thoughts in an informal atmosphere.

The 10th Fraunhofer Lounge:
Are we bringing up our children properly?

This was the topic of the paediatrician, evolutionary researcher, and father of four children Dr. med. Herbert Renz-Polster for the 10th Fraunhofer Lounge on 22nd March 2012. According to Renz-Polster, our society is developing into a world in which children are increasingly unable to develop their natural strengths and skills in peace and with confidence.

He spoke about the ever more individualistic early childhood socialization, the relevance of social collectives, and the social space necessary for children to develop. He criticized hectic support programs as an attack on childhood, highlighted the fears of the parents, exposed cherished myths, and discussed „guidelines for development“.

Angela Elis, editor and presenter at ARD, mdr, 3sat, and ZDF was the chairwoman for the evening and questioned everyday situations in the social collective of the „family“ and the development and educational pathways of today‘s society and their effects on adolescents.

The 11th Fraunhofer Lounge:
The sense and non-sense of modern worlds of work - What have I actually done today?

This was the topic of the 11th Fraunhofer Lounge on the evening of 18th October 2012. Theresia Volk, a management and organization consultant and author on economics, spoke about the „very normal madness in organizations today“ and about the huge gap between over-challenging and under-challenging situations for many employees in their everyday work.

Volk invited discussion about sensible work distribution, the feeling of being superfluous, and the symptoms of over-challenging situations. She indicated that commodity SENSE would become increasingly important in the future. She mentioned effects of job dissatisfaction and discussed possible therapies and routes to combat the feeling of ineffectiveness. She eloquently explained the consequences of spending one‘s energy in an unsuitable position and the mistake of blaming yourself.

The chairman for the evening was the businessman Klaus Hoogestraat and ensuing debate focused on the ever larger inequalities in work life in modern society.

In pleasant anticipation for the in 2013 continuing series, the tenth and eleventh Fraunhofer Lounge were successfully finalized with interesting discussions accompanied by piano sounds.

Website of the Fraunhofer Lounge

www.fep-lounge.de

1 *Chairwoman Angela Elis in conversation with Dr. med. Herbert Renz-Polster*

2 *Theresia Volk and chairman Klaus Hoogestraat*

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MEDICAL APPLICATIONS – SAXONY-BASED FRAUNHOFER INSTITUTES CONDUCT RESEARCH FOR THE FUTURE

Saxon key players in the field of medical engineering met in a workshop at Fraunhofer FEP in order to form a Saxon innovation cluster.

Health awareness has never before played such a big social role as today. Medical engineering now ranks among the fastest-growing industries and therefore is not just a market of today, but also of tomorrow and beyond. In Saxony, however, the statistics indicate that the industry has not yet reached the desired capacity and, in addition, that the R&D budget for SMEs is low. The potential is large, but the implementation of measures is often still is its infancy.

It was the intention of the Institute director Prof. Kirchhoff and Dr. habil. Christiane Wetzel, head of the medical applications working group, to pool the competencies of the Saxony-based Fraunhofer Institutes and to promote these for medical engineering and associated fields of the life sciences. Thus, a workshop was conducted on the 2nd of February 2012 in order to identify – together with the Faculty of Medicine of the TU Dresden – the need for research in the area of Saxony and, above all, opportunities to conduct joint activities, as well as to introduce concrete approaches to development.

Prof. Funk, Director of the Institute for Anatomy, and Prof. Deussen, Vice-Dean of Research, both representing the Faculty of Medicine of the TU Dresden, explained the clinical relevance of application-oriented research. Prof. Emmrich from the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig, representing the Fraunhofer Group for Life Sciences, combined his words of welcome with a wish not only for success, but also sustainability.

The consensus of the workshop, in which 12 Saxony-based Fraunhofer Institutes took part, was that research-based innovations require a direct transfer of knowledge and technology between medical practitioners, engineers, scientists and purchasers in order to be able to successfully form a closed value chain and to establish products on the market.

