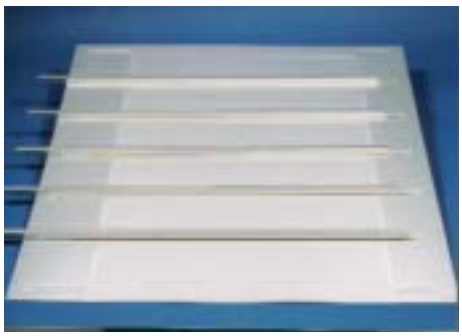
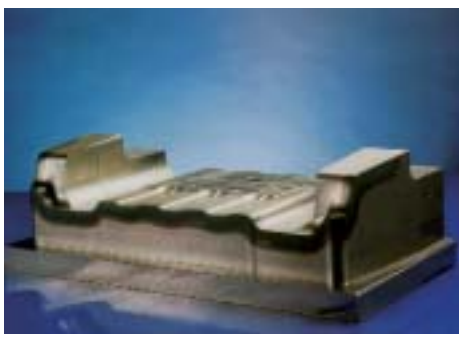
Fraunhofer Institut Werkstoff- und Strahltechnik

Annual Report 2001

10 Years Fraunhofer IWS in Dresden · 1992-2002 · 10 Years Fraunhofer IWS





Internet: www.iws.fraunhofer.de

Fraunhofer Institut Werkstoff- und Strahltechnik

Annual Report 2001

ZERTIFIKAT

DIN EN ISO 9001

fraunhofer Institut Werkstoff- und Strahltechnik

Bereiche:
Leitung und Verwaltung, Dünnschichttechnologie, Füge- und Randschichttechnologien, Abtragen und Trennen, Röntgen-/EUV-Optik, Thermische Beschichtungsverfahren

Standort:
Winterbergstraße 28 • 01277 Dresden

The year 2001 was very special to IWS with many highlights. The new millennium began just like the old one ended, with a contract boom for laser and surface technologies. This is especially interesting, since the economic situation in Germany by far did not meet expectations. Consultants, banks, and important managers frequently claim that growth will only happen in "future technologies" and not in the so-called "old economy". As so often in life, however, the truth might be between the extremes; and here we obviously find the laser and surface technologies, which explains the outstanding economic results of the IWS.

After a strong growth in previous years, we achieved an over-proportional growth in 2001. The total revenue as well as the industrial revenue increased by approximately 20 %.

In 2001 the IWS conducted an international technology audit. The audit analyzed the development and discussed the resulting strategy for the coming years. All auditors praised the positive development and the strategic concept of the IWS and encouraged us to continue on our chosen path. Beyond this we received suggestions for new and additional fields, which we have already begun to pick up.

One of the highlights in the year 2001 was the receipt of the American "R&D 100 Award" for the development of our laser-acoustic measurement system. This annual award is presented to the 100 best developments worldwide in a variety of research areas.

You will find more scientific and technological highlights on the following pages in our annual report.

With the year 2001 the IWS marked its 10th year within the Fraunhofer Society and has shown a positive development, especially during the last five years. It is our predominant goal to consolidate the rapid growth of the last years, since a growth in personnel is under constraints until the extension to building will be added.

Dresden, January 2002

Prof. Dr.-Ing. habil. Eckhard Beyer

Fraunhofer-Institut
für Werkstoff- und Strahltechnik IWS

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LAwave® Receives the "R&D 100 Award"

Researchers of the Fraunhofer Center for Surface and Laser Processing CSLP in the USA and of the Fraunhofer IWS in Dresden received the renowned "R&D 100 Award" for the joint development and market introduction of the laser-acoustic measurement system LAwave®. The award was presented on October 4th, 2001, during a ceremony in the Museum of Science and Technology in Chicago and appreciates the contribution in the field of applied nanotechnology.

Presentation of the "R&D 100 Award" on October 4th, 2001, in the Museum of Science and Technology in Chicago

New World Record

IWS managed to produce EUV mirrors (MoSi) with a reflectivity of 71.4 %. This number represents a worldwide unprecedented top value. In the future, EUV mirrors will be needed for lithography. They demonstrate an example for applied nanotechnology.

IWS Director Named President of the Laser Institute of America (LIA)

The 2002 president of the Laser Institute of America (LIA) will come from IWS. The largest laser organization in the world has elected Prof. Beyer for the year 2002 as its president. For the first time a Non-American citizen will take over the chairmanship of the LIA.

Robot with high performance beam scanning system

Lasertronic®

Our efforts in the field of fast beam scanning are pioneering the application of lasers in the manufacturing of automotive bodies. Since the application combines lasers, electronics, and information technology, we coined the term "lasertronic®".

CD laser lexicon

Laser Lexicon

Researchers at IWS have developed a multi-media based laser lexicon. This is offered on CD. The target groups are students, technicians, and engineers. The lexicon was introduced at the laser fair in Munich.

Outstanding Technology Audit

As the third institute of the Fraunhofer Society, IWS undertook a technology audit in January 2001. Old and new business fields were thoroughly examined regarding their market fitness and future perspectives as well as evaluated with respect to the institute's core competencies.

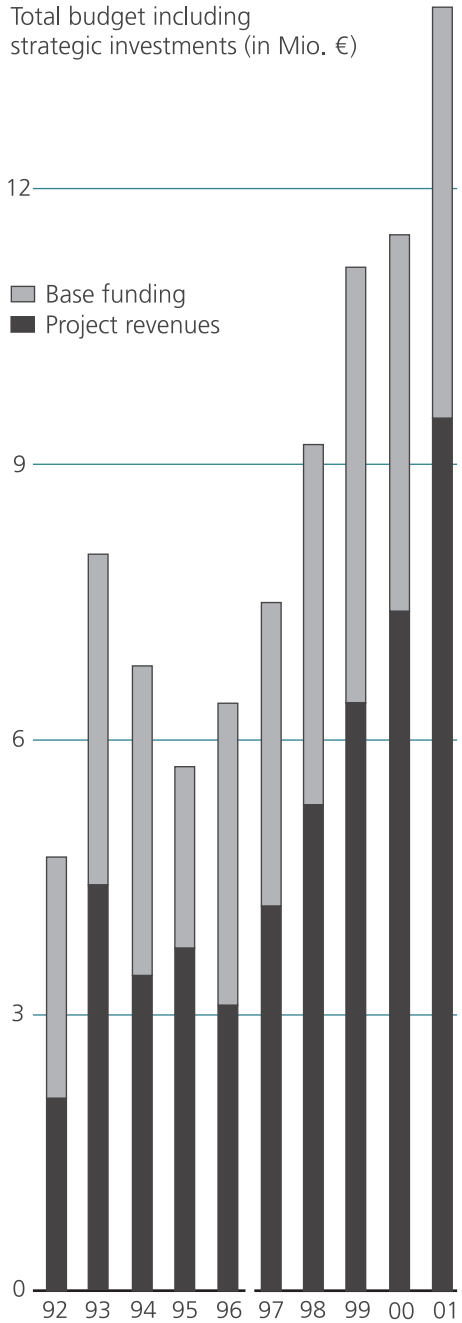
All auditors concluded:
- The IWS has demonstrated an extraordinary development. The R&D areas are oriented towards the future; competence, management, and equipment are very good.
- According to the auditors, the IWS ranks in a world leading position in some areas.

Auditors:
Dr. G. Barbezat
(Sulzer Metco Holding, Schweiz)
Dr. U. Brinkmann
(Zeitschrift LaserOpto)
Dr. E.-J. Drewes
(ThyssenKrupp Stahl AG)
Prof. Dr.-Ing. H. Flegel
(DaimlerChrysler AG)
Dr. W. Fleischer
(Bodycote Coating Centrum, Holland)
Dr. T. Krug
(Metaplas Ionon)
Prof. Dr. M. F. Modest
(Penn State University, USA)
Prof. Dr. W. Pompe
(TU Dresden)
Prof. Dr. H. K. Pulker
(Universität Innsbruck, Österreich)
Prof. Dr. H. Welling
(Laser Zentrum Hannover e. V.)
Dr. R. Wollermann-Windgasse
(Trumpf GmbH & Co.)

IWS management team
(f.l.t.r.: Dr. Nowotny, Dr. Wilhelm, Dr. Morgenthal, Prof. Beyer, Dr. Leson, Prof. Brenner, Dr. Schultrich, Prof. Günther)

10 Years IWS

In 1991 the IWS emerged from the Academy of Sciences and grew very strongly over the last years. The two-digit growth of the preceding years could be continued during 2001.



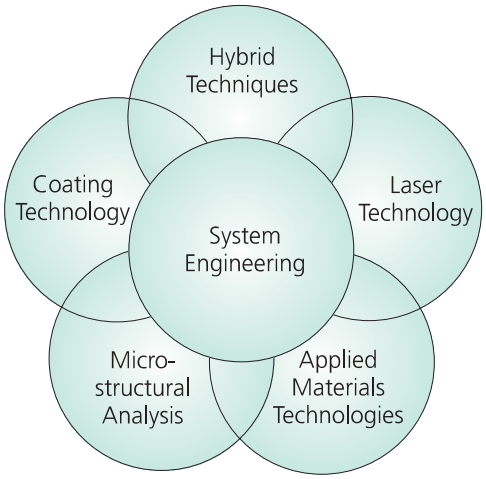
Fraunhofer IWS revenue development over the last 10 years

Overview

The Fraunhofer Institute for Material and Beam Technology conducts application-oriented research and development in the areas of laser and surface technology.

Key points are:

- Laser beam welding, cutting and ablation,
- Surface treatment as well as
- The deposition of thin films.



The main working areas of IWS, which enable us to provide you with one-stop solutions

A special feature of the IWS is the experience in beam and coating technologies in combination with a profound know-how in materials and comprehensive capabilities of material characterization. In order to offer optimized solutions for industrial production, we exploit the option of coupling beam technologies with other power sources. This leads to so-called *hybrid technologies*, which combine advantages of laser techniques with special features of other techniques in a cost-effective manner.

Through the close collaboration with system suppliers and equipment manufacturers, we are able to offer our customers *one-stop solutions* based on novel concepts. As a basis for this, the working system, the process, and the component performance must all be taken into overall consideration. The excellent facility at IWS enables us to respond to customer's requests with state of the art equipment. Furthermore, we are capable of running pilot production and testing, in house.

Laser Technology

- Laser hardening, re-melting and cladding
- Laser surface modification with additional materials (alloying and disperging)
- Repair coatings
- Rapid prototyping
- Laser beam welding and soldering
- Laser cutting and parting
- Laser cleaning and ablation (for restoration and technical purposes)
- Laser finishing
- Microstructuring, engraving and marking

Thin Film Technology

- Thin film technology on the basis of laser, vacuum arc, CVD, sputtering and electron beam processes
- Film systems and processes for hard coatings with carbides, nitrites, oxides, etc.
- Super hard amorphous carbon films
- Nanometer multilayer films for X-ray optical components
- Atmospheric pressure plasma-assisted CVD and atmospheric pressure laser-assisted CVD
- Plasma spraying

Hybrid Processes

- Induction assisted laser welding of heat treatable steels
- Plasma augmented laser processing (welding, re-melting)
- Laser assisted plasma spraying
- Thin film deposition through combined laser, vacuum arc, electron beam and CVD processes
- Modeling of short time heat treatment processes

Materials Testing

- Characterization of laser irradiated materials and components
- Wear and fatigue tests
- Mechanical, tribological and optical film properties
- Thermal shock resistance and temperature stability of ceramics
- Failure analysis

Structure Analysis

- Metallographical material characterization
- Structure analysis with electron-microscopy (REM, TEM)
- Characterization of surface properties with optical spectroscopy

System Technology

- Development of system components such as high speed beam scanners, flexible laser beam shaping units and welding monitors
- Optimization of laser machining systems
- Process diagnostic of PVD and CVD processes

Our Offer

We offer one-stop solutions in:

- Consulting
- Feasibility studies
- Contract research and development
- Process testing
- System development jointly with industrial partners
- Design and implementation of pilot systems
- Material and component testing
- Failure analysis
- Training of scientists, engineers, operators and laboratory assistants

Contacts

The Fraunhofer IWS offers you service and contract work and guarantees strict confidentiality upon request.

Buisness fields	Core services	Laser processing techn.	Coating processes	Material technol./Analysis	Simulation techniques	System engineering
Joining		■		□	□	□
Separation		■				□
Surface technology						
Removal / Cleaning		■		□	□	□
Wear protection		■	■	□	□	□
Repairs		■				□
Friction reduction			■	□		□
Oxidation protection		■	■	□		□
Functional coatings			■	□		□
Microtechnology		■	■	□		□
Optics						
X-ray mirror, EUV mirror			■	□	□	□
IR optics			■	□	□	
Prototyping		■		□		□
Process-monitoring		■	■			□

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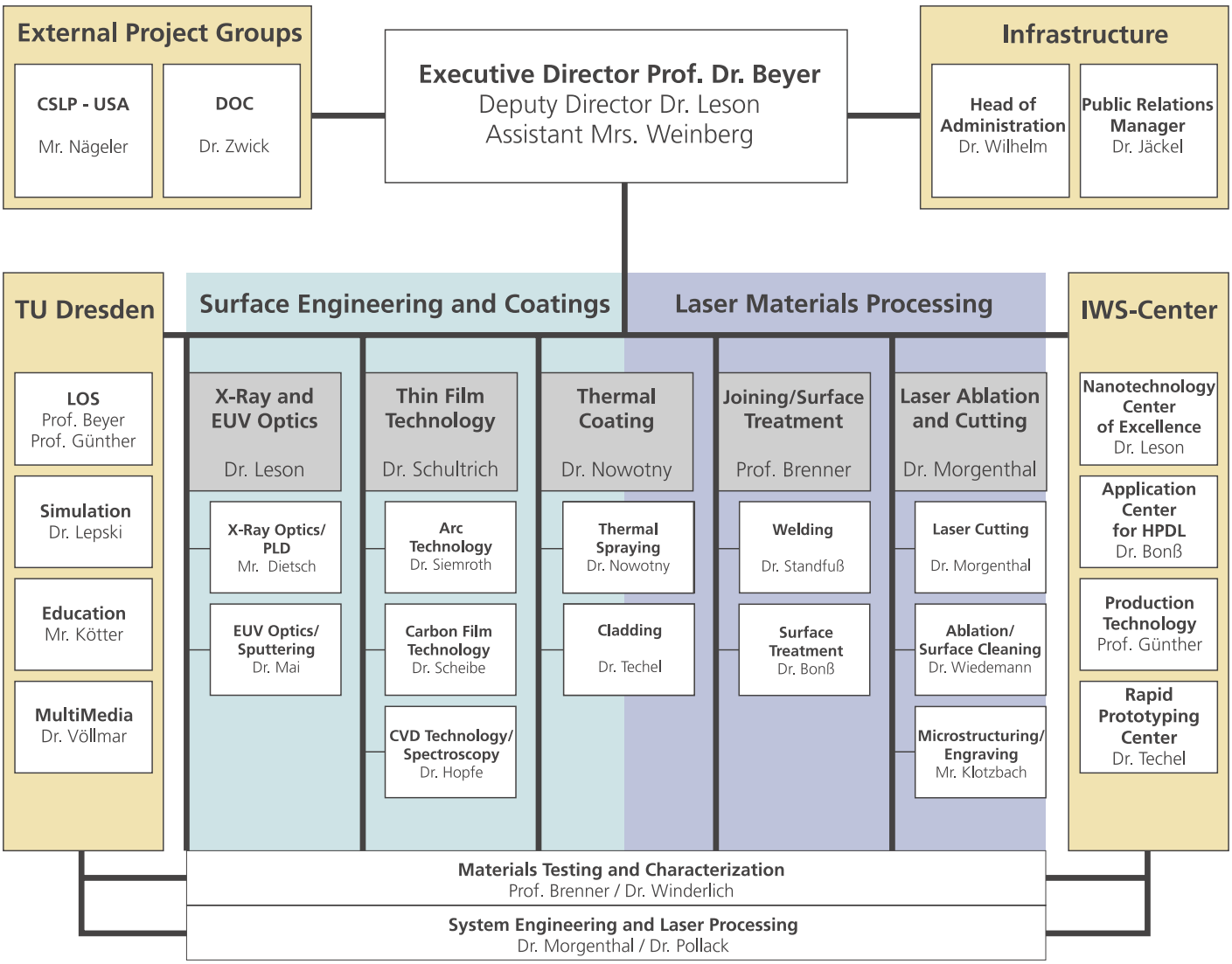
Organization and Contacts



Departments

The IWS is structured into 5 departments of independent subjects. Each department consists of 2 - 3 workgroups. The areas “Materials Testing and Characterization” as well as “System Engineering and Laser Processing” are organized to overlap the departments.

