

TECHNOLOGIES FOR MEDICAL APPLICATIONS





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Medical technology is a constantly evolving industry whose growth is supported by a multitude of innovations. The development of new products and medical devices is often based on sophisticated raw materials.

Essential research and development focuses of the Fraunhofer FEP have been technologies for the modification, functionalization and coating of surfaces for many years. Our know-how is used in particular for medical and biotechnological applications in order to be able to offer our customers and partners innovative solutions, technologies and efficient treatment methods.

Especially the topics of sterilization, hygienization and inactivation as well as the preparation of tissue transplants have experienced a significant increase in content due to the extension to further applications. Our portfolio ranges from the treatment of biological tissue using low-energy electrons, to biofunctional coating on surfaces, and the treatment of medical devices or implants.

In addition, there are many topics and research projects that come from related areas such as organic electronics and can be used for future application scenarios such as ward rounds 4.0 in the hospital of the future or light therapy with OLEDs. Our long-standing competence in the complete conception and development of hardware, for example for on-site sterilization, is also an important part of our portfolio for medical applications.

On the following pages we will inform you about applications and our services, which we offer with our broad technology portfolio and our laboratory units for medical applications of today and in the future.

TOPICS

Sensorics and Diagnostics

Medical Instruments and Materials

Implants

Bioelectronics

Optogenetics

Therapeutic Support Systems

Theranostics

Cleaning, Disinfection, Sterilization

Device Technology Development

Testing & Analytics

Coatings

Surface Modification

A close-up photograph of a polished metal ball joint and a tapered metal shaft. The ball joint is in the foreground, reflecting light and showing a grid pattern. The shaft is behind it, tapering towards the top right. The background is a light blue gradient.

APPLICATIONS



SENSORICS AND DIAGNOSTICS

HUMAN

- Energy harvesting for proximal sensors using piezoelectric layers
- 2D vibrometry of the eardrum (through the external auditory canal)
- Reflex microphone on round window (middle ear)
- Photoplethysmography with OLED-on-silicon technology (haemodynamic examination method for the diagnosis of chronic venous insufficiency)
- pH monitoring, e. g. for cycle recording
- Respiratory gas analysis
- Fitness and sport training optimization: pulse oximetry and lactate sensors
- Flexible imaging and optical sensor technology (VIS, NIR) e. g. as light therapy plaster, wound healing detector on the skin
- Sensor technology for vein recognition
- Sensors for microcirculation diagnostics
- Sensors for early detection of neurodermatitis relapses
- Sensor technology for gesture recognition

MEDICAL TECHNOLOGY

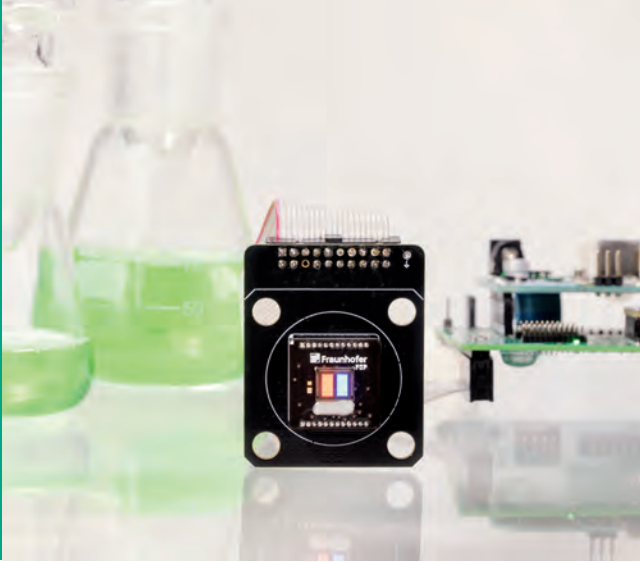
- Gastro-screening pills using bidirectional microdisplays
- Hall sensors for dynamic pressure measurement
- Cell-based sensor chips (electrochemical and optical)
- On-site analysis of bacteria using magnetic biosensors (magnetic layers)
- Plasmonic sensor for on-site analysis of pollutants in water
- Electrode development for blood sugar sensors
- Filters for X-ray sensors
- Intelligent antibacterial surfaces using bidirectional display technology

BIOTECHNOLOGY

- OLED-on-silicon sensors for measuring e. g. temperature, CO₂ and oxygen content, pH value, etc.

