Extract from the Annual Report 2022
To the website: https://www.ist.fraunhofer.de/en.html

In focus: Surface technology for the healthcare sector

In healthcare facilities such as hospitals or doctors' offices, surfaces play a central role in the transmission of infections. In order to minimize this risk, they must be regularly and thoroughly cleaned and disinfected. This applies to beds, seating, door handles and light switches as well as work surfaces, medical equipment and many other items.

In addition, coatings or modifications to the surfaces themselves can contribute towards improving hygiene and preventing infections. For this purpose, the Fraunhofer Institute for Surface Engineering and Thin Films is developing antimicrobial and easy-to-clean surfaces, environmentally-friendly cleaning systems, and sustainable interior concepts whose application is not limited solely to the healthcare sector.

The "Patient room of the future" in Braunschweig

Patient comfort and secure care are not mutually exclusive. This is demonstrated by the Fraunhofer IST, the Institute for Construction Design, Industrial and Health Care Building (IKE) of TU Braunschweig, and the Städtisches Klinikum Braunschweig in the "Patient room of the future".

The real laboratory was constructed in the grounds of the clinic in 2022. Within the framework of the cooperation, application-related issues with a focus on infection prevention and cleaning in normal care are to be addressed. The emphasis is on the development of innovative, practicable technical construction sample solutions, smart materials and surfaces, and future-proof equipment elements and products. In line with the motto "from bedside to bench and back", new ideas are continuously being implemented in the real laboratory, questions from the hospital's day-to-day practice are transferred to research, and innovative solutions are tested with regard to their practical suitability in the patient room.

To ensure that the ideas quickly find their way into application, the three research partners are working closely together with various manufacturers. Currently, 20 partners are active in the accompanying industry consortium. Further research projects are initiated on a regular basis, thereby taking into account the needs of neighboring sectors, with a view to maximizing efficiency and effectiveness.

Questions which form the focus for the Fraunhofer IST in the "Patient room of the future" are oriented to the following topics:

- Resilient surfaces for infection prevention
- New cleaning and disinfection systems for surfaces and devices
- Recyclability of the utilized materials and processes
- Digitalization

> **"The 'Patient room of the future' is more than just a room with two beds and two showers."**
>
> **Dr. Kristina Lachmann, Group Manager at Fraunhofer IST**

Dirt-repellent coating on a wood veneer.

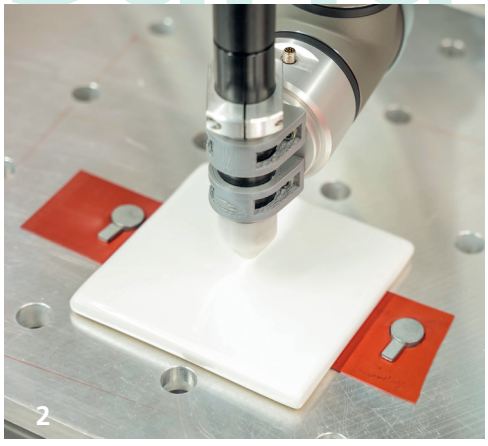
The surfaces and materials utilized in the patient room play a decisive role, as do the cleaning procedures. The real laboratory contains all the components of a two-bed room for normal care, with the special feature that two showers are integrated. In order to represent the broadest possible spectrum of materials and possibilities for component processing, the showers are designed differently. As a result, the influence of joints or wall seals as well as the use of different materials or designs of bathroom ceramics or fixtures can be examined comparatively.

In the room itself, a variety of materials are used, such as floor coverings made of plastic, wood veneers or imitation leather. The chemical and topographical properties of surfaces play an important role in the adhesion of dirt or microorganisms. The latter can lead to infectious diseases being transmitted from one person to another through contact and smear infections.

Particularly in sensitive areas such as hospitals or retirement homes, as well as in public spaces, this can lead to serious infections in immunocompromised, weakened patients. While aerosol-borne germs such as coronavirus are spread by droplets, "heavier" bacteria such as multi-resistant germs often adhere to surfaces or floors.

The materials and surfaces developed – and to be developed – as part of the patient room of the future have great potential for application, including far beyond healthcare and nursing. Durable and robust surfaces that are easy to clean and that become less quickly and heavily soiled, as well as alternative sustainable cleaning processes, are finding a wide range of applications in public facilities, stationary retail, the food-service industry, the passenger-transport sector, and also in private households, among other areas.

Surfaces



Robot-guided plasma coating of a tile.

Wear-resistant antibacterial coatings on a door handle.