Remote Locations

IWS is operating a Center for Surface and Laser Processing in the United States, as well a project group at the DOC (Surface Center in Dortmund, Germany). This project group strongly cooperates with ThyssenKrupp Stahl AG. The direct access to IWS know-how and the close cooperation form a solid base for these activities.

Center

IWS installed several centers within its walls focusing on actual R&D topics with special development emphasis utilizing cross-departmental cooperation.

Connection to the TU Dresden

Professorship for Surface Engineering and Thin Film Technology

During 2001, 48 colleagues were employed in the university department. The third party revenues yielded between 1.7 and 2 Mio. €.

The following courses were offered:

- Laser system technology (Prof. Beyer)
- Manufacturing technology II, part 3 (Prof. Beyer)
- Coating technologies (Dr. Schultrich, Prof. Beyer)
- Surface engineering / Nanotechnology (Dr. Leson, Prof. Beyer)
- Laser technology at Bradley University, USA (Prof. Beyer)

Animations, process and equipment simulations, as well as video spots are integrated into the multi-media based course materials, which are provided to the students. An additional multimedia based lexicon is offered for the course "laser technology".

Cooperation Fraunhofer IWS - TU Dresden

A special agreement regulates the cooperation between the IWS and the TU Dresden. Prof. Beyer works simultaneously as the executive director of the IWS as well as a chairman at the University. The work is distributed as follows: Research and education are performed at the university and applied research and development are performed at the IWS. IWS employees are tied into projects at the university and vice versa. In the end the IWS and university form one unit with a different emphasis for each part.

The advantages for IWS are:
- Cost effective basic research
- Education of junior scientists for the IWS
- Access to scientific helpers

The advantages for the TU are:
- R&D involvement in industrial projects
- Integration of newest R&D results into education
- Training of students on the most modern equipment

Professorship for Surface Engineering and Thin Film Technology
Head: Prof. Dr. Beyer
Deputy: Prof. Dr. Günther

- Laser Technology
- Thin Film Technology
- Mech. Surface Engineering
- Therm. Surface Engineering
- Hybrid Processes

CD for laser system technology course

CD laser lexicon

Laser production equipment

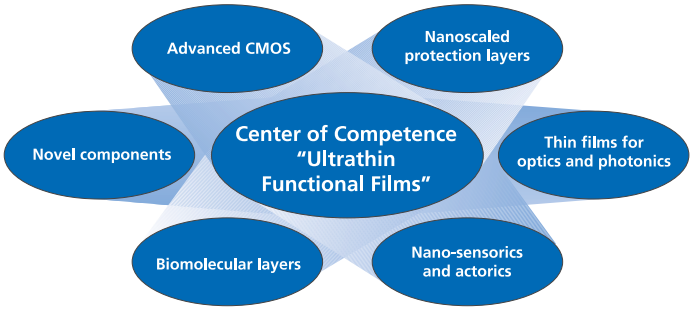
Centers and External Project Groups of the Fraunhofer IWS

Nanotechnology Center of Competence "Ultrathin Functional Films"

Nanotechnology is one of the key technologies for the 21st century. Already there are products in the market such as magnetic storage media and read/write heads for data storage which are covered with nanometer films, or scanning tunnel microscopes which make the world of molecules and atoms visible. Ultrathin films are a key element of nanotechnology. Applications range from microelectronics and optics to medicine and tribological systems.

To consequently explore the possibilities of industrial applications, forty-four companies, ten university institutes and twenty-one research institutes have formed a know-how network. IWS was awarded the coordination of the network by the Federal ministry of Research. IWS is one of the main contributors to the Nanotechnology Center of Competence, with nanometer film structures for X-ray optics being one prime example.

New technologies for the deposition of computer hard disks under industrial conditions are evaluated in a large BMBF-financed project in the framework of the Nanotechnology Center of Competence.



Workgroups of the Nanotechnology Center of Competence

Application Center for High Power Diode Lasers

In cooperation with leading laser and equipment manufacturers, the Fraunhofer IWS established a high power diode laser application center with the objective to offer optimized problem solutions to our customers.

Due to their comparatively high efficiency of about 50 % and the very compact design, high power diode lasers are ideal tools for the localized distortion-free hardening and coating. The welding of sheet metal of up to 1 mm in thickness can be done faster and at higher quality compared to conventional welding techniques. In response to customer requirements over the last years, special software products such as post-processors and surface temperature based laser power control packages have been developed, which simplified the application of high power diode lasers for surface engineering and surface refinement tasks as well as improved the process stability.

The application center is capable to accomplish processing tasks with leading know-how and the newest diode laser systems.

Demonstration of a hardening machine with an integrated high power diode laser in the laser hall of IWS during the workshop "Applications of High Power Diode Lasers"

Production Technology Center

The integration of efforts at the IWS and the Technical University Dresden occurs in research, development, and the application of production technology ranging from process development to the design of production flows.

Work emphasis:

- Process development in conventional and high-speed sector as well as development of hybrid-processes
- Feasibility studies and performance analysis, studies (products, manufacturing processes, technological and logistic process chains)
- Material flow and production simulation
- 3D visualization and animation of products, production chains, and production systems

Rapid Prototyping Center

Time-to-market: the time frame from an idea to the marketing of a new product decides success or failure. This correlation caused the institute's involvement in rapid prototyping and rapid tooling beginning several years ago.

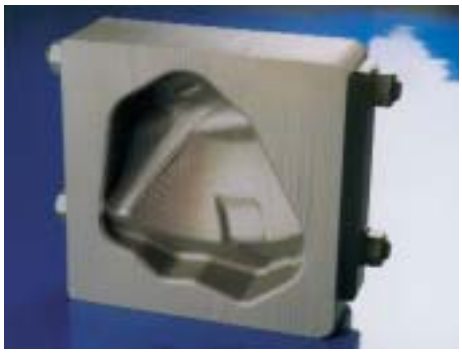
There are several prototyping systems installed at IWS. The capabilities include 3D modeling and data processing, contour scanning, the different processes to produce the models (such as laser beam generation and laser beam sintering), laminated object manufacturing (LOM) with sheet metal, and the final processing (milling, coating, measuring) of the tools.

Tools can be manufactured in a fraction of the time needed in the past with the help of metal-LOM as a rapid tooling process.

Surface of a tool made by metal-LOM

Beam technology:
Water jet abrasive cutting machine

Laser integrated CNC milling center



Blank lamellas of a stamping tool

Industrial Project Group at the Dortmund Surface Center (DOC) at ThyssenKrupp Stahl AG

Dr. Axel Zwick
Head of the Project Group
at DOC in Dortmund

Building of Dortmund Surface Center (DOC)

The Dortmund Surface Center (DOC = Dortmunder Oberflaechen Centrum) of the ThyssenKrupp Stahl AG opened in December 2000. The IWS participates at the DOC with an industrial project group. State-of-the-art equipment has been installed in an IWS-owned 1000 m^2 facility. The equipment includes a large system to provide corrosion and wear resistant coatings, which for the first time allows the coating of large parts of 1 m in diameter and 1 m in height with the IWS-developed Diamor® film. Additionally, IWS installed a plasma spraying and coating system at the DOC to test the novel laser assisted spraying technology.

IWS employees have at their disposal a worldwide unique mobile 4 kW Nd:YAG laser. This system can be used not only for process development but also for "trouble shooting" directly at the industrial customer's site. Almost all laser material processing operations including hybrid welding (MIG processes) can be performed using 75 m of optical fibres to bring the laser light to the workstation. Furthermore, a 5-axis system for 3D laser material processing has been installed in Dortmund.

The close cooperation of scientists and engineers of the Fraunhofer IWS with TKS employees allows innovative and application oriented solutions and processes approaches for the corporations of the ThyssenKrupp Group, their customers, and other interested parties.

Fraunhofer Center for Surface and Laser Processing (CSLP)

Stephan Nägeler
Director
CSLP / USA

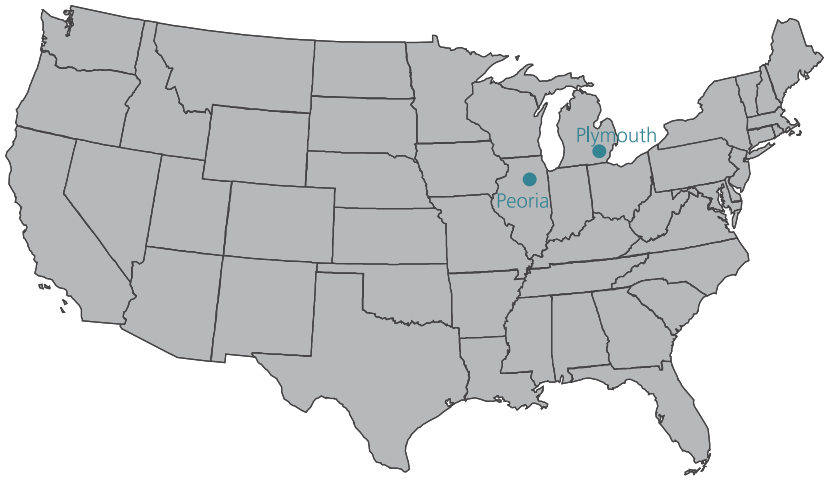
On October 4th, 2001, researchers at the Fraunhofer Center for Surface and Laser Processing CSLP in the USA and the Fraunhofer IWS in Dresden received the renowned "R&D 100 Award" for the joint development and market introduction of the laser-acoustic testing system LAwave®. Over a period of 15 years, Drs. Dieter Schneider and Thomas Schwarz developed an idea into a market-ready system, which is now worldwide the only commercially available tool based on laser-acoustic measurements. The largest fraction of sold systems are exported. An established American corporation supports sales in the USA.

The development and the marketing of the LAwave® system is just one example that shows the intertwinement and importance of the marketing of existing know-how and the acquirement of new know-how.

To achieve these objectives, IWS operates its Center for Surface and Laser Processing, which was established under the roof of Fraunhofer USA. The center is located in the facilities of Bradley University in Peoria, Illinois, and includes an industrial project group at the company Rofin-Sinar in Plymouth, Michigan.

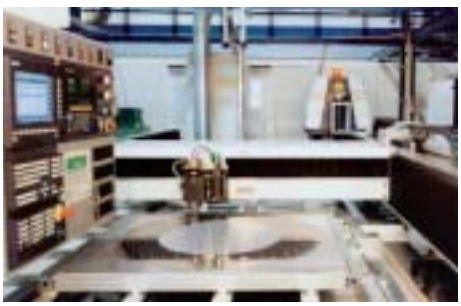
The strong cooperation of our scientists and engineers with the employees of Rofin-Sinar guarantees innovative solutions for customers of Rofin-Sinar. The cooperation with Bradley University is documented in a student exchange program. Students have the possibility to gain international experience in work and education.

For the first time an Institute of the Fraunhofer Society receives the "R&D 100 Award" in the year 2001



Institute Equipment

View of the IWS technology hall



High-speed laser cutting machine

Atmospheric plasma spraying with laser coupling

Laser Systems

20 kW CO_2 laser (HF-pumped)

Several 6 kW CO_2 laser (HF-pumped)

Several CO_2 slab laser, 2 to 3.5 kW, (HF-pumped, beam quality K > 0.8)

Several Nd:YAG laser to 4 kW cw and 1 kW pm laser

Nd:YAG laser system with pulse widths in the millisecond, nanosecond and picosecond range

Several high power diode lasers , 1.4 ... 2.5 kW

High power diode laser system (pulsed, fiber coupled), intensity > 10^5 W cm^{-2}

TEA CO_2 laser

Excimer laser

Pulsed Nd:YAG-Laser with OPO

Handling Systems

Gantry with 5 CNC-axes (plus external rotating axis) work range 4000 · 3000 · 1500 mm^3, with 2.5 to 20 kW CO_2 laser beams

CNC-laser processing equipment with 8 axes, speed up to 20 m min^{-1}, working range of 2400 · 1800 · 600 mm^3, with 2.5 ... 6 kW CO_2 laser beams

Laser induction hybrid gantry with 5 axes (6 kW or 20 kW CO_2 laser, 80 kW MF induction generator)

Precision machines (accuracy class 5 µm) with 5 and 4 CNC-axes, with 6 kW CO_2 laser beams

Combined CO_2 and Nd:YAG machine (2 or 3 kW) with 4 CNC-axes for precision cladding

Cutting Machines with linear drives up to 200 m min^{-1} feed with 3.5 kW CO_2 laser beams

Universal Excimer-laser-micromachine

Coating Systems

Laser CVD device with 6 kW CO_2 laser and Lamp CVD machine (24 kW) for fiber coating

Laser PVD (LPVD) coating device (Nd:YAG, Excimer, TEA CO_2 laser) in high vacuum and ultra high vacuum

Equipment for film deposition with vacuum arc technology (Laser-arc, pulsed high current arc, DC-arc, plasma filter)

Hybrid coating equipment: 40 kW electron beam and high current arc

Six inch-cluster tool for combined large area PLD and magnetron sputtering

Plasma spray systems

Special Components

Static and flexible dynamic beam shaping systems for beam power up to 10 kW

Power feeder and special equipment for independent laser cladding as well as temperature measurement system for process control

CNC sensor controlled wire feeder for laser welding

SCOUT sensor system for 3D shape recording (automatic teach-in) for laser handling of components (on-line / off-line contour tracing)

Beam diagnostic system for CO_2 and Nd:YAG laser

UV / VIS, FTIR und NIR diode laser spectrometer for process gas and plasma diagnostic

Camera system for short-time process analysis (4 channel high speed framing camera with 5 ns exposure time)

Special Equipment

Mobile 4 kW Nd:YAG laser in a container

Equipment for rapid prototyping by laser sintering

Portable Nd:YAG laser (6 ns pulses of $5 \cdot 10^7$ W, repetition rate up to 20 Hz) with articulated beam guide and zoom optic (Art-Light NL 102) for outdoor cleaning

Turnable laser handling system (400 ... 2000 nm, > 100 mJ) with flexible beam guide and controlled motion for the ablation of thin layers

Laser handling station with industrial robot system and CO_2 slab laser

Measurement Instruments

Texture analyses including:
- Metallography
- Analytical transmission electron microscopy
- Analytical scanning electron microscopy
- Adequate sample technique preparations

Materials testing:
- Servo hydraulic testing system
- Mechanical stress / strain tester
- Pendulum impact tester
- Automatic hardness tester
- Computer controlled micro hardness test system
- High frequency fatigue tester
- Flat bending torsion machine