LAB-ON-CHIP

- High-resolution surface scanning and activation (e. g. fingerprint, skin)
- Visualization for self-therapy, ward round
- Biocompatible encapsulation
- Point-of-use sensors with OLED on silicon technology
- Sensors in bandages/hosiery (phlebology)
- Multiplex rapid tests (allergies)



MEDICAL INSTRUMENTS AND MATERIALS

- Antimicrobial coatings for medical covering materials, wound dressings
- Optical coatings for optical filters
- (Super)hydrophilic coatings for acupuncture needles
- Photocatalytically active layers for safety workbenches, siphons

IMPLANTS

- Development of active material composites for prevention of implant loosening
- Hydrophilic surfaces for stents, dental implants, etc.
- Biocompatible coatings by surface modification of silicone and PUR with electron beam
- Antimicrobial coatings
- Insulating encapsulations for pacemaker electrodes
- Manufacturing of open porous metal structures
- Storage medium for cornea cultivation

BIOELECTRONICS

- Deposition and coating of biodegradable, flexible electronics on biodegradable substrates for active implants

OPTOGENETICS

- Light-induced cell stimulation e.g. in nerves, opto-cochlear implants, etc.

APPLICATIONS



THERAPEUTIC SUPPORT SYSTEMS

OLED LIGHT SOURCES

- For dermatological applications, e.g. wound healing, cancer therapy
- Pain therapy
- Psycho-therapeutic applications (e.g. light therapy)
- Proven cytocompatibility of OLEDs

THERAPY GLASSES AND WEARABLES WITH OLED LIGHT AND OLED MICRODISPLAYS

- Integration of OLED light sources with special wavelengths
- Dizziness therapy by display of patterns
- Trauma therapy and for psycho-therapeutic applications
- Pain therapy
- Rehab support with the help of microdisplay modules with text/symbol notification in wearables
- Controllable OLED backlight for time-sequential autostereoscopic 3D displays in wearables
- Smart contact lenses using OLED microdisplays
- Pupilometry with integrated controllable illumination (VIS/NIR)

SUPPORT GLASSES WITH OLED MICRODISPLAYS FOR VIRTUAL/AUGMENTED REALITY (VR/AR)

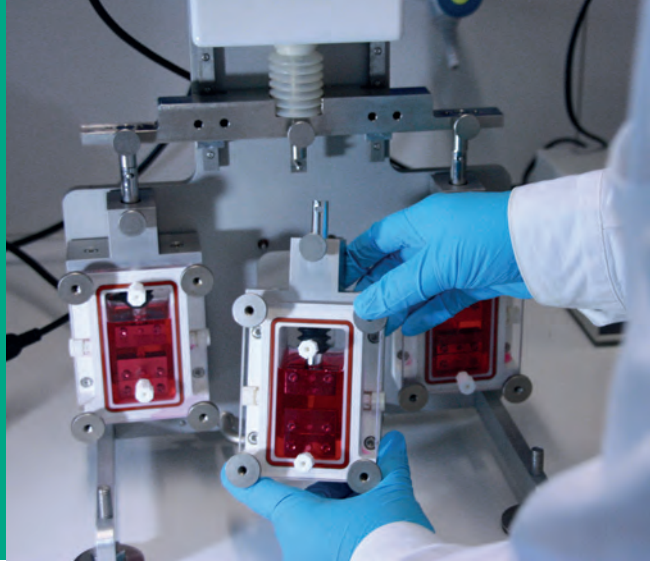
- On-site support for non-expert personnel to operate a defibrillator
- Support for data display at the bedside (ward round 4.0)
- Eyetracking glasses with bidirectional OLED microdisplays for early dizziness detection
- See-through glasses with bidirectional OLED microdisplays for data insertion into operating microscope
- Data glasses and eyetracking via bidirectional OLED microdisplays for human-machine interaction for visually impaired/handicapped persons
- Visualization of physiological parameters via OLED microdisplays in wearables for athletes
- Electronic visual aids with OLED microdisplays