This was the unanimous agreement of the numerous guests of the Faculty of Medicine of the TU Dresden from the departments of the Centre for Medical Radiology in Oncology, the Centre for Translational Bone, Joint and Soft Tissue Research, and Clinical Sensoring and Monitoring, as well as guests from the university clinics and polyclinics (e.g. for neurology) and the Dresden Heart Centre.

As a result, a „Saxon Innovations Cluster – Saxony Health Systems“ is to be formed, bringing additional positive momentum to the area. The attractiveness of the resulting innovation and research alliance creates, among other things, reasons for companies to decide to settle in the region. Furthermore, the early orientation of the development towards market needs generates a positive effect in favour of a clear increase of the exploitation rate of Saxony-based product ideas. This is an added advantage that, on the one hand, can strengthen the economic potential of industries in the Free State of Saxony in a sustainable manner via the „made in Saxony“ products, while on the other, ultimately benefits people on a medium to long-term basis via an effective and efficient health care system.

More information

www.fep.fraunhofer.de/biomedizintechnik

1 *The workshop committee (from l-r): Prof. Emmrich, Prof. Deussen, Prof. Funk, Dr. habil. Wetzel*

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RESEARCH WITH PRACTICAL RELEVANCE – 20 YEARS OF FRAUNHOFER IN DRESDEN

In 2012, the Dresden-based Fraunhofer Institutes und branches celebrated their successful growth at the Dresden site and looked back at 20 years of ingenuity.

In the last 20 years, the Dresden site has evolved into the largest agglomeration of Fraunhofer Institutes in Germany and is a major employer with over 1300 employees. The institutes are closely interlinked with local industries and generate projects with a sales volume of over 130 million euros per year.

With the construction of a new research centre for resource-saving energy technologies on Bodenbacher Straße, the formation of a nanoelectronics centre on Maria-Reiche-Straße, the expansion of the Dresden Institute Centre (IZD) on Winterbergstraße and the construction of a technical school with an adjoining test oval on Zeunerstraße, the current success story can be built on even further.

Fraunhofer employees in Dresden celebrated the 20-year anniversary in the terminal of Dresden airport on the 2nd of March 2012, together with customers, partners, sponsors, curators and those who accompanied Fraunhofer Dresden along the way. Along with Saxony's Minister-President Stanislaw Tillich, guest speakers included the President of the Fraunhofer-Gesellschaft, Professor Hans-Jörg Bullinger, the Lord Mayor Dirk Hilbert, the Chairman of the Fraunhofer Future Foundation, Dr. Alexander Imbusch, and the Rector of the TU Dresden, Professor Hans Müller-Steinhagen. The guest speakers took to the stage following an opening address and a prize-giving ceremony by Prof. Bullinger. After the formalities were over, a pantomime, casino and other attractions ensured an entertaining and stimulating evening. Music lovers and dancers were able to let their hair down and celebrate at a silent disco, where they could choose between two channels, or take part in classical dancing with the big band or else bop to music to suit every taste. Guests who wished to take a memory of the Fraunhofer Ball home with them were able to be photographed on the red sofa in front of the Fraunhofer Dresden backdrop.

Dresden's Fraunhofer Institutes thank all pioneers and leaders for their support and constructive cooperation. The successful implementation of research results on the market is only made possible through this interconnectedness. A big thank you also goes to the Rector of the TU Dresden and all partners of the Technical University, who enable the Fraunhofer Institutes to conduct research together with prominent scientists.

The Fraunhofer Society is currently represented in Dresden by five institutes and seven additional research institutions (as of March 2013):

Fraunhofer Institutes

- Fraunhofer Institute for Electron Beam and Plasma Technology FEP
- Fraunhofer Institute for Ceramic Technologies and Systems IKTS
- Fraunhofer Institute for Photonic Microsystems IPMS
- Fraunhofer Institute for Transportation and Infrastructure Systems IVI
- Fraunhofer Institute for Material and Beam Technology IWS
- Fraunhofer Centre for Nanoelectronic Technologies CNT (up to 31/12/2012)