Laser acoustic system for measuring the Young's modulus of thin films

Laser shock instrumentation with high speed pyrometer

Equipment surface and film analysis:
- Automatic spectral ellipsometer (270 - 1700 nm)
- UV / VIS spectrometer
- Raman micro spectrometer
- FTIR spectrometer, FTIR microscope
- Depth sensing indentation device
- Scratch tester
- Profilometer
- Tribometer
- X-ray florescence film thickness measuring device
- Sheet resistivity measuring device

X-ray diffractometer (CuKα)
X-ray diffractometer (MoKα)

Optical 3-D coordination system

Laser-Acoustic measurement station for the non-destructive determination of thin film properties, acknowledged through the "R&D 100 Award 2001" in the USA

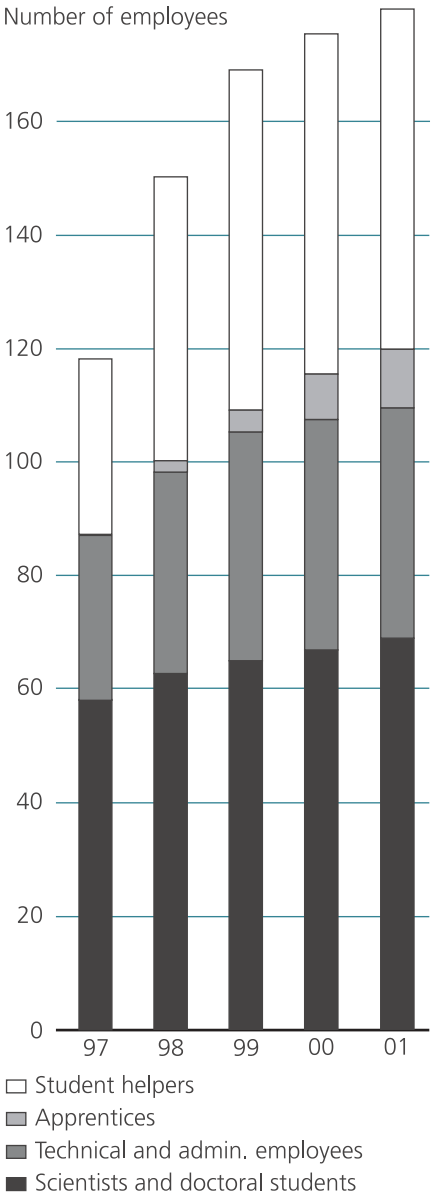
Laser-Arco® - the technology to deposit Diamor®

Total Employees

The TU Dresden (department for surface engineering and coating technology) and the Fraunhofer IWS are connected through a cooperation agreement. A number of university employees are working closely with IWS employees on joint projects. Basic research is conducted at the university; application related process development and system technical work is done at IWS.

For 2001 the employees are divided up as follows:

Employees of Fraunhofer IWS	Number	Employees of Chair for Surface Engineering and Thin Film Technology of TU Dresden	Number
Permanent staff	110	Permanent staff	40
- Scientists	68	- Scientists	28
- Technical staff	34	- Technical staff	10
- Administrative staff	8	- Administrative staff	2
Apprentices	10		
Research assistants	60	Research assistants	8
Total	180	Total	48



Building	5050 m²
- Processing technology area	1200 m²
- Lab space, workshops	1760 m²
- Demonstration labs	175 m²
- Office space	1550 m²
- Seminar rooms	240 m²
- Cafeteria	125 m²
Technology area at the DOC (Dortmund)	1100 m²

Guest Companies Located at Fraunhofer IWS

- EFD Induction GmbH Freiburg, Dresden Branch
- ALOtec Applied Laser and Surface System Technology GmbH Dresden
- Fraunhofer Institute for Non-Destructive Testing IZFP Saarbruecken, Dresden Branch

External Project Groups of Fraunhofer IWS

- at Fraunhofer Center for Surface and Laser Processing (Plymouth, Michigan, USA and Peoria, Illinois, USA)
- at the Dortmund Surface Center (DOC) at ThyssenKrupp Stahl AG

Budget and Revenue (preliminary*)

* Actual cost determination not yet finalized

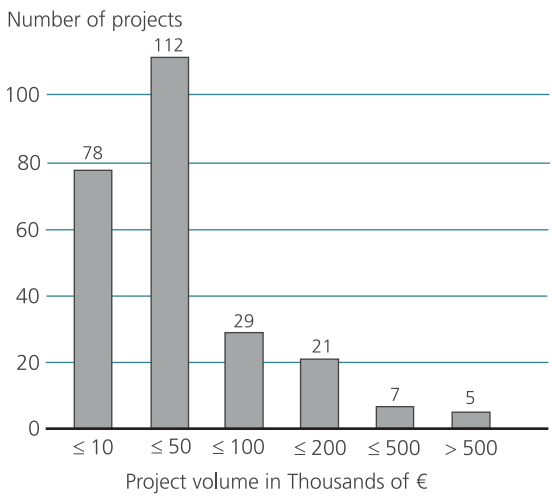
	Mio. €
Operational costs and investments	12.6
Budget	10.6
- Cost of sales	4.9
- Other expenses	5.7
Investment	2,0

	Mio. €	%
Revenue 2001	12.6	
Revenue Operations	10.6	
- Industrial revenues	4.9	46
- Revenues of public funded projects	3.4	32
- Base funding IWS	2.3	22
Revenue Investment	2.0	
- Industrial revenues	0.5	
- Revenues of public funded projects	0.7	
- Base funding IWS	0.8	

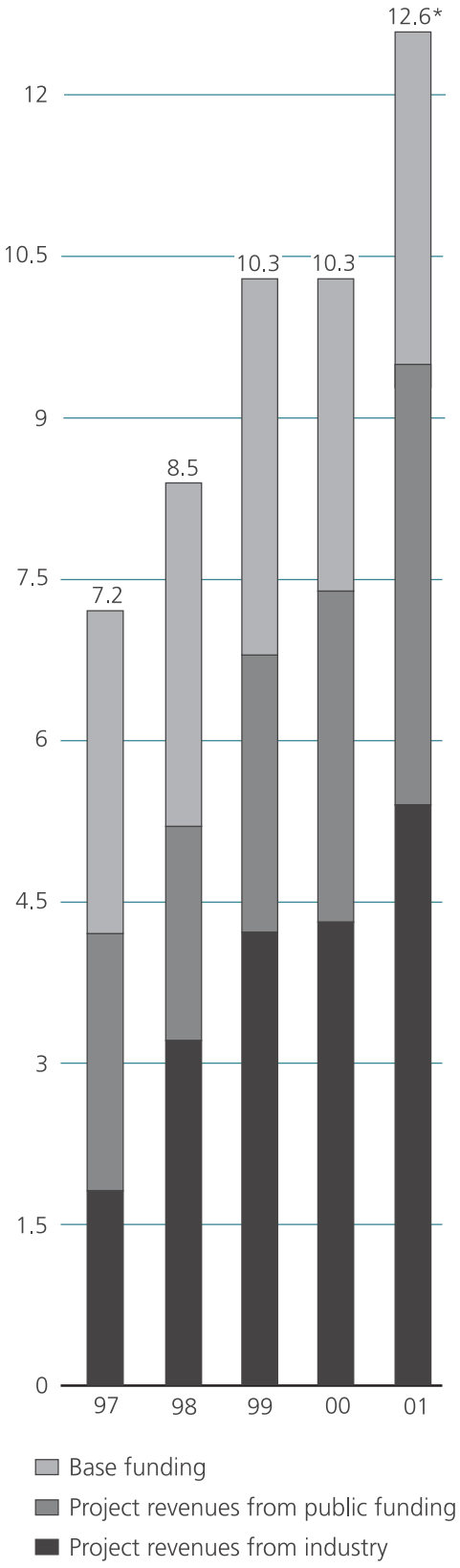
In 2001 IWS received additionally 1.4 Mio. € as strategic investment from the Fraunhofer Society.

Projects

In 2001, IWS handled 252 projects. The distribution of the projects with respect to their volume is shown in the graphic below. One hundred twelve of the projects were for 10 to 50 T€ (Thousands of Euro), for example.



Revenues in operations and investments without strategic investments (in Mio. €)



The Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft is the leading organization for institutes of applied research in Europe, undertaking contract research on behalf of industry, the service sector and the government. Commissioned by customers in industry, it provides rapid, economical and immediately applicable solutions to technical and organizational problems. Within the framework of the European Union's technology programs, the Fraunhofer-Gesellschaft is actively involved in industrial consortiums which seek technical solutions to improve the competitiveness of European industry.

The Fraunhofer-Gesellschaft also assumes a major role in strategic research: Commissioned and funded by Federal and Länder ministries and governments, the organization undertakes future-oriented research projects which contribute to the development of innovations in spheres of major public concern and in key technologies. Typical research fields include communications, energy, microelectronics, manufacturing, transport and the environment.

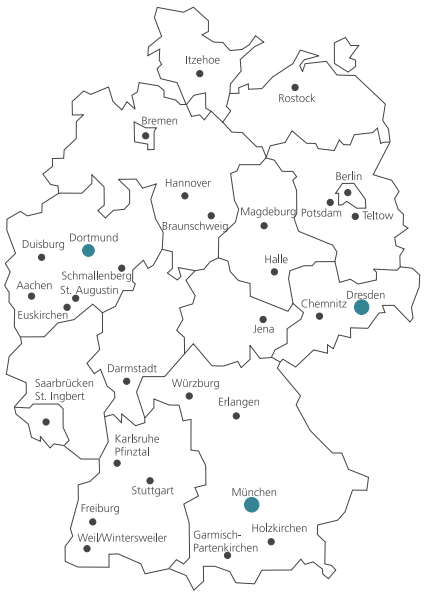
The global alignment of industry and research has made international collaboration imperative. Furthermore, affiliate Fraunhofer institutes in Europe, in the USA and in Asia ensure contact to the most important current and future economic markets.

At present, the organization maintains 56 research establishments at locations throughout Germany. A staff of some 11,000 - the majority of whom are qualified scientists and engineers - generate the annual research volume of more than 900 million €. Of this amount, over 800 million € is derived from contract research. Research contracts on behalf of industry and publicly financed research projects generate approximately two thirds of the Fraunhofer-Gesellschaft's contract revenue. One third is contributed by the Federal and Länder governments, as a means of enabling the institutes to work on solutions to problems that are expected to attain economic and social relevance in the next five to ten years.

Fraunhofer scientists specialize in complex research tasks involving a broad spectrum of research fields. When required, several institutes pool their interdisciplinary expertise to develop system solutions.

The Fraunhofer-Gesellschaft was founded in 1949 and is a recognized non-profit organization. Its members include well-known companies and private patrons who contribute to the promotion of its application-oriented policy.

The organization takes its name from Joseph von Fraunhofer (1787-1826), the successful Munich researcher, inventor and entrepreneur.



The Advisory Committee

The advisory committee supports and offers consultation to the Fraunhofer IWS. Members of the advisory committee in 2001:

O. Voigt, Prof.
Chairman of Windsolar AG,
Committee Chair

K. Arnold, Prof. Dr.
General Manager of Niles-Simmons Industrieanlagen GmbH

R. Bartl, Dr.
Director Production Planning MB Cars of DaimlerChrysler AG

E.-J. Drewes, Dr.
Head of Research, Central Quality and Testing of ThyssenKrupp Stahl AG

H. Ennen, MinR Dr.
Saxony Office, Brüssel

P. Lenk, Dr.
General Manager of von Ardenne Anlagentechnik GmbH

P. Linden, Dr.
Head of Production Technology of DaimlerChrysler AG

A. Mehlhorn, Prof. Dr.
President of the University of Technology in Dresden

B. L. Mordike, Prof. Dr.
University of Technology in Clausthal

R. J. Peters, Dr.
General Manager VDI Technology Center, Physics Technologies

W. Pompe, Prof. Dr.
Technical University Dresden

R. Röhrig, MinR Dr.
Federal Ministry for Education and Research

F. Schmidt, MinDir Dr.
Saxon Ministry of Science and Art

P. Wirth, Dr.
Chairman of Rofin-Sinar Laser GmbH

The eleventh committee meeting took place on February 21, 2001, at Fraunhofer IWS in Dresden.

The Institute Management Committee

The institute management committee advises the executive director and participates in decision making concerning the research and the business policy of IWS.

Members of the committee are:

Prof. Dr. E. Beyer	Executive Director
Dr. A. Leson	Deputy Director
Dr. S. Wilhelm	Head of Administration
Prof. Dr. B. Brenner	Department Head
Dr. L. Morgenthal	Department Head
Dr. B. Schultrich	Department Head
Dr. S. Nowotny	Department Head

Guests are:

Dr. R. Jäckel	PR-Manager
Dr. S. Schädlich	QM Representative
Dr. B. Schöneich	Works Committee
Dr. G. Wiedemann or Dr. S. Bonß	WTR Agent
Prof. Dr. U. Günther	Agent of the Professorship

Scientific Technical Council (WTR)

Scientific technical council of the Fraunhofer-Gesellschaft supports and advises divisions of the Fraunhofer-Gesellschaft with regard to technical and scientific policy The Counsel consists of members of the institute management and an elected representative of the scientific and technical staff of each institute. IWS members of WTR in 2001 were:
- Prof. Dr. E. Beyer
- Dr. G. Wiedemann (Jan. - March 2001)
- Dr. S. Bonß (March - Dec. 2001)

Network Surface Engineering and Photonics

The IWS is a member of the network Surface Engineering and Photonics. Members of the network are:
- Fraunhofer FEP Dresden
- Fraunhofer ILT Aachen
- Fraunhofer IOF Jena
- Fraunhofer IPM Freiburg
- Fraunhofer IST Braunschweig
- Fraunhofer IWS Dresden

Dr. Andreas Leson
Department Head
(Tel. 2583 317)

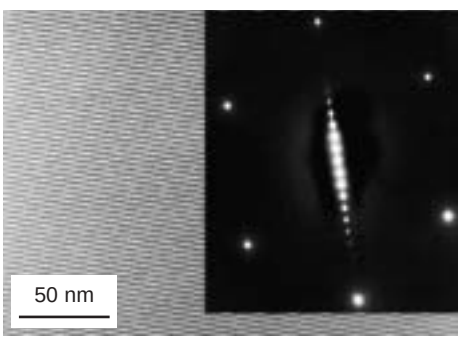
Dipl.-Phys. Reiner Dietsch
Team Leader X-Ray Optics / PLD
(Tel. 2583 249)

Multi-layer Films for X-Ray Optical Applications

Single and multi-layer systems, which were manufactured with PLD are characterized by the following:
- Highest film thickness accuracy,
- Smallest interface roughness,
- Extraordinary chemical purity,
- High lateral uniformity and
- Good thickness reproducibility.

Film systems of different material combinations can be deposited on substrates of up to 150 mm in diameter with or without a gradient of the period thickness along the longitudinal substrate axis.

The main application area is an X-ray optical element for beam shaping and monochromatization. In addition to the synthesis of single and multi-layer systems (e.g. Ni/C, C/C, W/C) according to clients desires, we also offer our long term experience in the areas of preparation, characterization and simulation for the conception and design of beam shaping X-ray optical elements.



