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RESEARCH NEWS

06 | 2011

Fraunhofer Press
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1 An alternative to antibiotics

Antibiotics are among the greatest achievements of medical science. But lately the former multi-purpose weapon fails in the battle against infectious diseases. Bacteria are increasingly developing resistance to antibiotics. Researchers have now found a therapeutic equivalent which could replace penicillin and related phamaceuticals.

2 Aircraft systems in the environmental chamber

How can air transport be made more environmentally compatible, economical and sustainable? The Fraunhofer flight test facility in Holzkirchen is soon to be expanded with the installation of a thermal test bench for aircraft systems, with the aim of achieving efficient energy management onboard.

3 ARD Mediathek enhanced with new search functions

This May new and improved search capabilities were introduced on the ARD Mediathek portal. Visitors to the website can now target their searches for TV and radio content more specifically. Information can also be extracted directly from video footage. All thanks to software from Fraunhofer.

4 Precise assembly of engines

In the automotive industry, combustion engines are still assembled mostly manually. Researchers from Fraunhofer are developing procedures and methods to automate assembly processes to continuously improve the quality of the engines. The use of the latest technologies helps to eliminate uncertainties during engine assembly.

5 Goodbye cold sores

Herpes infections on the lips, in the eyes or on the nose are painful, long-lasting and unpleasant. A new 3D herpes infection model brings hope: active ingredients and new treatments can be reliably tested with this model. Animal tests could soon be a thing of the past.

6 The fine art of etching

They see more than the naked eye and could make traffic safer: miniaturized thermal imaging sensors. But they are difficult to manufacture on a commercial scale. Researchers have now developed a new system. On it, special micro-electromechanical systems can be produced – with the correct etching technique.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 60 Fraunhofer Institutes at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 18,000, who work with an annual research budget totaling 1,66 billion euros. Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the USA and Asia serve to promote international cooperation.

Editorial notes:
Research News l Frequency: monthly l ISSN 09 48 - 83 83
Published by Fraunhofer-Gesellschaft l Press Office l Hansastraße 27 l 80686 München l
Telefon +49 89 1205-1333 l presse@zv.fraunhofer.de
Editorial Staff: Franz Miller, Isolde Rötzer, Britta Widmann l Reprints free of charge.
We encourage you to favor the online version and newsletter via www.fraunhofer.de/fhg/EN/press
This bulletin is also available in German as "Mediendienst".

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An alternative to antibiotics

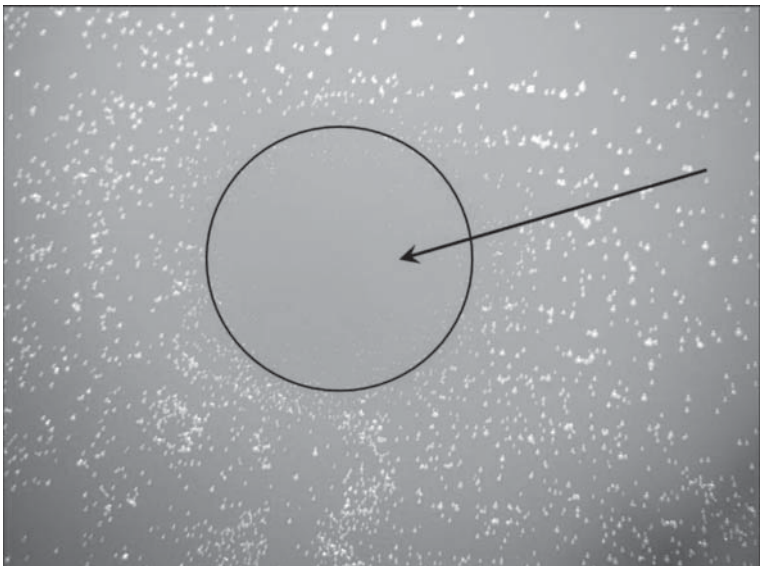
More and more pathogens are becoming immune to antibiotics. Some bacteria can no longer be combated. The World Health Organization WHO is warning about resistance to drugs which were once so potent. The WHO's director-general Margaret Chan has pointed out that if measures are not taken quickly, it may soon not be possible to treat many frequently occurring infections. Figures released by the WHO show that in 2010 nearly half-a-million people were infected with a strain of tuberculosis which is resistant to many antibiotics – one third of those infected died. The Organization states that the growing spread of resistant pathogens is attributable to the indiscriminate use of penicillin and other antibiotics.