THERANOSTICS

- Wound monitoring using integrated OLED light source and sensor
- Testing and monitoring of biofilms on implants / medical surfaces



SERVICES



CLEANING, DISINFECTION, STERILIZATION

PLANNING, CONSULTING, TRAINING

- On-site workshop for qualified status analysis
- Support in the purchase of new and substitute systems
- Complete planning of production-integrated cleaning concepts
- Customer-specific in-house trainings

TECHNOLOGICAL DEVELOPMENT

- Feasibility studies
- Development of customer-specific cleaning solutions
- Construction of customer-specific cleaning modules and pilot plants
- Development of sterilization concepts to reduce risks of infection
in e. g. geriatric care, hospitals, laboratories and public facilities

ANALYTICS

- Comprehensive laboratory and on-site analysis
- Development of concepts for integrated product and process analytics

DEVICE TECHNOLOGY DEVELOPMENT

- Lead-free ultrasonic transducer (Acoustocerebrography ACG)
- Sterile room locks
- Biobased dosimetry systems
- Bioreactors
- Filter technology (e. g. for water treatment in hospitals)
- Development and construction of customer-specific cleaning modules and pilot plants
- Development of customized electron beam and X-ray sources for low- and medium-energy applications:
 - for the handling of 3D objects, liquids and foils
 - for sterilization with product-specific energy ranges
 - with adapted construction for special applications
 - diving sources
 - ring sources
 - with segmented dose emission
- Plant engineering adapted for special applications and environments
 - BSL 2-suitable
 - In-line capable



TESTING AND ANALYTICS

- Tests of tools and therapy devices based on light and microcurrent, tourmanium ceramics, magnetic fields
- Test of devices for radiation shielding of mobile phones
- Tests for the development of novel sterilization packaging and encapsulation materials for medical electronics
- Biocompatibility test
 - lubricants
 - polymers
 - coatings
 - structured materials etc.
- Cytocompatibility and cytotoxicity test
- Test of antibacterial properties and sterility
- Serum and media tests
- Microbiological standard tests