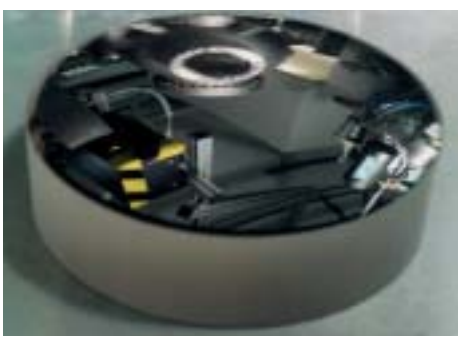
TEM photograph of a 100-fold Ni/C multi-layer for X-ray optical applications in a wide energy range

Dr. Hermann Mai
Team Leader EUV Optics / Sputtering
(Tel. 2583 248)

Sputter Coating of EUV Optics

Interference optics on the basis of Mo/Si-nanometer film systems are a central component for lithographic processes of the next generation, which are tailored for a wave length of 13.4 nm. To achieve the required reflectivity in the EUV range, it is necessary to deposit multilayer stacks with a precision in the pico-meter range as well as a film thickness uniformity of better the 99.9 %.

With magnetron sputtering, it is possible to deposit suitable multi-layers onto flat and bent super polished substrates of up to 150 mm in diameter, which fulfill the extreme requirements. IWS develops innovative solutions for the large area deposition of Mo/Si coatings on beam shaping mirrors and projecting optics. Another topic is the multi-layer synthesis with minimal defect density for the respective masking tools.



Spherical mirror, coated with a Mo/Si multi-layer coating

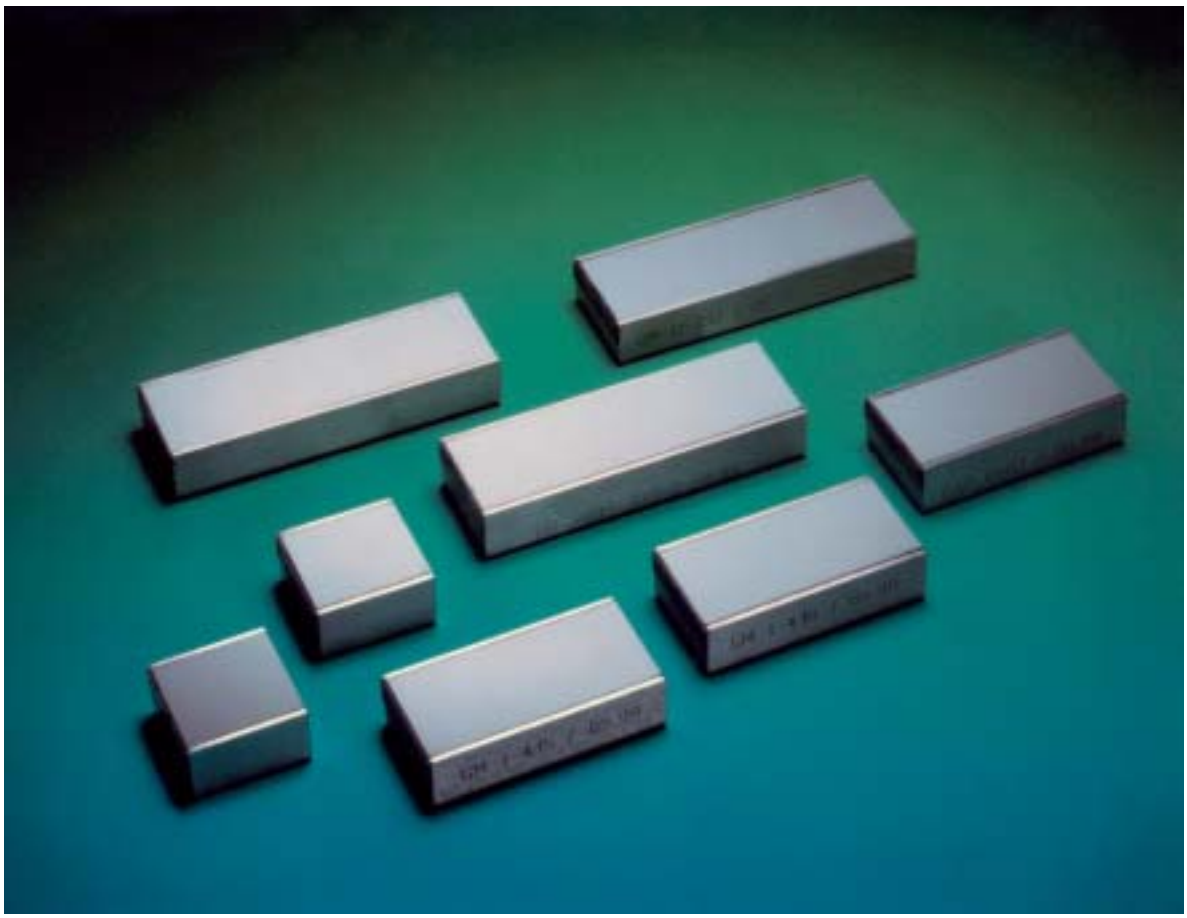
Samples of Work Performed in 2001

1. Picometer precision - a new quality in large area PLD

2. Mo-Kα-optical systems for laboratory X-ray sources

3. Highly reflective X-ray optics for EUV lithography

4. Inner diameter coating of parts with complex structures



Different precision X-ray mirrors for X-ray diffractometry, manufactured through pulse laser deposition

Dr. Bernd Schultrich
Department Head
(Tel. 2583 403)

Dr. Peter Siemroth
Team Leader Arc Technology
(Tel. 2583 409)

Coating and Surface Modification with Arc Technologies

Arc discharges as a source of energetic metal plasmas are widely used in industrial hard coating deposition on tools. The resulting films show superior surface properties. Stable adhesion can be achieved at low deposition temperatures. Promising applications such a coating on components offer a broad potential for new developments with arc technologies.

Based on long term experiences, with basic processes and applications of arc technologies, and by utilizing modern pulse techniques, IWS is developing innovative solutions for broad application spectrum from ultra thin films to large area coatings.

Arc coating of temperature sensitive fibers

Dr. Hans-Joachim Scheibe
Team Leader Carbon Film Technology
(Tel. 2583 408)

Superhard Carbon Films for Gliding Parts and Wear Protection

The laser controlled vacuum arc evaporation is the basic technology to deposit hydrogen free amorphous carbon films of high particle energies. Based on this technology we offer super hard coatings (Diamor®) with the following properties:

- Thickness up to several micrometers,
- Adjustable to a hardness of 20 und 75 GPa,
- Low friction coefficient for tribological applications,
- High corrosion resistance,
- Smooth films on a variety of materials,
- Deposition temperatures below 100 degrees Celsius.

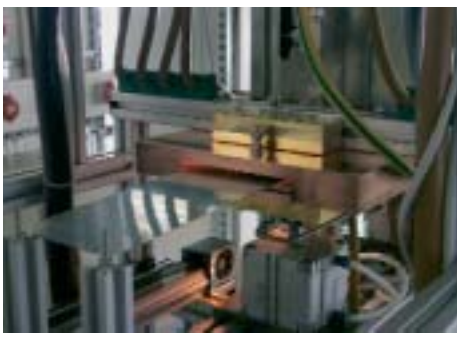
Diamor® coated forming and guiding roll made of steel

Dr. Volkmar Hopfe
Team Leader CVD Technology / Spectroscopy
(Tel. 2583 402)

CVD Coatings at Atmospheric Pressure with Plasma and Laser Activated Hybrid Processes; Process Control

Processes at atmospheric pressure can be easily integrated into technological production flows, in the continuous coating of bands of metal for example. Deposition temperature and rate can be controlled with plasma and laser deposition. The enables the coating of temperature sensitive materials such as certain steels, glasses, and plastics.

IWS develops application specific technologies including in-line reactors and process control systems. Sensors based on optical spectroscopy are developed for process control in CVD systems to monitor reactive and aggressive gasses at high temperatures. For customer specific solutions to continuously monitor the chemical composition and concentration of gas mixtures IWS is using the FTIR or NIR diode laser spectroscopy.



Arc-jet CVD reactor during the coating of stainless steel

Samples of Work Performed in 2001

1. Plasma cleaning of sheet metal as a pre-treatment prior PVD coating
2. Superhard carbon films for the protection of computer hard disks
3. Deposition of Diamor® films in an industrial PVD coater with newly developed Laser-Arco® coating module
4. Diamor® coatings for high-speed dry processing of light metals and precision processing of nonferrous metals
5. Spectroscopic characterization with plasma AP-CVD coated surfaces
6. Plasma chemical coating at atmospheric pressure
7. Quantitative mechanical evaluation of photoresist films for sub-100 nm structuring in the semiconductor industry
8. Simulation of the arc coating process

Dr. Steffen Nowotny
Department Head
(Tel. 2583 241)

Dr. Steffen Nowotny
Team Leader Thermal Spraying
(Tel. 2583 241)

Surface Protection

For the coating of components made of steel, light weight metals or other materials with metals, hard coatings and ceramics, IWS has plasma and flame spray, plasma powder and laser beam cladding as well as laser alloying and dispurging processes. High power hybrid technologies and the combination of laser, plasma and induction processes are a productive tool to extend the application area of surface technologies.

On the basis of modern systems the offer includes:

- Design of stress tailored coating systems,
- Process development form the basics to the coating of sample parts,
- Development and manufacturing of system components and the support during system integration and support for the user.

Dr. Anja Techel
Team Leader Cladding
(Tel. 2583 255)

Repair and Generation

To repair components, forms and tools, and to manufacture prototypes, IWS has laser beam and plasma powder cladding, selective laser sintering and diverse laser plasma combination processes. Depending on the process, either defined porous or 100 % dense coatings and 3-D structures can be generated of ceramics or metal alloys. The closed process chain from the digitizing and data preparation to the final processing can be utilized for all technologies. For these application fields we offer:

- Fast and flexible component, digitizing and data preparation,
- Precise repair of components and tools even with complex geometries,
- Manufacturing of metallic and ceramic samples and prototypes based on client's CAD data,
- System components and support during the introduction to manufacturing.

Vacuum plasma spray system

Modular laser coating unit

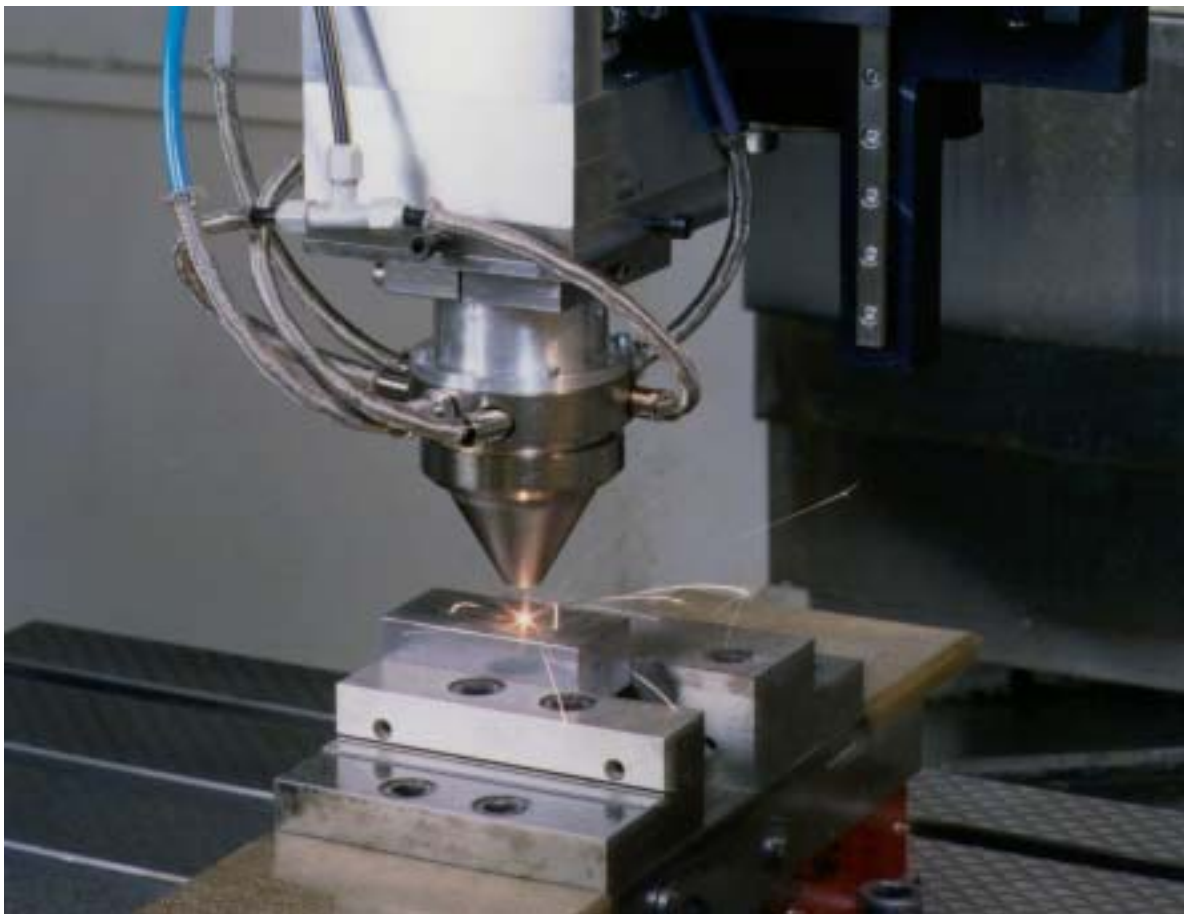
Samples of Work Performed in 2001

1. Preparation of ceramic coatings through laser based manufacturing processes

2. Laser-milling center for complete processing

3. Flexible manufacturing of large tools with close-to-series properties

4. Simulation of laser powder cladding



Cladding in the laser-milling center

Prof. Dr. Berndt Brenner
Department Head
(Tel. 2583 207)

Dr. Steffen Bonß
Team Leader Surface Treatment Technologies
(Tel. 2583 201)

Optimized Technologies for the Hardening of Steel Components through Laser and / or Induction

If conventional hardening technologies are not suitable because of certain geometric shapes, material and wear conditions, laser hardening can be ideal to produce wear-resistant parts with an increase in service life. This technology is especially suitable for the selective hardening of multi-dimension faces, inner or hard to reach surfaces, sharp edges steps, bores and grooves, as well as for low distortion hardening. With a strong foundation of long term experience in the broad fields of wear protection and hardening, we are able to offer:

- Development of surface hardening technologies with high powered diode lasers, CO_2 lasers, Nd:YAG lasers and / or induction,
- Prototype, process and system optimization.

Dr. Jens Standfuß
Team Leader Welding
(Tel. 2583 212)

Welding of Hard to Weld Materials

Laser welding is a modern welding process that is widely utilized in industry, especially in mass production. Such welding with a laser using a integrated heat treatment cycle developed at IWS offers a new process for the manufacturing of crack-free welded joints of hardenable steels, austenitic steels and special alloys. With our extensive experience in metal physics and a unique welding station with our integrated heat treatment process, we are able to offer:

- Development of welding technologies,
- Prototype welding,
- Process and system optimization,
- Preparation of welding instruction.

Hardening of a printing machine part with high power diode laser

Laser beam welding of a gear for automotive manual shifter, 16MNCr5 hardened

Dr. Bernd Winderlich
Team Leader Materials Testing and Characterization
(Tel. 2583 224)

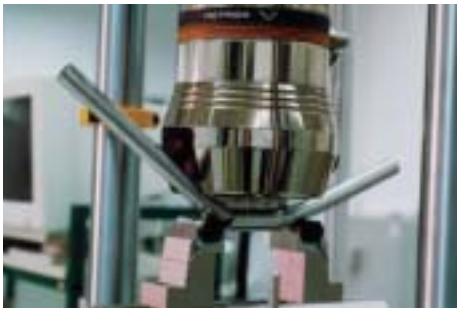
Complex Materials and Component Characterization

The control of modern joining and sheath processes requires knowledge from structural changes to the resulting component properties. Based on long term experience and extensive equipment in the area of structural, microanalytical and mechanical materials characterization we offer:

- Metallographic, electronmicroscopic (SEM, TEM) and microanalytical (EDX) characterization of the real structure of metals, ceramics and compound materials,
- Determination of material data for component dimensioning and quality assurance,
- Property evaluation of surface treated and welded components,
- Strategies for materials and stress adapted component design,
- Failure analysis.