Fraunhofer branches, research institutions and centres

- Fraunhofer Research Institution for Organics, Materials and Electronic Devices COMEDD (since 01/07/2012)
- Application Centre for Processing Machines and Packaging Technology AVV Dresden at the Fraunhofer IVV Freising
- Dresden branch of the Fraunhofer IFAM Bremen
- Dresden branch of the Fraunhofer IIS Erlangen
- Dresden branch of the Fraunhofer IWU Chemnitz
- Dresden branch of the Fraunhofer IZFP Saarbrücken
- ASSID (All Silicon System Integration Dresden) project group at the Fraunhofer Institute for Reliability and Microintegration IZM

More information

www.dresden.fraunhofer.de



FRAUNHOFER TALENT SCHOOL

Be a researcher yourself for three days at the Fraunhofer Talent School: 35 schoolchildren seized this opportunity from November 9 – 11, 2012.

The 4^{th} Fraunhofer Talent School took place in Dresden from November 9 – 11, 2012 at Fraunhofer FEP, IKTS and IPMS. A total of 35 Year 9 to 13 schoolchildren from 7 federal states, 10 of them girls, took part in the workshop this year following their successful application. From Friday to Sunday, the schoolchildren were able to experience what research work is like in reality with one of the following topics, which they had chosen in advance.

At the Fraunhofer Institute for Ceramic Technologies and Systems IKTS, the schoolchildren familiarized themselves with a fuel cell's structure, function and application possibilities and even build their own fully functioning example. At the Fraunhofer Institute for Photonic Microsystems IPMS, participants developed micro-electronic mechanical systems (MEMS). In the lab and clean rooms they experienced how, e.g. tiny cameras and projectors, which would fit into any mobile phone, are made from a blank silicon wafer and brought to life.

At Fraunhofer FEP it was about how modern physics can be used to conserve museum and archive treasures. In the process, the youngsters' mission was to protect at-risk paper documents from decay using electrons. They investigated how accelerated electrons partly link degraded cellulose fibers together again or link them to specially provided polymers and what influence this has on the paper's stability. They tested different monomers and electron treatment parameters to find a method which results in giving papers the required stability but where the treatment cannot be seen or felt.

After 2 days consisting of theory and lots of practice, all 3 groups had excellent, interesting research results to show. On the 3^{rd} day, once they had familiarized themselves with presentation techniques in an entertaining way during an evening seminar, they presented their results to their parents and relatives in an extremely creative fashion. The participants and also the parents expressed great enthusiasm for the opportunity of being able to take a peek at the science business for once and to get to know science applications and how to get there up close.

Website of the event

www.talent-school-dresden.fraunhofer.de


DRESDEN'S 10^{TH} LONG NIGHT OF SCIENCE

Dresden's 10^{th} Long Night of Science coincided with 20 years of Fraunhofer in Dresden on June 6, 2012. The Fraunhofer Institute Center attracted roughly 3,000 visitors with exciting experiments.

Together with four Dresden universities, as well as 37 non-university research institutions and companies related to science, Fraunhofer FEP opened its doors for the 10^{th} Long Night of Science on June 6, 2012. As 10 years of the Long Night coincided with 20 years of Fraunhofer in Dresden, visitors could expect a particularly varied program. Fraunhofer researchers demonstrated lots of exciting experiments on nanotechnology, energy, environment and health topics for young and old. The Fraunhofer Institute Center was therefore able to record 2,895 visitors in total, despite temporary poor weather conditions.

At Fraunhofer FEP, plasma was no longer merely grey theory but became illuminating: Especially for the 10^{th} Long Night, visitors were able to take a look inside a vacuum plasma coating plant and experience how transparent coatings are made out of a thick metal sheet. At the „View under current“ stand, where lights seemed to turn on by themselves, visitors saw that these invisible, conductive coatings can almost produce magic.

Visitors could become a battery component using the hand battery where they could experience how energized they are. Another experience awaited visitors at the „Small life great impact“ station, where they delved into the world of microorganisms and were able to observe living cells and bacteria using the Fraunhofer FEP biomedical lab's standard methods.

These were just a few of the highlights out of the 13 stations in total at Fraunhofer FEP, where you could not completely trust your senses.