Research scientists at the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig have found an alternative to the established antibiotics. In the future, antimicrobial peptides will take up the battle against pathogens. "We have already identified 20 of these short chains of amino acids which kill numerous microbes, including enterococci, yeasts and molds, as well as human pathogenic bacteria such as Streptococcus mutans, which is found in the human oral cavity and causes tooth decay. Even the multi-resistant hospital bug Staphylococcus aureus is not immune, and in our tests its growth was considerably inhibited," says Dr. Andreas Schubert, group manager at Fraunhofer IZI.

From familiar fungicidal and bactericidal peptides the research scientists produced sequence variations and tested them in vitro on various microbes. Putrefactive bacteria, for example, were incubated for an hour with the artificially produced antimicrobial peptides. As the new peptides contain cationic amino acid residues, they can bond with the negatively charged bacterial membrane and penetrate it. In their tests the research scientists compared the survivability of the pathogens with an untreated control. The experts focused on peptides with a length of less than 20 amino acids. "Antibiotic peptides unlock their microbicidal effect within a few minutes. They also work at a concentration of less than 1 µM, compared with conventional antibiotics which require a concentration of 10 µM," states Schubert, summarizing the test results. "The spectrum of efficacy of the tested peptides includes not only bacteria and molds but also lipid-enveloped viruses. Another key factor is that the peptides identified in our tests do not harm healthy body cells," the scientist explains.

The food sector could also benefit from the antimicrobial peptides given that the bacterial contamination of food products costs the industry billions every year. Fresh

lettuce and other salad greens, for example, are badly contaminated by yeasts and molds. The shelf-life of foodstuffs could be improved by adding antimicrobial peptides during the production process. "This is a definite possibility because the short-chain peptides tested during the project do not exhibit any allergological risk on being added to foodstuffs," says Schubert. Magdeburg-based company ÖHMI Analytic GmbH is the project partner in the development of peptides for salad greens. The research scientist is convinced that many possible applications exist, including in machinery manufacture – for instance to keep hydraulic fluids free of microbes. As a next step the expert and his team are going to test the antimicrobial peptides in vivo on infection models.



Here it can be clearly seen that the antimicrobial peptides have prevented the growth of bacteria, in this case Streptococcus mutans, which causes tooth decay. (© Fraunhofer IZI)

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Aircraft systems in the environmental chamber

The plane takes off from Munich in bright weather, temperature 10 degrees Celsius, and lands in Anchorage, Alaska, in driving snow, temperature minus 15. Parked on the airfield overnight, the aircraft takes off the next morning at a freezing minus 25 degrees, heading for Dubai, where the weather is a sunny 32 degrees. The temperature on the outside of the fuselage is over 80 degrees. The rapid changes in temperature pose a challenge for the technical systems and materials. How can it be ensured that the onboard equipment will function in all circumstances? Scientists at the Fraunhofer Institute for Building Physics IBP in Holzkirchen near Munich are finding answers to this question in their flight test facility. An additional piece of equipment – the thermal test bench – will help in the development of new systems such as the aircraft power supply, air conditioning and lighting. The project will be presented at the Paris Air Show in Le Bourget from June 20 to 26 (Hall 1, Booth F319).