Samples of Work Performed in 2001

1. Laser beam welding of aircraft fuselage structures
2. Crack-free laser beam welding of steel/cast iron joints
3. Innovative lightweight design through laser beam welding of magnesium alloys
4. Connection welding of overlapping galvanized sheet metal with minimized pore content
5. Improvement of the formability of laser-welded sheets made of fine-grain construction steels through localized tempering
6. High-speed rotation hardening with a high power diode laser
7. Improvement of the vibration stability of laser beam welded steel joints
8. Structure characterization of laser-gas nitrided titanium alloys
9. TEM investigations of the segregation behavior of martensitic steels
10. Quality control of thermal barrier coating through thermo-shock tests



Testing of car windshield wiper linkage made of aluminum

R&D-Offer: Laser Ablation and Cutting

Dr. Lothar Morgenthal
Department Head
(Tel. 2583 322)

Dr. Lothar Morgenthal
Team Leader Laser Cutting and System Engineering
(Tel. 2583 322)

Cutting Technology

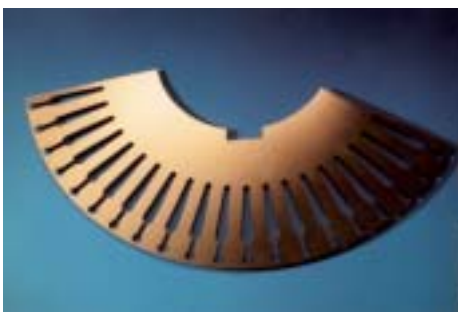
Metal-physical, process and manufacturing technological investigations of laser beam cutting can be carried out with lasers of different beam powers and wavelengths as well as on CNC tools. The treated parts can have dimensions of some millimeters up to meters. The main emphasis is the contour precise 2D high speed cutting of sheet metal on a highly dynamic cutting machine tool with linear drives. We use a flat part measurement & digitizing scanner system as well as materials characterization for the result control and quality assurance for part dimensions of up to 1800 mm · 1200 mm. We offer:

- Feasibility studies, sample production and R&D projects for all variations of laser beam cutting on materials and part samples,
- Technology and system development, testing and optimization,
- Development of system components for high speed processes, process control.

System Engineering and Laser Processing

IWS extended its specific offer for the development, testing, and production-ready realization of process adapted system solutions. Our departments offer:

- Processing optics, beam scanning systems, sensors for high speed and precision processing as well as process control,
- Handling systems, process control for industrial utilization of high power diode lasers for surface processing,
- Prototype development of coating equipment or their core modules for the PVD precision coating of bulk parts and the continuous atmospheric pressure band PVD including machine and process control software,
- Measurement systems to characterize coatings, non-destructive testing of parts with laser acoustic and spectroscopic methods.



Laser-cut electro sheet metal

Welding of the tube / base plate joint of an exhaust gas heat exchanger utilizing a beam scanning optics

Dr. Günter Wiedemann
Team Leader Ablation / Surface Cleaning
(Tel. 2583 251)

Ablation and Surface Cleaning

IWS has versatile technical equipment, scientific know-how and extensive practical experience in utilizing lasers for the ablation of thin layers or cleaning of surfaces in technical and restorative areas.

We offer:
- Consulting, feasibility studies,
- Technological investigations, including the generation of sample surfaces with excimer, Nd:YAG and TEA-CO_2 lasers,
- Application investigations,
- Structural analysis and testing (metallography, petrography, spectroscopy, SEM / EDX).

Dipl.-Ing. Udo Klotzbach
Team Leader Microstructuring / Engraving
(Tel. 2583 252)

Microstructuring with Lasers

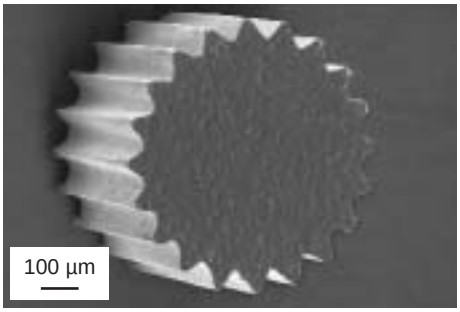
With state-of-the-art equipment and a solid know-how in the field, the work group follows the trend that laser micromachining gains importance with the miniaturization of functional elements in mechanical engineering, equipment manufacturing, and the automotive industry. In the same way the biotechnological and medial industries require the manufacturing of 3-D structures in the sub-mm range. The materials range from polymers, metals, and ceramics to quartz-like and biocompatible materials.

We offer:
- Microstructuring of different materials with excimer and Nd:YAG lasers for 3-D shaping and marking,
- Subsurface engraving of transparent materials,
- Microdrilling with high aspect ratios and a variety of bore geometries,
- Structural analysis and testing.

Samples of Work Performed in 2001

1. Laser application on the fly increases the dynamics and precision of robots
2. High-speed laser precision cut
3. Laser ablation and cleaning in the technical area
4. Microprocessing of silicon with frequency tripled diode-pumped Nd:YAG laser "GATOR UV"
5. Laser lexicon - from A to Z

Anti-slip preparation of polished flooring with laser microstructuring



Microstructuring of silicon with diode-pumped Nd:YAG-Laser

Masters Thesis

A. Bayerlein
(Technische Universität Dresden)
"Konzept und Beispiellegung zur Primärdatengewinnung für die Schneidteilgestaltung spanender Werkzeuge"

T. Böttger
(Technische Universität Dresden)
"Untersuchungen zur thermischen Stabilität durch Magnetron-Zerstäubung erzeugter Mo/Si-Multischichten"

K. Demmler
(Westsächsische Hochschule Zwickau (FH))
"Struktur und Eigenschaften von Ag/Si- und B_4C/Si-nm-Multischichten"

V. Fleischer
(Technische Universität Dresden)
"Bahnplaner für "fliegende" Laserbearbeitung"

R. Gaertner
(Technische Universität Dresden)
"Technologie- und Marktpotenzialabschätzung der Nanotechnologie in Deutschland"

M. Müller
(Hochschule Mittweida (FH))
"Entwicklung und Konstruktion eines integrierten Bearbeitungskopfes zum induktiv unterstützten Laserrandschichthärten"

D. Römer
(Berufsakademie Sachsen, Staatliche Studienakademie Dresden)
"Design und Implementierung einer Java-3D-Simulation für die Beschichtungsanlage"

K. Scholz
(Hochschule für Technik und Wirtschaft Dresden (FH))
"Overlap Welding of Zinc Coated Steel Sheet with Superposition of CO_2 and Diode Laser"

Dissertation

U. Virkus
(Technische Universität Dresden)
"Oberflächengestaltung durch die Verfahrensfolge Spanen/Glattwalzen unter stofflichen, geometrischen und kinematischen Aspekten"

Lecturing and Committees

Prof. E. Beyer:
Course "Manufacturing techniques II, Part 3" at the Institute for Production Technology at the University of Technology, Dresden

Prof. E. Beyer:
Lecture "Laser System Technology - Basics and Applications" as an elective technical subject in a compulsory program at the Institute for Production Technology at the University of Technology, Dresden

Prof. E. Beyer, Dr. B. Schultrich, Dr. S. Nowotny:
Course "Coating Technologies" as an elective technical subject in a compulsory program at the Institute for Production Technology at the University of Technology, Dresden

Prof. E. Beyer, Dr. A. Leson:
Course "Surface Engineering / Nanotechnology" as an elective technical subject in a compulsory program at the Institute for Production Technology at the University of Technology, Dresden

Prof. E. Beyer:
Course "Laser technology" at Bradley University, USA

Prof. E. Beyer:
Scientific Company for Laser Technology (WLT)

Prof. E. Beyer:
Laser Institute of America (LIA), Board of Directors

Prof. E. Beyer:
Member of the Materials Research Association, Dresden

Prof. E. Beyer:
Member of the Federal Association of Medium-sized Industries e.V.

Prof. B. Brenner, Dr. G. Wiedemann:
Lecture series and practical training "Lasers in Material Processing", in the supplementary course “Laser Technology” at the Technical College, Berlin

Prof. B. Brenner:
Technical committee 9 of the AWT

Prof. B. Brenner:
Member of the advisory board of AiF

Dr. R. Jäckel:
Workgroup "Research Institutions Outside of Universities" for the project "Demand Oriented Start-Up Establishments from Universities as in the Example of the High-Tech Region Dresden (Dresden exists)"

Dr. R. Jäckel:
Working committee "Fairs and Public Relations" of the Materials Research Association, Dresden

Dr. G. Kirchhoff:
Working committee "Sound Emission Analysis" of the DGzfP

A. Kluge:
Speaker for the computer operators of the Fraunhofer Society

Dr. A. Leson:
Member of the Board of the German Physical Society

Dr. A. Leson:
Speaker for the Nanotechnology Center of Competence "Ultrathin Functional Films"

Dr. A. Leson:
Committee Member of the Magazine "Vacuum and Research in Practice"

Dr. A. Leson:
Chairman of the VDI-working circle "Study programs in nanotechnology"

Dr. A. Leson:
Member of the steering commitee in the VDI-competence area nanotechnology

Dr. S. Nowotny:
Lecture "Laser Materials Processing" in the department of Mechanical Engineering / Manufacturing Technology at the University for Technology and Business, Dresden

Dr. S. Nowotny:
DVS Working committee V9.2 / AA 15.2 "Laser Beam Welding and Related Techniques"

Dr. B. Schultrich, Dr. H.-J. Scheibe, Dr. A. Leson:
Working committee Plasma Surface Technology of the DGO

Dr. B. Schultrich:
Member of the Board of Directors of the European Research Society "Thin Films" e.V.

Dr. A. Techel, Dr. S. Nowotny:
VDI Working committee "Rapid Prototyping" in the VDI district society, Dresden

Dr. B. Winderlich:
Work group "Stability and Construction" of the DVS-BV Dresden

Participation in Fairs and Exhibitions

Hannover Industrial Fair, April 23rd - 28th , 2001

Following tradition, IWS exhibited the latest applied research results in the area of laser and surface technology in the joint 70 m^2 booth "Laser Technology" in hall 7. For the first time, partnering companies participated in the IWS exhibition. Results of joint research projects were presented together with Arnold GmbH&Co. Ravensburg, EFD Induction GmbH Freiburg, ALOtec GmbH Dresden, and Prometec GmbH Aachen.

The main emphasis was put on intelligent systems for the application of lasers under the trademark "lasertronic®". At one station a robot guided a high performance laser scanning system, which is now used in series production of exhaust coolers for diesel engines at the company Behr GmbH & Co. Stuttgart. The second station demonstrated a robot-guided modular coating head, which integrates powder feeder, diode laser fiber coupling, and beam focusing. The system can be easily integrated into various machine tools.

First applications of nanotechnology for daily life were introduced in the nano-house during the "Nanoworld 2001" (hall 18). The IWS-coordinated Nanotechnology Center of Competence "Ultrathin Functional Films" presented applications and products of nanotechnology, which have been provided by the members (especially from IFW Dresden and IBM Mainz) of the center.

The approximately 210 relevant leads supported the decision to extend the IWS exhibition at the Hannover fair 2001.

StoneTec 2001 Nuremburg, May 24th - 27th, 2001

At the 12th international trade fair for natural stone and natural stone processing, IWS presented as a world novelty a mobile system for the anti-slip preparation of already installed polished floors. The system based on laser micro structuring received great response from the visiting audience. The exhibition also included activities in the area of laser surface cleaning, restoration, and monument maintenance.

Laser Fair 2001 Munich, June 18th - 22nd, 2001

The IWS coordinated the joint 240 m^2 booth to exhibit together with 6 other Fraunhofer institutes. Among the exhibitions were the latest developments in the area of laser systems technology, such as the high-performance beam scanning optics lasertronic® SAO, the temperature control systems for laser beam hardening lasertronic® LompocPro, and the modular coating units lasertronic® LPA.

The IWS also participated in the booth of Lambda Physik AG Goettingen with a presentation of a micro structuring system with frequency tripled, diode-pumped Nd:YAG-laser.

Lively discussion about laser system technology at the joint booth "laser technology", hall 7 (Hannover fair 2001)

Presentation of laser beam welding at the joint booth "laser technology", hall 7 (Hannover fair 2001)

Fair Materialica 2001 Munich, October 1st - 4th, 2001

Emerged from the Materials Week Show, this year's Materialica 2001 presented itself jointly with the Materials Week Symposium in the Munich fair grounds. The IWS was represented through the Nanotechnology Center of Competence "Ultrathin Functional Films". The center exhibited together with two other nanotechnology competence centers the first results of applied nanotechnology. The members of the centers provided the exhibited objects.

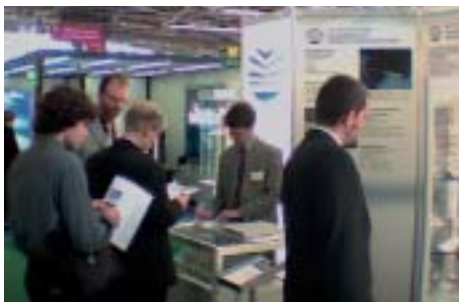
57th Hardening Colloquium Wiesbaden, October 10th - 12th, 2001

The IWS cooperates very closely with the company EFD Induction GmbH in Freiburg. Both partners exhibited at a joint booth. A video presentation showed the laser beam hardening with high power diode lasers for a variety of parts.

Euromold Fair 2001 Frankfurt / M., November 28th - December 1st, 2001

The IWS participated for the 6th time in a joint Fraunhofer booth at this show covering molds, model, and tool making as well as foundry technology. Results of the project "Melato" were presented for the first time. This project aims to develop a new process chain for the fast manufacturing of complex shaped tools with edge dimensions of up to 1.5 m. The exhibited stamping tools have been manufactured with the LOM technology (laminated object manufacturing).

Besides LOM, the 3D laser build-up welding technology was presented, which can be applied to repair tools and to coat tools for wear protection. Many new contacts with users have been established.