Website of the event

www.dresden-wissenschaft.de

ANHANG

ANHANG

ANHANG

NAMEN, DATEN UND EREIGNISSE

NAMES, DATES AND EVENTS

Mitgliedschaft in Gremien

A. Arnold

- International Council for Coatings on Glass ICCG e. V.
- Netzwerk »Dresden - Stadt der Wissenschaft«

H. Bartzsch

- Europäische Forschungsgesellschaft Dünne Schichten e. V. (EFDS)
- Silicon Saxony e. V.

P. Frach

- Fraunhofer-Allianz Photokatalyse
- AMA Fachverband für Sensorik e. V.
- Deutsche Gesellschaft für Galvano- und Oberflächentechnik e. V. (DGO)
- Europäische Forschungsgesellschaft Dünne Schichten e. V. (EFDS), Fachausschuss »Oberflächen und Beschichtungen in der Bio- und Medizintechnik«
- Photonic Net

V. Kirchhoff

- Bundesverband mittelständische Wirtschaft (BVMW)
- Europäische Forschungsgesellschaft Dünne Schichten e. V. (EFDS)
- Fraunhofer-Verbund Light & Surfaces

H. Klostermann

- Kompetenznetz Industrielle Plasma-Oberflächentechnik, AG Neuartige Plasmaquellen und Prozesse, INPLAS

G. Mattausch

- Informationstechnische Gesellschaft (ITG) des VDE: Fachausschuss 8.6 »Vakuumtechnik und Displays«
- Organizing Committee der »EBEAM – International Conference on High-Power Electron Beam Technology«
- Organizing Committee der »International Conference on Electron Beam Technologies – EBT«

Chr. Metzner

- Kompetenzzentrum Maschinenbau Chemnitz/Sachsen e. V. (KMC)

W. Nedon

- Forschungsallianz Kulturerbe FALKE

F.-H. Rögner

- Fraunhofer-Allianz Reinigungstechnik

N. Schiller

- Technical Advisory Committee der »Annual Technical Conference« der »Society of Vacuum Coaters – SVC«
- Fraunhofer-Allianz Polymere Oberflächen POLO
- Organic Electronics Saxony e. V. (OES)

Chr. Wetzel

- Europäische Forschungsgesellschaft Dünne Schichten e. V. (EFDS), Fachausschuss »Oberflächen und Beschichtungen in der Bio- und Medizintechnik«

Vorlesung

M. Junghähnel
Fertigungsverfahren und Werkstoffe der Optik, PVD-Basisprozesse: Magnetronsputtern
TU Ilmenau, Fachgebiet Anorganisch-nichtmetallische Werkstoffe
Fakultät Maschinenbau
Ilmenau, Deutschland
06. Juni 2012

Vorträge

F.-H. Rögner
Reinigungskosten reduzieren? Reden Sie darüber!
EFDS-Workshop »Nasschemische Reinigung - Optimal beherrschen - Reinigen vor dem Beschichten«
Fraunhofer-Institutszentrum Dresden, Deutschland
26. Januar 2012

M. Junghähnel
Herstellung und Charakterisierung von transparenten, elektrisch leitfähigen Dünnschichten auf der Basis von Titanoxid
Kolloquium Werkstofftechnik der TU Ilmenau
Ilmenau, Deutschland
02. Februar 2012

M. Junghähnel
PVD-Basisprozesse und ihre reaktiven Varianten II
OTTI-Fachforum »Schichten auf Glas«
Regensburg, Deutschland
07.–08 .März 2012

F.-H. Rögner
Der Elektronenstrahl als Werkzeug - von »Makro« bis »Nano«
Vortragsreihe: Mikro- und Nanotechnik für die Gesellschaft
Braunschweig, Deutschland
15. März 2012

M. Merkel, G. Mattausch, B.Graffel
Micro Welding and Micro Surface Treatment with the Electron Beam: Opportunities and Challenges
2nd International Electron Beam Welding Conference, IWBW
Aachen, Deutschland
26.–30. März 2012