"The thermal test bench comprises a number of different elements, but the main one is the aircraft calorimeter, which is integrated into the low-pressure chamber of our flight test facility," explains project manager Dr.-Ing. Gunnar Grün from Fraunhofer IBP. "We can simulate environmental conditions inside the aircraft, as well as external conditions on the ground or in flight, and see how the equipment copes." The scientists hope to obtain fundamental insights into the effect of ambient temperature on the thermal behavior of aircraft systems. They will also study the interplay between components, materials and ambient temperature, particularly in the context of more electric architecture on aircraft. Three metal and fiber-composite fuselage sections of a Dassault business jet will be used to study the interplay of new electric systems and aircraft parts in different conditions. "For reasons of space, large electrical components are accommodated in the rear, while other systems are located in the cockpit," says Grün. "With the thermal test bench we will be able to show how the waste heat from the lights, the power electronics or the inflight entertainment impacts on the environment in the aircraft interior – and vice versa." This will enable the research scientists to draw conclusions about how the systems should be arranged and how the waste heat can be efficiently removed or reused. "Imagine you want to use a laptop in the sauna. It has to release heat in order to function. At the high temperatures the built-in fan no longer does the job and so you have to find a different solution, for example heat conduction," the specialist continues. The test facility is part of the Clean Sky project, in which Fraunhofer IBP, European companies and other research establishments are studying the interplay of thermal and electrical systems.

To complement this research and obtain a comprehensive picture of the energy balance in aircraft, an electrical test bench is also being built under the Clean Sky project, by aircraft engine manufacturer Safran in Paris. "At present there is a mix of electric, pneumatic and hydraulic systems in airplanes which require extensive maintenance and cleaning. Some of the fluids used damage the environment. The aim for the future is to increasingly use electric systems in aircraft, saving weight and aviation kerosene. Electric systems are also more efficient," states Grün, describing the background to the project. To achieve these aims, research scientists will have to find answers to a lot of questions. For example, whether the onboard power system will remain stable under an increased electric load. "Imagine what would happen at home if you plugged ten hairdryers into the same power socket and switched them all on at the same time: the fuse is certain to blow," Grün explains.

Fraunhofer IBP's flight test facility is about to be expanded with the addition of a thermal test bench for studying the thermal behavior of aircraft systems. (© Fraunhofer IBP)

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ARD Mediathek enhanced with new search functions

Since May 2008, German public service broadcaster ARD has been pooling the TV and radio content of its nine regional broadcasting organizations and making it available online through a single media library called ARD Mediathek. Now, led by its Southwest German unit SWR and working with the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS in Sankt Augustin, the broadcaster's website ARD.de has conducted a project to improve its search functions so that users can reach the programs they want to catch up on more quickly. The upgraded site was relaunched in May.

Previously, users could only find programs and podcasts by way of their title, the transmission date and brief descriptions. Now, with the audio mining solution developed by Fraunhofer IAIS, program soundtracks are also analyzed and automatically enriched with metadata. As a result, visitors to the site can target their searches more specifically. "The regional broadcasters often put programs in the media library with inadequate metadata, but our technology enables people to still find the content they want. Our audio mining solution uses a voice-recognition facility which searches through the audiovisual database and converts the soundtrack into written text. The search engine for ARD Mediathek then analyzes how often the word is used. This increases the hit rate. The way the search results are sorted according to relevance has also been optimized," says Angelika Pauer from Fraunhofer IAIS. The IAIS team has developed essential components of the audio mining technology within the THESEUS research program, funded by the German Federal Ministry for Economics and Technology (BMWi).

What's more, visitors to ARD Mediathek can use the new 'videoquote' function to share extracts from audio and video content with other users on an external website. This is how it works: The user sees a piece of footage that they would like to quote, perhaps a statement by a politician. At the click of a button the section of video being watched is displayed in text form at the bottom of the screen. Any part of the text can then be highlighted and posted as a link e.g. to Twitter or Facebook or sent as an email. By clicking on the link the recipient directly accesses the desired passage in the video clip. The 'videoquote' function has been made available initially for genres such as politics, talk shows, news, reportage and documentaries, but there are also plans to use it for entertainment programs. "Using 'videoquote' visitors can recommend interesting video content on Twitter, Facebook or their blog. This will make the ARD's programs better known on the internet," Pauer adds.