BIOMEDICAL LABORATORY UNIT

CELL BIOLOGY

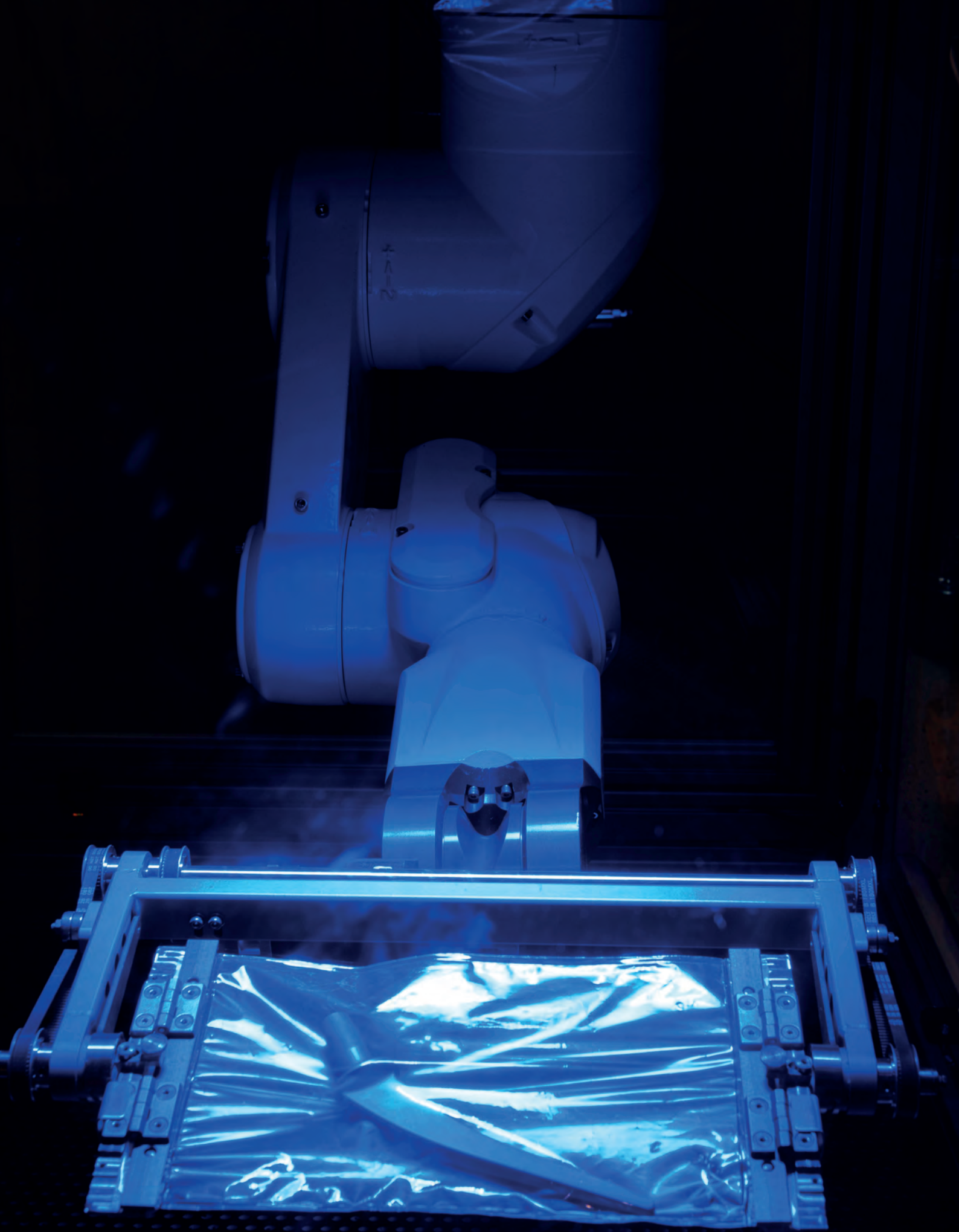
- Studies about biocompatibility of surfaces
- Verification of (bio-)functionality of devices, substances and media
- Development of task-specific test models
- Systematic investigation of the influence of test products on cell biological processes in significant cells, e. g. by:
 - revitalization tests
 - determination of dose-response ratios
- Cell cycle analysis
- Quantification of apoptotic, necrotic and vital cells
 - status analysis, consulting and optimization of procedures
- Development of technologies, quality assurance systems and components within the framework of contract research and the use of funding programmes
- Biological evaluation of medical devices according to DIN 10993-5

MICROBIOLOGY

- Development and adaptation of individual microbiological test regimes for:
 - antibacterial surfaces
 - sterile packaging, sterile processes
 - pharmaceutical raw materials
 - implants, devices and disposable products
- Cooperation in the disinfection and biofunctionalization of surfaces and products as well as in the development of transport and sterilization cycles
- Proof of efficacy for methods for germ reduction and determination of dose-response ratios
- Status analysis, consulting and optimization of procedures for germ reduction
- Development of test methods for quality assurance in production processes
- Testing according to various standards (e. g. DIN) and regulations

BIOANALYTICS AND SURFACE ANALYTICS

- Wettability studies
- Determination of surface energy
- Drop roll test (wetting conditions)
- Flow cytometry
- Fluorescence microscopy
- Impedance methods
- Microbiology and cell biology
- Use of bioreactors