W. Schönberger, P. Frach, H. Bartzsch, D. Glöß
Präzisionsbeschichtungen im industriellen Maßstab: Anforderungen, Realisierung, Anwendungen
7. Vakuumtechexpo, Konferenz und Industrieausstellung
Moskau, Russland
10.–12. April 2012

J.-P. Heinß, P. Lang, Chr. Metzner, D. Weiske
Development of novel metal strip cooling equipments for demands of high-rate vacuum coating
39th ICMTF International Conference on Metallurgical Coatings and Thin Films
San Diego, USA
23.–27. April 2012

G. Gotzmann
Surface modification using PVD to apply silver-copper-mixed layers
39th ICMTF International Conference on Metallurgical Coatings and Thin Films
San Diego, USA
23.–27. April 2012

P. Frach, P. Pötschick, H. Bartzsch, A. Delan
Magnetron Assisted PECVD Process for Deposition of a-Si:H and µc-Si:H from a Silane-Hydrogen-Argon Gas Mixture
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

M. Junghähnel, F. Fietzke, M. Vinnichenko, S. Cornelius
Recent Developments of TiO_2:Nb Sputtered with High Deposition Rates from a Rotatable Magnetron System
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

G. Mattausch, Chr. Metzner, F.-H. Rögner
Plasma-Activated Electron Beam Physical Vapor Deposition – Novel Technologies and Tools
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

M. Fahland, J. Neidhardt, R. Thielsch, A. Wahl, R. Kleinhempel, R. Blüthner, T. Preußner
Large Area PECVD Process Using Dual Rotatable Magnetrons
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

H. Morgner, K. Häfner, O. Zywitzki, T. Modes, Chr. Metzner, B. Siepchen, C. Drost
Influence of Substrate Temperature and Activation Treatment on CdTe Solar Cells
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

F. Fietzke, M. Junghähnel
Deposition of Nb-Doped TiO_2 Films on large Area by Co-Sputtering with Precise Process Control
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April–03. Mai 2012

J. Fahlteich, S. Amberg-Schwab, U. Weber, K. Noller, O. Miesbauer, E. Kücükpinar, N. Schiller, Ch. Boeffel
Roll-to-Roll Technology on Pilot Scale for Transparent Ultra-High Multilayer Barriers
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April – 03. Mai 2012

M. Fahland, T. Vogt, J. Fahlteich, N. Schiller
Deposition of Full Dielectric Solar Control Stack on Polymer Films Using a Combined PVD/PECVD Approach
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April – 03. Mai 2012

Chr. Metzner, B. Scheffel, H. Morgner, F. Händel
Functional and Decorative Coatings onto Metal Strips Deposited by Plasma-Activated High-Rate Electron Beam Physical Vapour Deposition (EBPVD)
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April – 03. Mai 2012

P. Frach, Chr. Gottfried, F. Fietzke, H. Klostermann, H. Bartzsch, D. Glöß
Pulse Magnetron Sputtering with High Power Density-Process and Film Properties
55th Annual SVC – Society of Vacuum Coaters – Technical Conference
Santa Clara, USA
28. April – 03. Mai 2012

J. Fahlteich, L. Müller-Meskamp, M. Fahland, St. Günther, N. Schiller
Verkapselung flexibler Elektronik - Übersicht, Stand der Technik, Anforderungen
OES Verkapselungsworkshop
Dresden, Deutschland
10. Mai 2012

N. Schiller, J. Fahlteich, M. Fahland, St. Günther, St. Straach
Barriereschichten auf Kunststofffolien
OES Verkapselungsworkshop
Dresden, Deutschland
10. Mai 2012

M. Junghähnel
Hochrateabscheidung von TCOs auf der Basis von ZnO und TiO_2 durch Sputtern oxidischen Rohrtargets
EFDS-Workshop »Transparente leitfähige Oxide-Festkörperphysikalische Grundlagen und Technologien«
Dresden, Deutschland
21. – 22. Mai 2012