Lively discussion about nanotechnology at the fair "Materialica 2001" in Munich

Visitors in the "Nano-house" at the joint both "Nanoworld 2001", hall 18 (Hannover fair 2001)

The "Open House" generated lots of interest and lively discussion among the attendees

Prof. Kottmann (left) and Prof. Beyer during the signing of the cooperation contract

A magnet for visitors during the Tschirnhaus exhibition: the computer simulation of the focusing lens apparatus and the focusing mirror from the IWS

Special Events

January 24th - 25th 2001
International technology audit at the Fraunhofer IWS, Dresden

February 21st 2001
Meeting of the IWS Advisory Committee

April 11th - July 29th 2001
Exhibition in honor to the 350iest birthday of Ehrenfried Walther von Tschirnhaus; The IWS substantially contributed with numerous presentations to the great success of the exhibition in the Dresdener Zwinger

October 4th 2001
"R&D 100 Award" ceremony for development and market introduction of the laser-acoustic testing system LAwave®

October 10th 2001
Signing of a cooperation contract between the Fachhochschule Dortmund and the Fraunhofer IWS Dresden

October 27th 2001
Open house at the Fraunhofer Institutes Center Dresden

December 6th 2001
2nd symposium "surface technology" at the Dortmund Surface Center of the ThyssenKrupp Stahl AG

IWS 2001 Prizes

1. The best innovative product idea for the opening of a new business area

   Mrs. Annett Klotzbach
   "High precision laser tool makes robots more dynamic and flexible"

2. The best scientific-technical achievement

   Mr. Danny Weißbach
   "Precision coating of curved substrates through Large Area PLD"

3. The best scientific achievement of a junior scientist

   Mr. Veiko Fleischer
   "Development of a path planning system for the super-positioning of scanner and robot motions during laser processing on-the-fly"

   Mr. Gunther Göbel
   "Contribution for the computer assisted optimization of the irradiation parameters during laser beam hardening"

   Mr. Harald Schulz, Mr. Michael Leonhardt
   "Generation of hydrophobic (water rejecting) surfaces through the combination of a surface structure effect with a surface energy effect"

4. Special prizes

   Mr. Jan Hauptmann
   in recognition for his special efforts during the marketing of an IWS patent

   Dr. Bernd Schultrich
   in recognition for his special efforts in the area of training and education

Patent Applications

[P1] B. Brenner, V. Fux

"Verfahren zur Erzeugung von verschleißbeständigen Randschichten"

Anmelde-Az.: P 10 137 776.2 - 45

[P2] R. Dietsch, T. Holz

"Anordnung für röntgenanalytische Anwendungen"

Anmelde-Az.: P 10 107 914.1 - 33

[P3] T. Holz

"Röntgenoptische Anordnung"

Anmelde-Az.: PCT / DE 01 / 02 043

[P4] A. Lenk, M. Panzner, R. Frenzel, U. Lappan, K. Lunkwitz, D. Scharnweber, S. Schmidt, F. Simon, M. Thieme, H. Worch

"Ultrahydrophobe Oberflächen, Verfahren zu deren Herstellung sowie Verwendung"

Anmelde-Az.: PCT / DE 01 / 02 167

[P5] C.-F. Meyer, H.-J. Scheibe, B. Schultrich, H. Ziegele

"Method and Device for Coating Substrates in a Vacuum"

Anmelde-Az.: US 09 / 763, 650

[P6] C.-F. Meyer, H.-J. Scheibe

"Device and Method for Coating Substrates in a Vacuum"

Anmelde-Az.: US 09 / 763, 636

[P7] L. Morgenthal, D. Pollack, D. Kretzschmar, T. Schwarz, S. Thalheim

"Messanordnung zur simultanen Bestimmung der Tiefe von in Substratoberflächen mittels Energiestrahlung ausgebildeten Bohrungen oder nutenförmigen Einschnitten"

Anmelde-Az.: P 10 142 206.7

[P8] L. Morgenthal, D. Pollack, D. Weißbach, R. Gnann, A. Van Spankeren

"Laseroptisches Element zur Formung eines Laserstrahls"

Anmelde-Az.: P 10 129 982.6 - 51

[P9] B. Schuhmacher, B. Schultrich, O. Zimmer, P. Siemroth, S. Schenk, C. Schwerdt, J. Stahl, D. Wolfhard, G. Grundmeier, M. Kammer, U. Seifert, R. Brisberger, E. Bechem, M. Kretzschmer

"Korrosionsgeschütztes Stahlblech und Verfahren zu seiner Herstellung"

Anmelde-Az.: PCT / DE 01 / 02 886

[P10] H.-J. Weiß

"Verfahren zur Herstellung von hydrophoben bis hydrophilen Oberflächen"

Anmelde-Az.: P 10 124 076.7

Issued Patents

[P11] E. Beyer, S. Nowotny

"Method for Applying a Coating by Means of Plasma Spraying While Simultaneously Applying a Continuous Laser Beam"

Veröffentlichungs-Nr.: US 6 197 386 B1

[P12] B. Brenner, S. Bonß, H.-J. Scheibe, H. Ziegele

"Wear Resistance Edge Layer Structure for Titanium or its Alloys Which Can be Subjected to a High Mechanical Load and has a Low Coefficient of Friction, and Method of Producing the Same"

Veröffentlichungs-Nr.: US 6 231 956 B1

[P13] B. Brenner, F. Tietz

"Verfahren zur Erzeugung verschleißbeständiger Randschichten aus ausscheidungshärtbaren Werkstoffen"

Veröffentlichungs-Nr.: DE 10 030 433

[P14] B. Brenner, A. Wetzig, D. Naunapper, C. Duschek

"Verschleißbeständige Nockenwelle und Verfahren zu ihrer Herstellung"

Veröffentlichungs-Nr.: EP 925 377 B1

[P15] V. Hopfe, G. Leonhardt, A. Techel

"Vorrichtung zum kontinuierlichen gleichmäßigen Überziehen von Endlosfaserbündeln und Verwendung dieser Vorrichtung zum kontinuierlichen, gleichmäßigen Überziehen von Endlosfaserbündeln"

Veröffentlichungs-Nr.: DE 4 018 940 C2

[P16] L. Morgenthal, D. Pollack, A. Mertz

"Process for Controlling the Laser Beam Intensity Repartition for Processing Element Surfaces"

Veröffentlichungs-Nr.: EP 698 800 B1, AT 173 968 E

[P17] T. Schülke, B. Schultrich, P. Siemroth, N. Urbanky, C. Wenzel, W. Klimes

"Process for the Production of Metallic Coatings on Semiconductor Structures"

Veröffentlichungs-Nr.: EP 909 341 B1, US 6 274 492 B1

[P18] P. Siemroth, B. Schultrich, H. Kleinert, S. Großer

"Verfahren und Vorrichtung zur Modifizierung von metallischen Werkstückoberflächen durch elektrische Entladungen"

Veröffentlichungs-Nr.: DE 19 637 513 C2

[P19] T. Sievers, U. Stürmer, G. Wiedemann

"Process for Producing Non-slip Floor Covering"

Veröffentlichungs-Nr.: US 6 167 879 B1

[L01] E. Beyer

"Survey of Laser Hybrid Processes"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe (2001), S. 404 - 415

[L02] E. Beyer, L. Morgenthal, B. Brenner

"Laser Hybrid Processes and Laser Remote Welding in Automotive Industry"

Global Automotive Laser Applications Conference, Erice, Sizilien, Italien (2001), (in Druck)

[L03] S. Bonß

"Neue Fertigungskonzepte durch Hochleistungsdiodenlaser"

Stahl (2001), Heft 3, S. 28 - 30

[L04] S. Bonß, B. Brenner, E. Beyer

"Innovations in Laser Hybrid Technology"

Industrial Laser Solutions for Manufacturing Bd. 16 (2001), Heft 1, S. 29 - 32

[L05] S. Bonß, B. Brenner, E. Beyer

"Laser Gas Alloying of Titanium - New Possibilities for Severe Wear Loaded Components in Medicine"

Materialswissenschaft und Werkstofftechnik Bd. 32 (2001), Heft 2, S. 160 - 165

[L06] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"Temperaturgeregeltes Randschichthärten mit Hochleistungsdiodenlasern"

Tagungsband zur 4. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik" (OWT 01) und zum 4. Werkstofftechnischen Kolloquium (WTK) - Schriftenreihe Werkstoffe und werkstofftechnische Anwendungen Bd. 7 (2001), S. 309 - 314

[L07] S. Bonß, M. Seifert, K. Barthel, B. Brenner, E. Beyer

"New Developments in High Power Diode Laser Welding"

20th International Congress on Applications of Laser and Electro Optics - ICALEO 2001, CD-proceedings

[L08] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"High Precision Heat Treatment with High Power Diode Lasers"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe (2001) S. 529 - 539

[L09] S. Braun, R. Dietsch, M. Haidl, T. Holz, H. Mai, S. Müllender, R. Scholz

"Mo/Si-Multilayers for EUV Applications Prepared by Pulsed Laser Deposition (PLD)"

Microelectronic Engineering Bd. 57 - 58 (2001), S. 9 - 15

[L10] B. Brenner, S. Bonß, M. Seifert, U. Stamm

"Neuere Entwicklungen zum Strahlschweißen mit Hochleistungsdiodenlasern"

5. Konferenz "Strahltechnik" (2001), S. 117 - 125

[L11] B. Brenner, J. Standfuß, B. Winderlich

"Induktiv unterstütztes Laserstrahlschweißen zum rissfreien Fügen von härtbaren Stählen"

Schweißen und Schneiden 2001 - Große Schweißtechnische Tagung DVS-Bericht Bd. 216 (2001), S. 289 - 297

[L12] S. Carvalho, F. Vaz, L. Rebouta, D. Schneider, A. Cavaleiro, E. Alves

"Elastic Properties of (Ti, Al, Si) N Nanocomposite Films"

Surface and Coatings Technology Bd. 142-144 (2001) Heft 1 - 3, S. 110 - 116

[L13] R. Dietsch, T. Holz, A. Leson, H. Mai, D. Bahr, L. Brügemann, J. Lange, A. Hofmann, F. Pink

"Nanometer-Multischichten für die Röntgenanalytik"

Vakuum in Forschung und Praxis Bd. 13 (2001), Heft 4, S. 222 - 231

[L14] R. Dietsch, T. Holz, D. Weißbach, V. Melov, J. Schreiber, R. Scholz

"Evolution of Stress and Microstructure in Ni/C Multilayers Used as X-Ray Optics in a Wide Energy Range"

X-Ray Mirrors, Crystals and Multilayers Proc. of the SPIE Bd. 4501 (2001), (in Druck)

[L15] W. Grählert, V. Hopfe

"Gesicherte Interpretationen der FTIR-Reflexionsspektren von SiC-CVD-Schichten durch Spektrensimulation"

Zeitschrift für Metallkunde Bd. 92 (2001), Heft 10, S. 1175 - 1179

[L16] J. Hackius, B. Brenner, B. Winderlich, J. Standfuß, E. Beyer, S. Nägeler

"Laserhybridschweißen von Aluminiumlegierungen"

LaserOpto Bd. 33 (2001), Heft 2, S. 49 - 55

[L17] J. Hauptmann, G. Wiedemann

"Lasermikrostrukturierung sorgt für rutschfeste Fußbodenbeläge"

Maschinenmarkt Bd. 107 (2001), Heft 23, S. 38 - 43

[L18] K. Hasche, K. Herrmann, M. Krumrey, G. Ulm, S. Schädlich, W. Frank, M. Procop

"Calibrated Reference Standards for Films in the Nanometer Range"

2nd International Conference EUSPEN (2001), S. 396 - 399

[L19] E. Hensel, S. Bonß, M. Seifert

"Hochleistungs-Diodenlaser zum Härten selektiver Oberflächen"

Maschinenmarkt Bd. 107 (2001), Heft 16, S. 74 - 76

[L20] T. Himmer

"Werkzeugfertigung durch Blechpaketieren - Möglichkeiten und Grenzen heute"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L21] V. Hopfe, D. W. Sheel, W. Grählert, O. Throl

"NIR Laser Diode and FTIR Bases Process Control for Industrial CVD Reactors"

Surface and Coatings Technology Bd. 142-144 (2001), Heft 1 - 3, S. 328 - 332

[L22] V. Hopfe, D. W. Sheel, D. Raisbeck, J. M. Rivero, W. Grählert, O. Throl, A. M. B. van Mol, C. I. M. A. Spee

"NIR Diode Laser Based Process Control for Industrial CVD Reactors"

13th European Conference on Chemical Vapor Deposition - EUROCVD 13 (2001), S. Pr3-1153 - Pr3-1159

[L23] R. Jäckel

"lasertronic® - Intelligente Systeme unter Nutzung des Lasers"

wt Werkstattstechnik Bd. 91 (2001), Heft 6, S. 373

[L24] J. Kaspar, A. Luft

"Microstructure Formed in Body Centred Cubic Metals by Laser Shock Processing"

Surface Engineering Bd. 17 (2001), Heft 5, (in Druck)

[L25] A. Klotzbach

"High-Precision Laser Tool Makes Robots More Dynamic and Flexible"

Euro-Materials Bd. 8 (2001), Heft 3, S. 12 - 13

[L26] A. Klotzbach, L. Morgenthal, T. Schwarz, E. Beyer

"Laser Processing on the Fly with Systems of Coupled Axes"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe (2001), (in Druck)

[L27] A. Klotzbach, L. Morgenthal, T. Schwarz, V. Fleischer, E. Beyer

"Laser Welding on the Fly with Coupled-Axes Systems"

The Industrial Laser User (2001) Heft 25, S. 32 - 34

[L28] A. Klotzbach, L. Morgenthal, T. Schwarz, V. Fleischer, E. Beyer

"Laser Welding on the Fly with Coupled Axes Systems"

20th International Congress on Applications of Laser and Electro Optics - ICALEO 2001 (in Druck)

[L29] J. Krauser, V. Hoffmann, W. Harneit, M. Waiblinger, N. Stolterfoht, A. Weidinger, C. Trautmann, H. Hofsäss, C. Ronning, B. Schultrich, H. Sturm

"Graphitic Nanowires Embedded in Diamond-Like Carbon Films"

Euroconference on Electronic Properties of Novel Materials, Molecular Nanostructures (2001) (in Druck)

[L30] J. Krauser, A. Weidinger, M. Waiblinger, V. Hoffmann, C. Trautmann, B. Schultrich, H. Höfsäss, C. Ronning

"Conduction Ion Tracks in Diamond-Like Carbon Films"

6th Applied Diamond Conference / 2nd Frontier Carbon Technology Joint Conference (2001), (in Druck)

[L31] A. Krell, S. Schädlich

"Nanoindentation Hardness of Submicrometer Alumina Ceramics"

Materials Science and Engineering A Bd. A307 (2001), Heft 1 - 2, S. 172 - 181

[L32] H.-G. Kusch, T. Heinze, G. Wiedemann

"Hazardous Emissions and Health Risk During Laser Cleaning of Natural Stones"

Tagungsband Lasers in the Conservation of Artwork - LACONA IV (2001), S. 61 - 64

[L33] D. Lepski, H. Eichler, V. Fux, S. Scharek, E. Beyer

"Calculating Temperature Field and Single Track Bead Shape in Laser Cladding with Marangoni Flow Using Rosenthal's Solution"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe (2001), S. 167 - 177

[L34] A. Leson

"Nanometer-Schichtsysteme für Röntgenoptiken"

Zweites Fachforum - Nanotechnologie: Die Schlüsseltechnologie des 21. Jahrhunderts in der industriellen Anwendung (2001), Tagungsband zur Fachkonferenz, S. 7 - 18

[L35] A. Leson, S. Braun, R. Dietsch, T. Holz, M. Mai

"Nanometer Multilayer Coatings for Application in the X-Ray Range"

Proceedings of the 2nd International Conference "The Coatings in Manufacturing Engineering"(2001)

[L36] A. A. Levin, D. C. Meyer, A. Gorbunov, A. Tselev, P. Gawlitza, H. Mai, W. Pompe, P. Paufler

"Comparative Study of Interfaces of Fe-Al Multilayers Prepared by Direct and Crossed-Beam Pulsed Laser Deposition"

Thin Solid Films Bd. 391 (2001), Heft 1, S. 47 - 56

[L37] A. A. Levin, D. C. Meyer, P. Paufler, A. Gorbunov, A. Tselev, P. Gawlitza

"Thermally Stimulated Solid State Reactions in Fe-Al Multilayers Prepared by Pulsed Laser Deposition"

Journal of Alloys and Compounds Bd. 320 (2001), Heft 1, S. 114 - 125

[L38] H. Mai, R. Dietsch, T. Holz

"Ultrapräzise nm-Schichtstapel als Grundlagen moderner Röntgentechnologien"