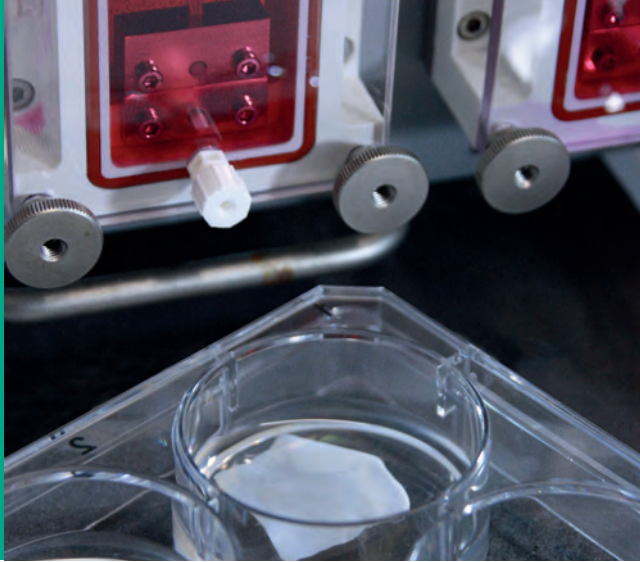


TECHNOLOGIES



COATINGS

- Antimicrobial coatings
 - silver and silver-copper mixed layers e. g. on fleece and velours
 - silver particles in a SiO_2 matrix produced by magPECVD
- Barrier coatings
- Coatings that promote or reduce wetting
- Biocompatible coatings
 - TiO_x , Ta_2O_5 for implants
 - development of electron beam based structuring methods for the use of tetrahedral bonded amorphous carbon layers in medical technology (DLC)
 - Ta and Zr layers on Ti alloy as protective layers for prostheses
 - carbon- or carbon-based coatings with biocompatible advantageous properties for wear reduction
 - development of carbon layer systems for endoprostheses
- Conductive and insulating coatings
- Optical coatings
 - fluorescence technologies
- Photocatalytically active coatings
 - Anatase TiO_2
- Piezoelectric coatings
- Other coatings:
 - carbon layers on plastic web for sensors of an electron microscope
 - stacked AlN layers for ultrasonic transducers
 - decorative coatings in dental technology (e. g. drill handpieces)
 - anti-fingerprint coatings
 - easy-to-clean coatings for medical devices
 - disinfection-resistant layers
 - scratch and wear resistant coatings for instruments and implants
 - mechanical filters for dental medicine (mercury) or for water treatment in clinics
 - optical filters (X-ray sensors, endoscopes)
 - insulating coating for pacemaker electrodes



SURFACE MODIFICATION

BIOMEDICAL ENGINEERING

- Reduction of bacterial adhesion / biofilm formation
- Easy-to-clean surfaces
- Protection against biocorrosion
- Surface modification of silicone and PUR for biocompatible coatings
- Modification of graft tissues
- Modification of parylene with low-energy electron beam technology
- DLC coating and electron beam modification of the coating

TISSUE ENGINEERING

- Sterilization
- Improvement of cell adhesion and growth
- Partial modification for targeted control of cell adhesion

CLEANING TECHNOLOGIES

- With liquid media (solvent, aqueous)
- By plasma
- By means of contact roller
- Photocatalytic