Cleaning

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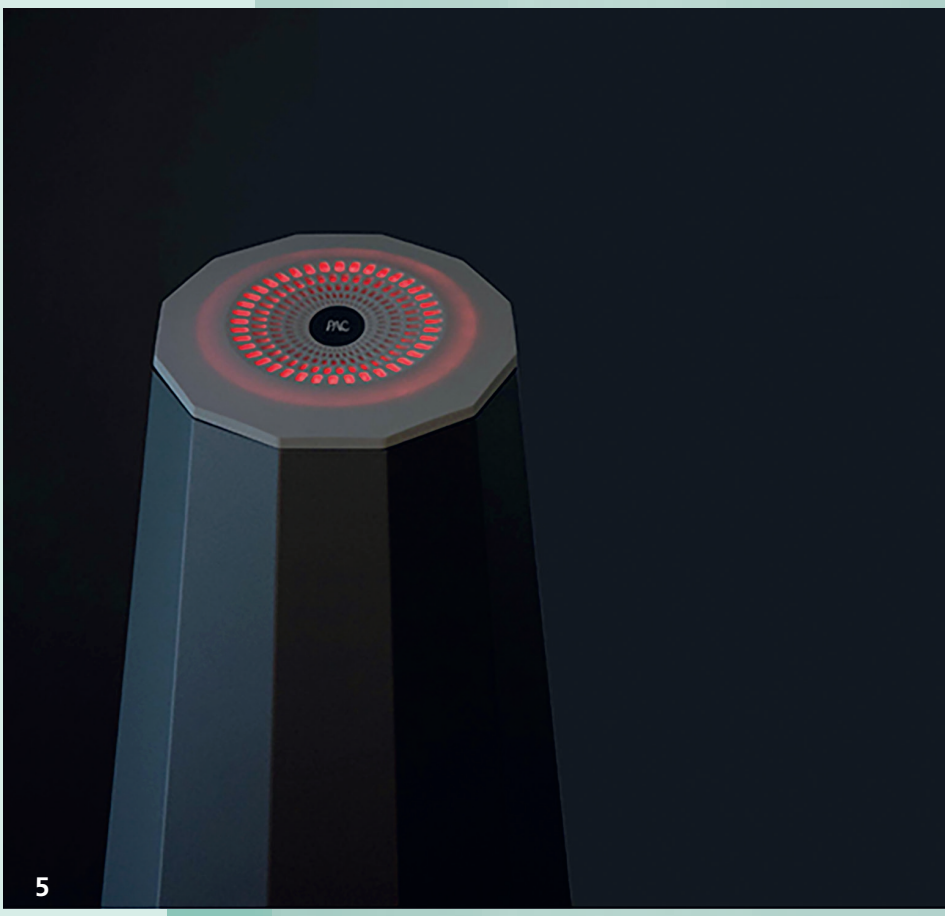

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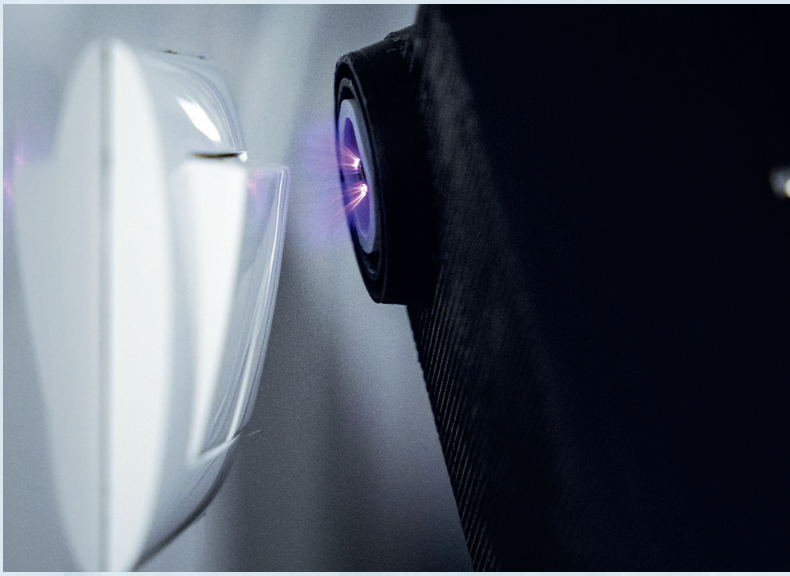
In collaboration with the HAWK Göttingen and the Fraunhofer WKI, researchers at the Fraunhofer IST have developed an air purifier which combines the advantages of plasma, UV-C and photocatalysis. The "PlasmaAirCleaner" thereby fulfills the function of air purification and, at the same time, enables surface disinfection, for example in hospital rooms. Left: By means of a special "bypass function", the air flowing through the room is able to pass either through the activated carbon or to bypass it. In "activated-carbon mode", all guideline values for gas concentrations in the room must be observed. Right: In "bypass-ozone mode", in contrast, the surfaces in the room are disinfected by the outflowing ozone. A red light indicates the activated-ozone mode.