G. Mattausch, B. Graffel, F. Winckler, F.-H. Rögner, M. Merkel, K. Wrobel, R. Böhme, H. Schlemm
Thermal Processing of Materials at the Micrometer Scale - Challenges and Opportunities for the Electron Beam
10th International Conference on Electron Beam Technologies
Varna, Bulgarien
01. – 04. Juni 2012

G. Mattausch, B. Scheffel, O. Zywitzki, Chr. Metzner, F.-H. Rögner
Techniques and Tools for the Plasma-activated EB high-rate Deposition of Zirconia
10th International Conference on Electron Beam Technologies
Varna, Bulgarien
01. – 04. Juni 2012

F. Winckler
Neue Möglichkeiten für die Elektronenstrahl-Materialbearbeitung
3. Tag der Forschung an der HTW Dresden
Dresden, Deutschland
06. Juni 2012

F.-H. Rögner
Grundlagenuntersuchungen zur Stabilisierung holzschliffhaltiger Papiere
3. Tag der Forschung an der HTW Dresden
Dresden, Deutschland
06. Juni 2012

M. Fahland, J. Fahlteich, St. Günther, T. Vogt
Optical and electrical properties of zinc oxide based TCO layers on polymer films
AIMCAL Europe 2012 Web Coating Conference
Prag, Tschechien
11. – 13. Juni 2012

St. Günther, M. Fahland, J. Fahlteich, B. Meyer, St. Straach, N. Schiller
High rate low pressure PECVD for barrier and optical coatings
AIMCAL Europe 2012 Web Coating Conference
Prag, Tschechien
11. – 13. Juni 2012

N. Schiller, M. Fahland, J. Fahlteich, St. Günther, St. Straach
Vacuum roll-to-roll technologies for transparent barriers on polymer webs
AIMCAL Europe 2012 Web Coating Conference
Prag, Tschechien
11. – 13. Juni 2012

J. Fahlteich, N. Schiller, O. Miesbauer, E. Kücükpinar-Niarchos, K. Noller, U. Weber, S. Amberg-Schwab, Ch. Boeffel
Roll-to-Roll Technology on Pilot Scale for Transparent Ultra-High Multilayer Barriers
LOPE-C 2012 - Large-area Organic Printed Electronics
München, Deutschland
19. – 21. Juni 2012

V. Kirchhoff
Overview Fraunhofer FEP
AIS-User Conference, Fraunhofer FEP
Dresden, Deutschland
21. Juni 2012

H. Bartzsch, D. Glöß, P. Frach, M. Gittner, Chr. Gottfried, K. Suzuki
Low demage magnetron sputtering of TCO films
9th International Conference on Coatings on Glass and Plastics, ICCG 2012
Breda, Niederlande
24. – 28. Juni 2012

N. Schiller, M. Fahland, J. Fahlteich, St. Günther, St. Straach
Vacuum roll-to-roll technologies for transparent barriers on polymer webs
9th International Conference on Coatings on Glass and Plastics, ICCG 2012
Breda, Niederlande
24. – 28. Juni 2012

St. Günther, M. Fahland, J. Fahlteich, B. Meyer, St. Straach, N. Schiller
High rate low pressure PECVD for barrier and optical coatings
9th International Conference on Coatings on Glass and Plastics, ICCG 2012
Breda, Niederlande
24. – 28. Juni 2012

B. Scheffel
Protection of cultural heritage by real-time corrosion monitoring MUSECORR
Symposium der Forschungsallianz Kulturerbe
Dresden, Deutschland
16. Juli 2012

G. Mattausch, V. Kirchhoff
Thermische Elektronenstrahl-Technologien
DFG Schwerpunktprogramm Treffen
Bonn, Deutschland
19. Juli 2012

Chr. Metzner, K. Häfner, H. Morgner, O. Zywitzki, B. Siepchen, B. Späth, Ch. Drost
Abscheidung von CdTe-Solarabsorberschichten
8. ThGOT Thementage Grenz- und Oberflächentechnik
Leipzig, Deutschland
04. – 06. September 2012

P. Frach
In-situ Prozesskontrolle bei der Herstellung präzisionsoptischer Schichtsysteme durch reaktives Magnetron-Sputtern
8. ThGOT Thementage Grenz- und Oberflächentechnik
Leipzig, Deutschland
04. – 06. September 2012