Galvanotechnik Band 92 (2001) Heft 9, S. 2490 - 2503

[L39] L. Morgenthal

"Laserschneiden und Verbinden von Blechen"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L40] S. Nägeler, S. Bonß, K. Barthel, B. Brenner, E. Beyer

"New Developments in High Power Diode Laser Welding"

9th Annual Automotive Laser Applications Workshop - ALAW 2001 (2001), S. 278 - 302

[L41] M. Neuhäuser, H. Hilgers, T. Witke, P. Siemroth

"Superharter Kohlenstoff abgeschieden mit gepulstem Hochstrombogen als Nanoschutzschicht für Magnetspeicherplatten"

Vakuum in Forschung und Praxis , Bd. 13 (2001), Heft 4, S. 215 - 220

[L42] S. Nowotny

"Nachbearbeitung von Blechpaketen - Verbesserung der Oberflächenqualität und Standzeit von Werkzeugen"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L43] S. Nowotny

"Generieren metallischer Prototypen und Beschichten von Freiformflächen durch 3D-Präzisionsauftragschweißen mit Leistungslasern"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L44] S. Nowotny

"Industrielle Anwendung der Prozesskette zum LPA"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L45] S. Nowotny, T. Heptner, B. Hommel

"Generieren metallischer Prototypen und Beschichten von Freiformflächen durch 3D-Präzisionsauftragschweißen mit Leistungslasern"

Informationsbroschüre zum Abschluß des BMBF-Verbundprojekts PROLAS (2001), ISBN 3-8167-6046-5

[L46] S. Nowotny, S. Scharek, T. Naumann, R. Gnann, T. Heptner, E. Beyer

"Integrated Laser Milling Center for Complete Machining"

20th International Congress on Applications of Laser and Electron Optics - ICALEO 2001 Bd. 90a (2001), (in Druck)

[L47] S. Nowotny, S. Scharek, R. Zieris, T. Naumann, E. Beyer

"Hybridtechnologie und Präzisionstechnik zum Laserstrahl-Auftragsschweißen"

LaserOpto Bd. 33 (2001), Heft 1, S. 57 - 60

[L48] C. Oldenbourg, B. Schick, T. Heinze

"Laser Cleaning Tests on Medieval Wall-Painting in Irland"

Tagungsband Lasers in the Conservation of Artwork - LACONA IV (2001), S. 315 - 318

[L49] H. Ollendorf, T. Schülke, D. Schneider

"Testing the Adhesion of Hard Coatings Including the Non-destructive Technique of Surface Acoustic Waves"

Adhesion Measurement of Films & Coatings Bd. 2 (2001), S. 49 - 77

[L50] J. H. Ouyang, S. Nowotny, A. Richter, E. Beyer

"Characterization of Laser Clad Partially-Stabilized ZrO_2 Ceramic Coatings on Steel 16MnCr5"

Surface and Coatings Technology Bd. 137 (2001), Heft 1, S. 12 - 20

[L51] J. H. Ouyang, S. Nowotny, A. Richter, E. Beyer

"Laser Cladding of Yttria Partially Stabilized ZrO_2 (YPSZ) Ceramic Coatings on Aluminum Alloys"

Ceramic International Bd. 27 (2001), Heft 1, S. 15 - 24

[L52] D. Schneider, B. Schultrich, P. Siemroth, M. Leonhardt, A. Franke

"Characterization of Coatings and Machined Surfaces by Surface Acoustic Waves"

2nd International Conference "Coatings in Manufacturing Engineering" (2001), S. C4-1 - C4-10

[L53] D. Schneider

"Lasers Set to Stun with Advanced Surface Analysis"

Materials World Bd. 9 (2001), Heft 4, S. 11 - 12

[L54] D. Schneider, B. Schultrich, T. Schwarz

"Laser-Acoustics, a Method for Testing Coatings and Material Surfaces"

Zeitschrift für Metallkunde Bd. 92 (2001), Heft 9, S. 1046 - 1051

[L55] B. Schultrich

"Schichthaftung und nm-Grenzflächenengineering"

Vakuum in Forschung und Praxis Bd. 13 (2001), Heft 1, S. 58 - 60

[L56] B. Schultrich

"Superharte Schutzschichten durch nm-Schichtdesign"

Zweites Fachforum - Nanotechnologie: Die Schlüsseltechnologie des 21. Jahrhunderts in der industriellen Anwendung (2001), Tagungsband zur Fachkonferenz, S. 39 - 40

[L57] B. Schultrich

"Licht als Werkzeug - Vom Brennspiegel zum Solarofen und Leistungslaser"

Ehrenfried Walther von Tschirnhaus (1651-1708) - Experimente mit dem Sonnenfeuer (2001), S. 108 - 113

[L58] B. Schultrich

"Aktivierte Beschichtung von Kunststoffen: Vorteile und Probleme"

8. Neues Dresdner Vakuumtechnisches Kolloquium (2000), S. 47 - 54

[L59] B. Schultrich, H.-J. Scheibe, V. Hopfe

"Lasergestützte physikalische und chemische Dampfphasenabscheidung dünner Schichten"

LaserOpto Bd. 33 (2001), Heft 2, S. 42 - 48

[L60] B. Schultrich, C. P. G. Schrauwen

"Dekorative PVD-Beschichtung von Kunststoffen - aktuelle Entwicklungstrends und Perspektiven"

Jahrbuch Oberflächentechnik Bd. 57 (2001), S. 167 - 180

[L61] H. Schultrich, B. Schultrich

"TEM-Simulation of Amorphous Carbon Films: Influence of Supercell Packaging"

Ultramicroscopy Bd. 88 (2001), Heft 2, S. 111 - 125

[L62] M. Seifert, S. Bonß, B. Brenner, E. Beyer

"Improved Temperature Control for High Precision Heat Treatment with High Power Diode Lasers"

20th International Congress on Applications of Laser and Electron Optics - ICALEO 2001 (in Druck)

[L63] P. Siemroth, T. Schülke

"Copper Metallization in Microelectronics Using Filtered Vacuum Arc Deposition - Principles and Technological Development"

Surface and Coatings Technology Bd. 133 - 134 (2000), Heft 1 - 3, S. 106 - 113

[L64] G. Sobott, T. Heinze, K. Neumeister, J. Hildenhagen

"Laser Interaction with Polychromy - Laboratory Investigations and On-Site Observations"

Tagungsband Lasers in the Conservations of Artwork - LACONA IV (2001) , S. 151 - 154

[L65] A. Techel

"Werkstoffe und Strategien für das 3D-Laser-Präzisions-Auftragschweißen"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen"(2001)

[L66] A. Techel

"Schnelle Werkzeugfertigung durch automatisiertes Metall-LOM und Folgeprozesse"

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L67] A. Techel

“Anwendungspotential der neuen Rapid Tooling Prozesskette”

Tagungsband Workshop "Rapid Tooling: Fakten - Trends - Visionen" (2001)

[L68] A. Techel, S. Nowotny

“Harte Schichten für leichte Metalle - Laserstrahl-Beschichten und Reparieren von Bauteilen aus Leichtmetall”

Laser-Praxis (2001), Heft 1, S. 47 - 48

[L69] A. Techel, S. Nowotny

“Reparieren und Generieren mit Leistungslasern”

Galvanotechnik Bd. 92 (2001), Heft 5, S. 1248 - 1251

[L70] S. Thiel, S. Lehnicke, O. Zimmer, S. Piltz

“Abformung von Mikrostrukturen in Glas”

VDI-Z Bd. 142 (2000), Heft 7, S. 26 - 30

[L71] V. Vergès-Belmin, G. Wiedemann, L. Weber, M. Cooper, D. Crump, R. Gouerne

“A Review of Health Hazards Linked to the Use of Lasers as Cleaning Tools for Stone Building Components and Artefacts”

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[L72] G. Wiedemann, L. Goretzki, U. Bauer-Bornemann, K. Dickmann, K. Neumeister, H. Seidel, R. Sobott

“Laser Cleaning of Unpainted and Painted Natural Stones: Overview of the Results of a National German Project”

Tagungsband Lasers in the Conservations of Artwork - LACONA IV (2001), S. 311 - 314

[L73] G. Wiedemann, P. Haller, A. Wagenführ, E. Beyer

“Umweltgerechte Holzschutzmaßnahmen für den Außenbereich - Stand der Forschung zur Laserbearbeitung von Holzoberflächen”

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[L74] G. Wiedemann, P. Haller, A. Wagenführ, H. Wust, E. Beyer

“Umweltgerechte Holzschutzmaßnahmen für den Außenbereich - Stand der Forschung zur Laserbearbeitung von Holzoberflächen”

Weltmesse für Holz - LIGNA 2001 (2001), (in Druck)

[L75] G. Wiedemann, J. Hauptmann, T. Heinze, A. Kempe, H.-G. Kusch, M. Panzner, H. Wust

“Laserabtragen dünner Deckschichten - eine alternative Reinigungsmethode für die Restaurierung und Denkmalpflege - Möglichkeiten und Grenzen”

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[L76] B. Winderlich, B. Brenner, J. Standfuß, V. Fux, E. Beyer

“Steigerung der Schwingfestigkeit von Schweißverbindungen durch induktiv unterstütztes Laserstrahlschweißen”

DVM-Bericht Nr. 128, S. 295 - 305

[L77] R. Zieris, T. Naumann, S. Nowotny, G. Eckart, U. Füssel, E. Beyer

“Neuheiten beim Laser-Plasma-Hybridspritzen”

9. Workshop Plasmaspritzen (2001), S. 50 - 56

[L78] R. Zieris, S. Nowotny, E. Beyer

“Erzeugen dichter und flächenhafter Beschichtungen mittels Laser-Plasma-Hybridtechnik”

Tagungsband zur 4. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik"(OWT 01) und zum 4. Werkstofftechnischen Kolloquium (WTK) - Schriftenreihe Werkstoffe und werkstofftechnische Anwendungen Bd. 7 (2001), S. 13 - 17

[L79] O. Zimmer, J. Vetter, N. Rackwitz, P. Siemroth

“Calculation and Measurement of the Time Dependent Erosion Rate of Electromagnetic Steered Rectangular Arc Cathodes”

Proceedings of the 28th International Conference on Metallurgical Coatings and Thin Films (Surface and Coatings Technology) Band 146-147 (2001) Heft 1-3, S. 195 - 200

[T01] E. Beyer

"Survey of Laser Hybrid Processes"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe, München, 18. - 22. Juni 2001

[T02] E. Beyer

"Remote Welding Systems"

9th Annual Automotive Laser Applications Workshop - ALAW 2001, Dearborn, USA, 14. März 2001

[T03] E. Beyer

"Lasertechnik für die Produktion"

Lehrveranstaltung "Produktion im 21. Jahrhundert", Dresden, 18. Juni 2001

[T04] E. Beyer

"Laser Hybrid Processes and Laser Remote Welding in Automotive Industry"

Global Automotive Laser Applications Conference, Erice, Sizilien, Italien, 03. August 2001

[T05] E. Beyer

"Research in Laser Material Processing and Surface Technology"

Technology Colloquium "New Lasers - New Partners - New Applications", Stuttgart, 30. Oktober 2001

[T06] E. Beyer

"Laserhybridverfahren in der Oberflächentechnik"

DOC-Symposium 2001, Dortmund, 06. Dezember 2001

[T07] E. Beyer, P. Haller, A. Wagenführ, G. Wiedemann

"Umweltgerechte Holzschutzmaßnahme für den Außenbereich - Stand der Forschung zur Laserbearbeitung von Holzoberflächen"

Intern. Symposium Holz Innovativ, Rosenheim, 08. März 2001

[T08] E. Beyer, P. Haller, A. Wagenführ, G. Wiedemann, H. Wust

"Umweltgerechte Holzschutzmaßnahme für den Außenbereich - Stand der Forschung zur Laserbearbeitung von Holzoberflächen"

LIGNA 2001 - Vortragsreihe: Zukunftsweisende Aspekte im Ingenieurholzbau, Hannover, 23. Mai 2001

[T09] S. Bonß, M. Seifert, K. Barthel, B. Brenner, E. Beyer

"New Developments in High Power Diode Laser Welding"

20th International Congress on Applications of Lasers and Electro-Optics - ICALEO 2001, Jacksonville, Florida, USA, 15. - 18. Oktober 2001

[T10] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"Temperaturgeregeltes Randschichthärten mit Hochleistungsdiodenlasern"

4. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik" (OWT 01) und 4. Werkstofftechnisches Kolloquium (WTK), Chemnitz, 20. - 21. September 2001

[T11] S. Braun, H. Mai, M. Moss, R. Scholz, A. Leson

"Mo/Si-Multilayers with Different Barrier Layers for Applications as EUV Mirrors"

Microprocesses and Nanotechnology Conference, Matsue, Japan, 31. Oktober - 02. November 2001

[T12] S. Braun, H. Mai, M. Moss, R. Scholz, A. Leson

"Morphology of Mo/Si Multilayers with B_4C and C Barrier Layers"

EUV Lithographie Workshop, Matsue, Japan, 29. - 31. Oktober 2001

[T13] B. Brenner

"Industrial Applications of New Laser Welding Technologies"

Eröffnung Laser-Centrum ViTO, Mol, Belgien, 11. Juni 2001

[T14] B. Brenner, S. Bonß, M. Seifert, U. Stamm

"Neuere Entwicklungen zum Strahlschweißen mittels Hochleistungsdiodenlasern"

5. Konferenz "Strahltechnik" SLV-Halle, 27. - 28. November 2001

[T15] B. Brenner, J. Standfuß, B. Winderlich

"Induktiv unterstütztes Laserstrahlschweißen zum rissfreien Fügen von härtbaren Stählen"

Schweißen und Schneiden 2001 - Große Schweißtechnische Tagung, Essen, 11. - 13. September 2001

[T16] R. Dietsch, T. Holz, D. Weißbach, R. Scholz

"Large Area PLD of nm-Multilayers"

COLA 2001, Tsukuba, Japan

[T17] G. Ecke, R. Kosiba, J. Liday, R. Dietsch

"Evaluation of AES Depth Profiles of Ultrathin Ni/C Multilayer Structures with Respects to Depth Resolution Effects"

9. ECASIA 2001, Avignon, Frankreich

[T18] T. Himmer

"Werkzeugfertigung durch Blechpaketieren - Möglichkeiten und Grenzen heute"

Workshop "Rapid Prototyping: Fakten, Trends, Visionen", Fraunhofer IWS Dresden, 20. - 21. März 2001

[T19] T. Holz

"Abscheidung von Nanometer-Multischichten und ihre Anwendungen in der Röntgenoptik"

Institut für Physikalische und Theoretische Chemie der Universität Bonn, Bonn, 19. Januar 2001

[T20] V. Hopfe

"Laser-CVD - Status und industrielles Potenzial"

65. Physikertagung und Frühjahrstagung des Arbeitskreises Festkörperphysik (AKF) der DPG, Hamburg, 26. - 30. März 2001

[T21] A. Klotzbach, L. Morgenthal, T. Schwarz, V. Fleischer, E. Beyer

"Laser Welding on the Fly with Coupled Axes Systems"

20th International Congress on Applications of Lasers and Electro-Optics - ICALEO 2001, Jacksonville, Florida, USA, 15. - 18. Oktober 2001

[T22] A. Klotzbach, L. Morgenthal, T. Schwarz, E. Beyer

"Laser Processing on the Fly with Systems of Coupled Axes"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe, München, 18. - 22. Juni 2001