The fact that users can now jump directly to passages they want to quote will only intensify this effect. The new 'search in video' function makes it easy to find keywords in moving footage. A click on this button displays a search field and a time bar which marks the places where the search term appears in the video. Thus it is possible to find specific content in long videosequences.

The ARD.de editorial team and the research scientists at Fraunhofer IAIS had already worked together successfully in 2009, when the audio mining technology was used for launching the 'Web Duel' feature. Visitors to media library were able to select an election topic and two leading politicians and then see what they had said on the subject on programs broadcast by ARD. "Computers and television are moving closer and closer together. People want to use the search functions on the internet for radio and TV content too. This trend will strengthen with the increasing spread of internet-capable TVs," says Pauer, concluding: "Our software system makes it possible to search audio and video content. Now we can take the techniques we are familiar with from the web and apply them to moving images."

Since May the ARD Mediathek portal has offered new functionality, including an enhanced media content search facility. (© Fraunhofer IAIS)

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Precise assembly of engines

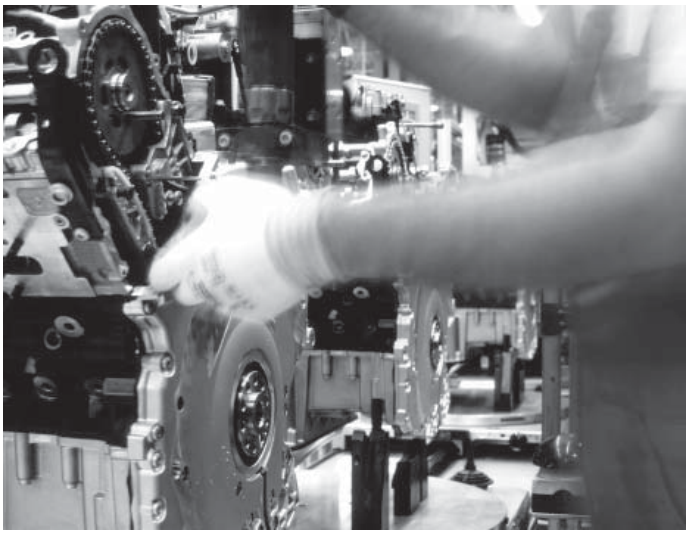
Valves, nozzles, pistons, spark plugs and camshafts – the heart of each car is its engine. It is a complex structure with many levels and individual parts and must therefore be assembled in a correspondingly precise way. Parts that are slightly damaged, malformed or assembled the wrong way can cause engine damage. The results would be an angry customer and damage to the reputation of the car manufacturer.

While assembly is mostly automated for the construction of the body, the engine is still assembled by hand over long stretches. The current methods for automating engine assembly have proven either useless or too expensive. The work of the project group "Resource-efficient mechatronic processing machines" of the Fraunhofer Institute for Machine Tools and Forming Technology IWU under the management of Prof. Dr.-Ing. Gunther Reinhart shows greater promise. In cooperation with the car manufacturer Audi, the engineers initiated the project: "Forward-looking methods and processes for precision assembly and process monitoring for novel combustion engines." The objective is clearly defined: the quality of the engine assembly is to be optimized continuously, therefore increasing customer satisfaction further. The use of the latest technologies in the areas of robotics and sensor technology is intended to help eliminate uncertainties during engine assembly. "Monitoring the process throughout is not possible, since the engine continues to be assembled mostly manually. And engines are becoming more complex all the time. This can cause increased levels of rework," says graduated engineer Christoph Sieben from the IWU. The automated assembly technology of the IWU scientists would identify the defect early, during engine assembly, and forward the corresponding information or, for certain assembly processes, would not permit the defect to occur in the first place.