M. Fahland
Optische Eigenschaften von transparenten leitfähigen Oxiden auf Kunsstofffolien
8. ThGOT Thementage Grenz- und Oberflächentechnik
Leipzig, Deutschland
04. – 06. September 2012

B. Scheffel, T. Modes, Chr. Metzner
Spotless arc activated high-rate deposition using novel dual crucible technology for titanium doixide coatings
13th International Conference on Plasma Surface Engineering, PSE 2012
Garmisch-Partenkirchen, Deutschland
10. – 14. September 2012

P. Frach
High Power Density Pulse Magnetron-Sputtering-Process and film properties
13th International Conference on Plasma Surface Engineering, PSE 2012
Garmisch-Partenkirchen, Deutschland
10. – 14. September 2012

F.-H. Rögner
Elektronenbehandlung von Saatgut – eine umweltfreundliche Pflanzenschutzmaßnahme
58. Deutsche Pflanzenschutztagung
Technische Universität Braunschweig, Deutschland
10. – 14. September 2012

J. Schönfelder
Einführung eines Screeningregimes zur qualitätsgesicherten Testung von Kulturmedien und Kulturmedienbestandteilen für die Organkultivierung von Spenderhornhäuten
110. DOG-Kongress
Berlin, Deutschland
20. – 23. September 2012

O. Zywitzki, T. Modes
High resolution EBIC and TEM Investigations on CdTe solar cells
27th European Photovoltaic Solar Energy Conference and Exhibition, PVSEC
Frankfurt, Deutschland
24. – 28. September 2012

J. Fahlteich, C. Scholz, St. Mogck
FlexSOL – a Proposal Suggestion
ICT-Proposer's Day
Warschau, Polen
26. – 27. September 2012

F.-H. Rögner
Reinigungskosten reduzieren - Eine interdisziplinäre Aufgabe!
ZVO Oberflächentage
Darmstadt, Deutschland
27. September 2012

M. Fahland, P. Frach, H. Bartzsch, M. Junghähnel, D. Glöß, T. Vogt, J. Fahlteich
Deposition Technology for Transparent Conducting Oxides on Temperature Sensitive Substrates
2nd International Symposium on Transparent Conducting Coating
Seoul, Korea
04. – 05. Oktober 2012

N. Schiller, M. Fahland, J. Fahlteich, St. Günther
Vacuum coating technologies for flexible substrates and transparent barrier films for organic electronics
SEMICON Europa 2012 and Plastic Electronics Conference and Exhibition
Dresden, Deutschland
09. – 11. Oktober 2012

G. Mattausch, B. Graffel, F. Winckler, F.-H. Rögner, M. Merkel, K. Wrobel, R. Böhme, H. Schlemm
Thermal Surface Treatment at the Micrometer Scale - Challenges and Opportunities for the Electron Beam
International Conference on High-Power Electron Beam Technology
Reno, USA
14. – 16 Oktober 2012

G. Mattausch, B. Scheffel, O. Zywitzki, Chr. Metzner, F.-H. Rögner
Novel Techniques and Tools for the Plasma-activated Electron Beam high-rate Deposition of dense Zirconia Coatings
International Conference on High-Power Electron Beam Technology
Reno, USA
14. – 16 Oktober 2012

M. Junghähnel, T. Kopte
Large Area sputtering of TiO:Nb thin films with high deposition rates using a rotable magnetron system
TCM 2012, 4th International Symposium on Transparent Conductive Materials
Hersonissos, Kreta, Griechenland
21.–26. Oktober 2012

F.-H. Rögner
Wie viel darf Reinigung kosten? Kann man nicht beantworten, aber beeinflussen!
parts2clean, Messe und Fachforum
Stuttgart, Deutschland
23.–25. Oktober 2012

J. Fahlteich, M. Fahland, St. Günther, St. Straach, N. Schiller
Niederdruck Plasma-Technologien zur Rolle-zu-Rolle-Beschichtung von Kunststofffolien mit Barriereschichten
20. Dresdner Vakuumtechnisches Kolloquium – NDVK
Dresden, Deutschland
25.–26. Oktober 2012