Disinfection

Cleaning and disinfection are directly connected to infection prevention in hospitals and are defined by hygiene plans that are based on the recommendations of the German commission for hospital hygiene and infection prevention (KRINKO). Depending on, for example, the surface area, existing equipment, the floors or the type of rooms, varying provisions are stipulated here and a variety of chemical cleaning agents are recommended.

The Fraunhofer IST has accrued many years of experience in the development of new plasma sources and the deployment of electrochemical systems on the basis of diamond electrodes. Both can be used for cleaning and disinfection and have the potential of a "green cleaning and disinfection agent". Reactive species for the removal of organic contaminants or the control of microorganisms are obtained in both systems through the utilization of air, water and electricity. In the patient room of the future, investigations will be carried out to determine the extent to which these sustainable and resource-conserving systems can compete with conventional cleaning systems in practice, and whether the material properties of the equipment elements are altered as a result of the processes being used. The potential of the automation of cleaning processes and an integrated quality control system will thereby also be taken into account.

Cleaning and disinfection systems without chemical additives offer a wide range of application possibilities, as do robust easy-to-clean surfaces. Optimal matching of the cleaning system with the surface to be cleaned allows the development of sustainable interior concepts and helps to reduce costs and protect the environment.



Modular plasma source for the cleaning and disinfection of surfaces.

Automated cleaning by means of plasma technology: integration of a plasma source into a robot arm.

Circular Economy

In hospitals, high demands are placed on surfaces and materials in terms of their chemical and mechanical resistance. Nevertheless, it may be necessary to replace, refurbish or extend certain components in rooms.

In collaboration with the architects of the IKE at the TU Braunschweig, the researchers at the Fraunhofer IST want to investigate how patient rooms can be designed on a modular basis. This is relevant, for example, when, as in the case of a pandemic, an increased number of isolation rooms are suddenly needed or, in the event of a disaster, the number of rooms with an increased level of care is no longer sufficient.

Modular room design also promotes the sustainable use of resources. Is it possible to exchange only certain equipment elements? How do these have to be designed, installed or constructed in order for replacement to be cost-efficient in operation? The solutions developed within this context are once again not limited to hospitals. They can also be transferred – tailored to the specific requirements and framework conditions – to other areas, e.g. the interior design of hotel rooms, communal facilities or mobile homes, to name just a few examples.

A modular design with interchangeable elements is one approach for sustainably extending the useful life of existing premises. This is, however, only one aspect. A further aspect concerns the life cycle of the individual products that are installed during the interior outfitting process. The aim is to develop products – from the raw material through to recycling – and the associated processes in such a way that they can be integrated into a circular economy. For this purpose, the Fraunhofer IST implements methods and tools of life-cycle engineering and sustainable factory planning for technical-economic-ecological analyses of product and production systems.

View into the patient room of the future. The beds are hereby opposite each other instead of next to each other.

Fraunhofer Institute for Surface Engineering and Thin Films IST | Riedenkamp 2 | 38108 Braunschweig | Germany

Digitalization

The long-term goal of the Fraunhofer IST is to create a digital twin of the patient room in order to be able to quickly and cost-effectively test various constellations in advance with regard to the optimum design of the room as well as the processes and conditions within the framework of healthcare research and under the premise of infection control.

Digitalization also provides an important contribution towards progress and sustainability in hospitals. It is an enabler for enhanced energy and resource efficiency, for increased patient comfort, and for a reduction in the workload of staff. Through digitalization, which necessitates appropriate data acquisition, workflows can be improved and, simultaneously, medical care can be optimized. In data acquisition, sensory systems play a particularly important role: firstly, in terms of monitoring the patient status, and secondly, for the continuous determination and optimal adjustment of environmental conditions, such as the room climate.

Digitalization is also directly related to issues of sustainability and the conservation of resources. In the future, the patient room could be equipped with a digital twin in order to enable the rapid and cost-effective advance testing of various constellations with regard to the optimum design of the room as well as the processes and conditions within the context of healthcare research and under the premise of infection control, and in order to record material flows and energy fluxes.

Contact

Dr. rer. nat. Kristina Lachmann
Phone +49 531 2155-683
kristina.lachmann@ist.fraunhofer.de