[T23] A. Klotzbach, L. Morgenthal, T. Schwarz, E. Beyer

"Laserstrahlschweißen mittels High-Power-Strahlablenkoptiken und integrierter Prozesssensorik"

Werkstoff-Forum 2001, Hannover

[T24] H.-G. Kusch, T. Heinze, G. Wiedemann

"Hazadous Emission and Health Risk During Laser Cleaning of Natural Stones"

LACONA IV - Laser in the Conservation of Artwork, Paris, 11. - 14. September 2001

[T25] D. Lepski, H. Eichler, V. Fux, S. Scharek, E. Beyer

"Calculating Temperature Field and Single Track Bead Shape in Laser Cladding with Marangoni Flow Using Rosenthal's Solution"

Lasers in Manufacturing: at Laser Conference 2001 - 15th International Conference on Lasers and Electrooptics in Europe, München, 18. - 22. Juni 2001

[T26] A. Leson

"Zukünftige Entwicklungen in der Beschichtungstechnologie"

Institutskolloquium DLR Stuttgart, Stuttgart, 08. März 2001

[T27] A. Leson

"Nanotechnologie - Vision oder Realität"

Symposium, TFG Venture Capital AG, Berlin, 28. März 2001

[T28] A. Leson, S. Braun, R. Dietsch, T. Holz, M. Mai

"Nanometer Multilayer Coatings for Application in the X-Ray Range"

2nd International Conference "The Coatings in Manufacturing Engineering", Hannover, 9. - 10. Mai 2001

[T29] A. Leson

"F&E-Strategie des Kompetenzzentrums ´Ultradünne funktionale Schichten"

BMBF Workshop, Bonn, 16. - 17. Mai 2001

[T30] A. Leson

"Nanotechnologie-Kompetenzzentrum ´Ultradünne funktionale Schichten´ - bisherige Aktivitäten und Ausblick"

MFD-Mitgliederversammlung, Dresden, 23. Mai 2001

[T31] A. Leson

"Das Technologie-Audit als Instrument der strategischen Institutsplanung"

Fraunhofer-Abteilungsleiter-Treffen, Dresden, 29. - 30. Mai 2001

[T32] A. Leson, S. Braun, R. Dietsch, T. Holz, H. Mai, M. Moss

"Ultrathin Films: Manufacturing and Applications"

Chinese-German-Symposium, Braunschweig, 05. September 2001

[T33] A. Leson

"Nanotechnologie in Sachsen - Entwicklungspotential einer neuen Technologie"

Technologie-Abend des Sächsischen Landtages, Dresden, 20. September 2001

[T34] A. Leson, H. Mai, P. Gawlitza, T. Sebald

"Nanostructured Thermal Barriers - Tailored Coatings for Extreme Conditions"

Nano-Workshop auf der "Materials Week", München, 04. Oktober 2001

[T35] A. Leson, S. Braun, H. Mai, M. Moss, N. Kaiser, S. Yulin, T. Feigl, T. Kuhlmann

"X-Ray Optics and Nanotechnology"

2. German - Ukrainian Workshop, München, 20. - 21. Oktober 2001

[T36] A. Leson

"Nanometer-Schichtsysteme für Röntgenoptiken"

Zweites Fachforum - Nanotechnologie: Die Schlüsseltechnologie des 21. Jahrhunderts in der industriellen Anwendung, Würzburg, 23. - 24. Oktober 2001

[T37] A. Leson

"Nanometer Film Systems - Manufacturing and Applications"

US/Germany Joint Meeting on Nanoscale Science and Engineering, Massachusetts Institute of Technology MIT, 05. - 06. Dezember 2001

[T38] A. Leson

"Nanometerschichtsysteme - Herstellung und Einsatzbereiche"

Fachkonferenz "Aktuelle Anwendungen der Nanotechnologie", Bad Homburg, 12. - 13. Dezember 2001

[T39] H. Mai, S. Braun

"Zur Präparation und Charakterisierung von röntgenoptisch nutzbaren nm-Multischichten"

Vortrag am Institut für Physikalische Hochtechnologie, Jena, 19. September 2001

[T40] S. Nägeler, S. Bonß, K. Barthel, B. Brenner, E. Beyer

"New Developments in High Power Diode Laser Welding"

9th Annual Automotive Laser Applications Workshop - ALAW 2001, Dearborn, USA, 14. März 2001

[T41] S. Nowotny

"Generieren metallischer Prototypen mit realen Gebrauchseigenschaften und Werkzeugreparatur durch Laser-Pulver-Auftragsschweißen"

Workshop "Rapid Prototyping: Fakten, Trends, Visionen", Fraunhofer IWS Dresden, 20. - 21. März 2001

[T42] S. Nowotny

"Laser/Plasma-Hybridtechnik und Laserstrahl-Präzisionsauftragsschweißen zum Erzeugen funktionsangepasster, hochbelastbarer Oberflächenschichten"

183. Arbeitstagung des DVS-Arbeitskreises Thermisches Spritzen, Technische Universität Dresden, 23. März 2001

[T43] S. Nowotny

"Laser Rapid Prototyping mit Pulvern Zweites Fachforum ´Beschichten und Formen mit Pulvern"

IHK Regensburg, 06. - 07. November 2001

[T44] S. Nowotny, S. Scharek, T. Naumann, R. Gnann, T. Heptner, E. Beyer

"Integrated Laser Milling Center for Complete Machining"

20th International Congress on Applications of Lasers and Electro-Optics - ICALEO 2001, Jacksonville, Florida, USA, 15. - 18. Oktober 2001

[T45] S. Nowotny, T. Schülke, A. Techel, E. Beyer

"New Developments and Applications in Laser Build-Up Welding"

International Conference on Metallurgical Coatings and Thin Films, Session B6-1, San Diego, Florida, 01. - 04. Mai 2001

[T46] T. Sebald, E. Beyer, P. Gawlitza, A. Leson, H. Mai, M. Bobeth, W. Pompe, R. Reiche

"Funktionell gradierte Wärmedämmschicht für die Innenbeschichtung von Bauteilen mit extremem Wärmeübergang mittels Puls-Laser-Deposition"

Abschlusskolloquium des DFG-SSP "Gradientenwerkstoffe", Darmstadt, 20. - 21. September 2001

[T47] M. Seifert, S. Bonß, B. Brenner, E. Beyer

"Improved Temperature Control for High Precision Heat Treatment with High Power Diode Lasers"

20th International Congress on Applications of Lasers and Electro-Optics - ICALEO 2001, Jacksonville, Florida, USA, 15. - 18. Oktober 2001

[T48] H.-J. Scheibe

"Laser-Arc - Laser-Induced, Pulsed Vacuum Arc Deposition: Process, Technology and Applications"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T49] H.-J. Scheibe

"Neuartige superharte Kohlenstoffschichten (Diamor®) - Beschichtungstechnologien auf der Basis gepulster Vakuumbogenverdampfung (Laser-Arc) - Einsatz bei Trockenbearbeitung, Minimalmengen- und Mangelschmierung - Lasermaterialbearbeitung mit CO_2-, Festkörper-, Excimer- und Hochleistungsdiodenlasern"

Lehrgang "Werkstoffe und Beschichtungen für Hochleistungswerkzeuge", Dresden, 18. - 19. Oktober 2001

[T50] H.-J. Scheibe, B. Schultrich

"Harte Kohlenstoffschichten für die Umformung und Zerspanung mit verminderten Schmierstoffeinsatz"

VDI-Seminar "Bearbeitungsverfahren für rationelle Fertigung", Stuttgart, 19. - 20. November 2001

[T51] D. Schneider

"Quality Control of Hard Coatings by Laser Acoustic"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T52] D. Schneider

"Laserakustik - LAwave"

Fraunhofer-Abteilungsleiter-Treffen, Dresden, 29. - 30. Mai 2001

[T53] D. Schneider, B. Schultrich

"Characterization of Coatings and Machined Surfaces by Ultrasonic Surface Waves"

The Coatings, Hannover, 09. - 10. Mai 2001

[T54] D. Schneider, B. Schultrich

"Laser-Akustische Prüfung von Nano-Schichten und Bearbeitungs-Randschichten"

6. Workshop Nanometer-Schutzschichten - Kompetenzzentrum "Ultradünne funktionale Schichten", Fraunhofer IWS Dresden, 05. - 06. Juli 2001

[T55] B. Schultrich

"Abscheidung nanostrukturierter Schichten mittels Pulslaser und Laser-Arc"

65. Physikertagung und Frühjahrstagung des Arbeitskreises Festkörperphysik (AKF) der DPG, Hamburg, 26. - 30. März 2001

[T56] B. Schultrich

"Subplantation Modelling for Technological Phase Diagram of ta-C Deposition"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T57] B. Schultrich

"Nanostrukturierte und ultradünne Kohlenstoffschichten"

6. Workshop Nanometer-Schutzschichten - Kompetenzzentrum "Ultradünne funktionale Schichten", Fraunhofer IWS Dresden, 05. - 06. Juli 2001

[T58] B. Schultrich

"Superharte Schutzschichten durch nm-Design"

OTTI-Fachforum Nanotechnologie: Die Schlüsseltechnologie des 21. Jahrhunderts in der industriellen Anwendung Würzburg, 23. - 24. Oktober 2001

[T59] B. Schultrich, H.-J. Scheibe

"Neue Möglichkeiten zur Trockenbearbeitung durch superharte amorphe Kohlenstoffschichten (Diamor)"

VDI-Seminar "Trockenbearbeitung", Stuttgart, 26. - 27. Juni 2001

[T60] B. Schultrich, H.-J. Scheibe

"Superhard Amorphous Carbon Films for Forming and Cutting Tools"

The Coatings, Hannover, 09. - 10. Mai 2001

[T61] B. Schultrich, H.-J. Scheibe, P. Siemroth

"Diamor® - Superharte amorphe Kohlenstoffschichten, die neue Generation der Schutzschichten"

Fraunhofer-Abteilungsleiter-Treffen, Dresden, 29. - 30. Mai 2001

[T62] B. Schultrich, S. Völlmar

"Von Tschirnhaus' Sonnenofenexperimenten zur Lasermaterialbearbeitung"

Ehrenfried Walther von Tschirnhaus - Kolloquium zu seinem 350. Geburtstag, Dresden, 10. April 2001

[T63] H. Schulz, B. Schultrich, H.-J. Scheibe

"Harte Kohlenstoffschichten für die Umformung und Zerspanung mit vermindertem Schmierstoffeinsatz"

VDI-Seminar "Hochleistungsverfahren für die rationelle Fertigung", Dresden, 10. - 11. Mai 2001

[T64] T. Schülke

"Diamor Films for Dry Machining"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T65] T. Schülke, H.-J. Scheibe, P. Siemroth, B. Schultrich

"Industrial Laser-Arc Coater for the Deposition of Superhard Amorphous Carbon Films (Diamor)"

Surface Engineering and Vacuum Metallurgy, San Francisco, USA, 23. Oktober - 02. November 2001

[T66] T. Schülke, D. Schneider, B. Schultrich

"Non-destructive Testing of Mechanical Properties of Thin Films Below 100 nm with Laser-Acoustic Waves"

Surface Engineering and Vacuum Metallurgy, San Francisco, USA, 23. Oktober - 02. November 2001

[T67] P. Siemroth

"Industrial Precision Deposition by Filtered High Current Arc"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T68] J. Standfuß, U. Stamm, B. Brenner, E. Beyer

"Laser Beam Welding of Cast Irons with Hardenable Steels"

20th International Congress on Applications of Lasers and Electro-Optics - ICALEO 2001, Jacksonville, Florida, USA, 15. - 18. Oktober 2001

[T69] A. Techel

"Werkstoffe und Strategien für das 3D-Laser-Präzisionsauftragschweißen"

Workshop "Rapid Prototyping: Fakten, Trends, Visionen", Fraunhofer IWS Dresden, 20. - 21. März 2001

[T70] A. Techel

"Schnelle Werkzeugfertigung durch automatisiertes Metall-LOM und Folgeprozesse"

Workshop "Rapid Prototyping: Fakten, Trends, Visionen", Fraunhofer IWS Dresden, 20. - 21. März 2001

[T71] A. Techel

"Anwendungspotential der neuen Rapid Tooling Prozesskette"

Workshop "Rapid Prototyping: Fakten, Trends, Visionen", Fraunhofer IWS Dresden, 20. - 21. März 2001

[T72] G. Wiedemann

"Aktuelles zur Gerätetechnik"

5. Forum Laser in Restaurierung und Denkmalpflege, Nürnberg, 26. - 27. Oktober 2001

[T73] G. Wiedemann, A. Kempe

"Laserstrahlreinigung in Restaurierung und Denkmalpflege - Grundlagen und Anwendung"

Fachakademie für Restauratorenausbildung A. R. Goering Institute e. V., München, 20. September 2001

[T74] G. Wiedemann, H. Wust

"Modifizieren von Holzoberflächen mit Laserstrahlung"

Tagung des Verbandes ak. Holzingenieure, Technische Universität Dresden, 09. November 2001

[T75] B. Winderlich, B. Brenner, J. Standfuß, V. Fux, E. Beyer

"Steigerung der Schwingfestigkeit von Schweißverbindungen durch induktiv unterstütztes Laserstrahlschweißen"

28. Tagung des DVM-Arbeitskreises Betriebsfestigkeit, Schaffhausen, Schweiz, 17. - 18. Oktober 2001

[T76] H. Wust, E. Beyer, H.-G. Kusch, G. Wiedemann

"Laser Cleaning Applied in the Restoration of a Medieval Wooden Panel Chamber at Pirna"

Vortrag/Vorlesung für Studenten im Rahmen des "European Course in the Framework of Culture 2000" - Videokonferenz, Padua (Italien) / Dresden, 10. Mai 2001

[T77] R. Zieris

"Werkstoffsysteme beim Laser-Plasma-Hybridspritzen"

AP-Frühjahrstagung - MDS-Leitprojekt VDI-TZ, Düsseldorf, 20. - 21. Februar 2001

[T78] R. Zieris

"Reparieren und Generieren mit Hochleistungs-Diodenlasern"

MDS-Herbsttagung AP 5, Augsburg, 10. - 11. Oktober 2001

[T79] R. Zieris, T. Naumann, S. Nowotny, G. Eckart, U. Füssel, E. Beyer

"Neuheiten beim Laser-Plasma-Hybridspritzen"

9. Workshop Plasmatechnik, Technische Universität Ilmenau, 21. - 22. Juni 2001

[T80] R. Zieris, S. Nowotny, E. Beyer

"Erzeugen dichter und flächenhafter Beschichtungen hoher Haftfestigkeit mittels Laser- und Plasmastrahl"

4. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik" (OWT 01) und 4. Werkstofftechnisches Kolloquium (WTK), Chemnitz, 20. - 21. September 2001

[T81] O. Zimmer

"High-Rate Sputter Cleaning for Large Area PVD Deposition"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

[T82] O. Zimmer, J. Vetter

"Calculation and Measurement of the Time Dependend Erosion Rate of Electromagnetically Steered Rectangular Arc Cathodes"

The International Conference on Metallurgical Coatings and Thin Films - ICMCTF 2001, San Diego, USA, 30. April - 04. Mai 2001

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- IWS is a ten minute walk from there, in the direction of Grunaer Weg

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Photos:	page 23:	Rolf Günther
	page 34:	Deutsche Messe AG Hannover
	page 36 (mid. Pic.):	Aloys Reminghorst (Ruhr Nachrichten)
	all other Pictures:	Fraunhofer IWS Dresden

Title Photos

top: welded aircraft test panel

middle: with LOM manufactured stamping tool

bottom: three dimensional hardening of a cutting ledge