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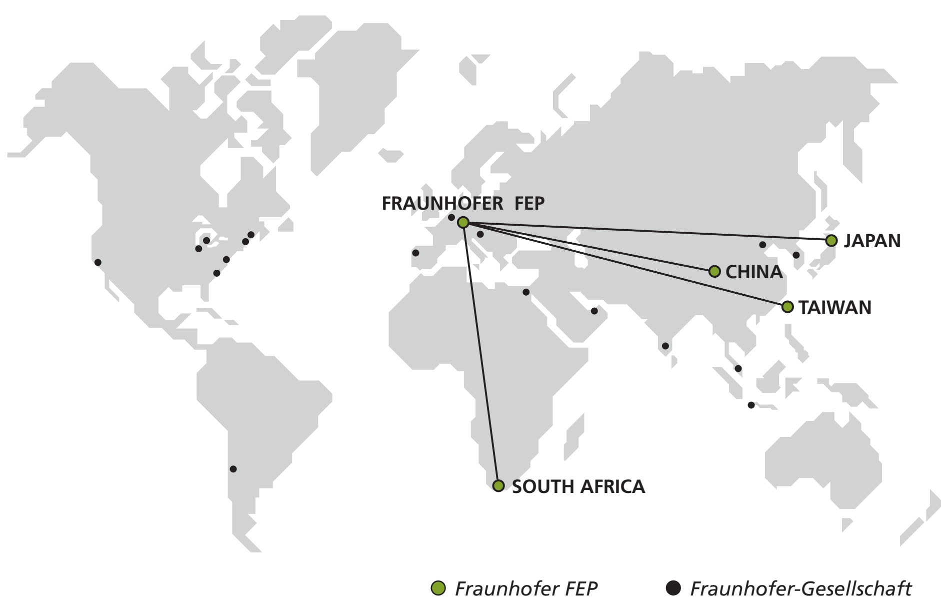

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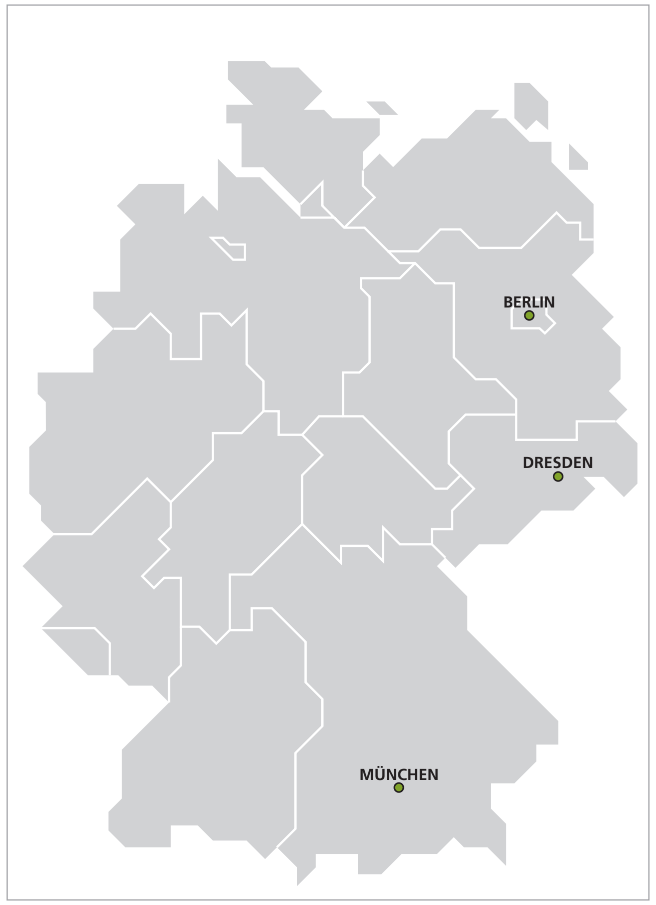

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