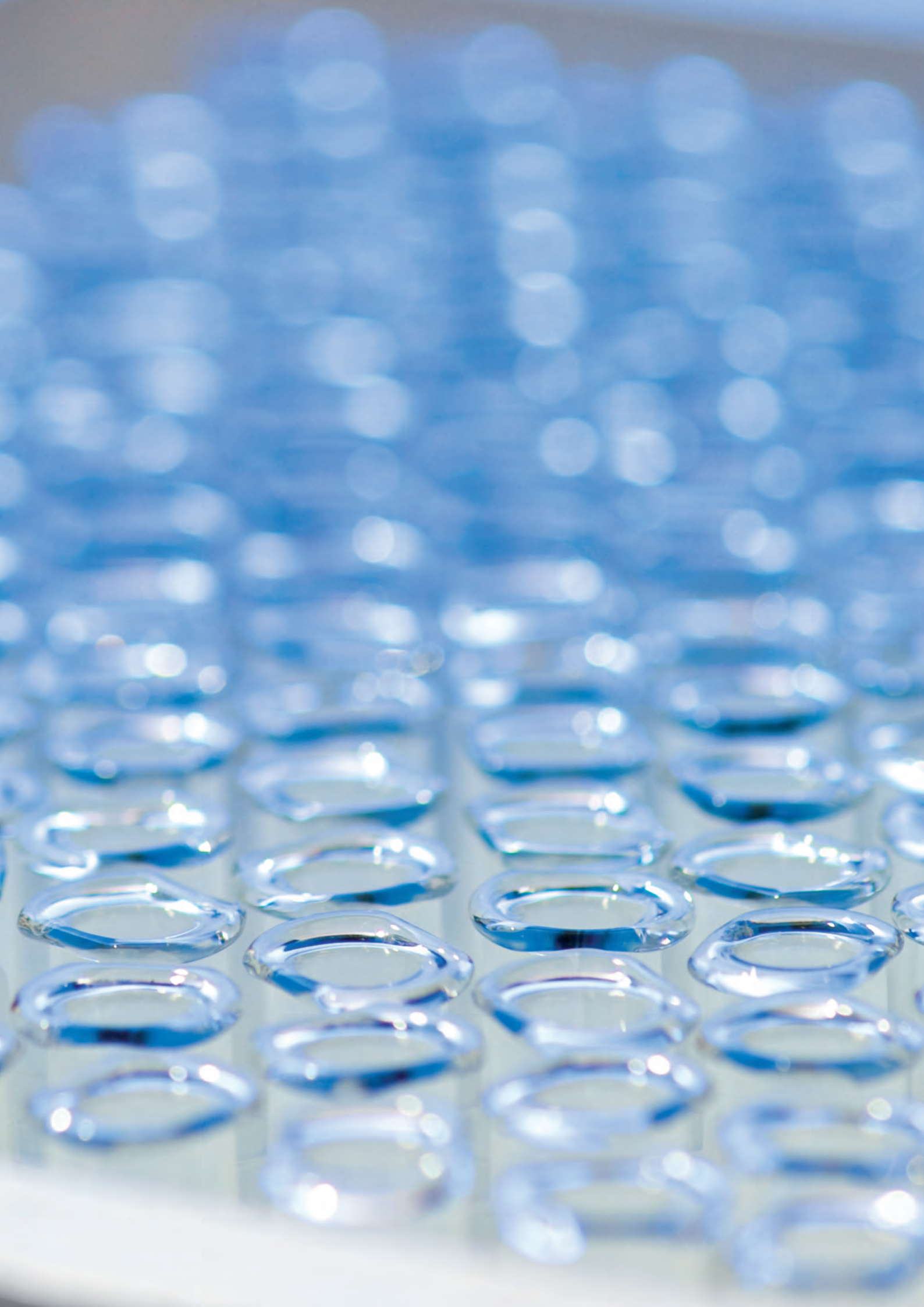
STERILIZATION

- Low-energy electron beam sterilization of:
 - hydrogels
 - biological and biologically active coatings
 - transplant tissues, implants and components
 - smart implants and prostheses
 - cardiological sensors
 - RFID transponders
 - integrated circuits
 - microelectrodes
 - OLEDs

INACTIVATION

- Cell inactivation
- Inactivation of somatic cell therapeutics using low-energy electrons
- Virus inactivation for vaccine production, processing of hatching egg waste, etc.





NETWORKS



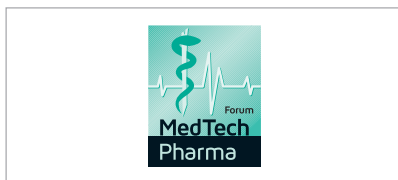
Flex+ Open Innovation Portal

Open Innovation Portal for flexible electronics
www.flex-plus.de/Group/Welcome



Innovation Network CleanHand

New technologies for the disinfection of objects to improve hygienic conditions
www.cleanhand.de



Forum MedTech Pharma

A Network for Innovations
www.medtech-pharma.de



Fraunhofer-Allianz Reinigungstechnik

Bundled Fraunhofer competence in industrial cleaning, pre-treatment and surface technology
www.allianz-reinigungstechnik.de



Innovationscluster Sensorik Sachsen SenSa

Innovation cluster for the promotion of digital networking of the sensor technology players in Saxony
www.sensorik-sachsen.de



International Atomic Energy Agency

www.iaea.org



CEPI - New vaccines for a safer world

A global alliance financing and coordinating the development of vaccines against infectious diseases
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