The researchers first catalogued the status quo, evaluating current data on documented, assembly-related engine problems for in-line and V-type engines over the past five years. The focus of the analysis was on the parts used and on the processes involved. "We generalized the engine assembly sequence and broke it down into eight blocks. The individual assembly functions are also recorded in a standardized way," declares Christoph Sieben. This makes it possible to assign errors during assembly to uniformly defined assembly sequences and assembly functions. As a result of this generalization of engine assembly, the analysis can be utilized for all kinds of engines. "We now know which assembly sequences require action," says Christoph Sieben. The project group wants to develop new automation solutions next. The core piece of the test facility is a new type of lightweight robot: it weighs only 16 kilograms

but can lift up to seven kilograms. What is so special about the "KUKA robot"? It is very sensitive and flexible, unlike other traditional robots that can perform tasks only within certain parameters. The researchers are now looking for new ways to combine innovative sensor technology and robots. "For example, we are pondering how a transfer from medical sensor technology to industrial processing could be effected," elaborates Christoph Sieben.

A high-performance control technology can be developed by integrating sensor systems of many variations: ideally, the robot will not only detect the problem, it will also solve it. Camera systems that record the directional orientation of a part are a current example. If it does not correspond to the standard, the robot can decide whether the part will be used or if it has to be replaced. Christoph Sieben explains: "The process monitoring system that is to be developed further on this basis has the ability to automatically deduce the inspection criteria and the required tolerances during the entire assembly process and then to react." The project will end in 2014. The plan is that the prototype will then be ready for series production.



Currently, there is little use of automation in the assembly of chain drives. (© AUDI AG)

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Goodbye cold sores

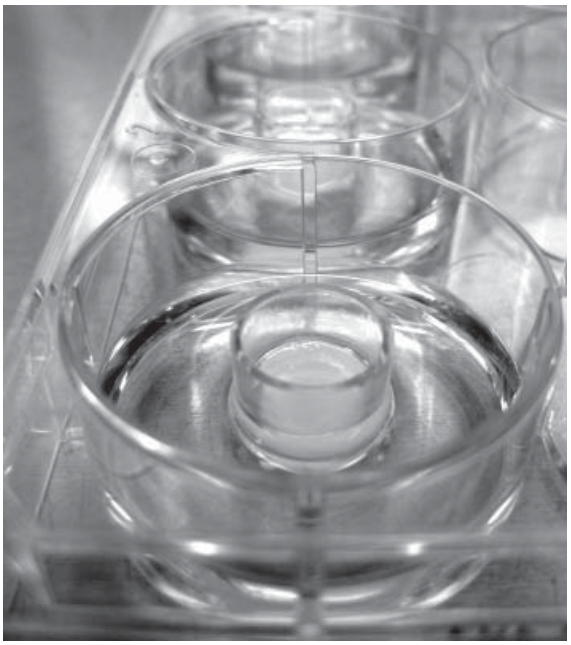
It burns and itches on your upper lip: a herpes infection is on the advance. Caught early, the number and size blisters can be controlled with virus-controlling salves, but the herpes simplex virus can recur at any time. "About 90 percent of the world's population carry it in them all their lives, once infected, and become sick again in stress situations," explains Dr. Anke Burger-Kentischer of the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart. Coming down with a herpes virus is not always without its dangers. In the worst cases the nervous system and the brain become inflamed. The researcher, together with her team and the cell systems department, developed a 3D herpes infection model. This makes it possible for the first time to integrate the complicated dormant stage of the virus into a model of the skin. A patent application has been submitted for the new process.

The expert explains the particularity of the virus: "After the blisters subside, the herpes virus retreats to the nerve cells and rests there. At this stage, only the virus' DNA can be proven." As soon as a human suffers too much stress or is even exposed to too much intense sun, the nerve cell may release the virus. It travels along the neural pathways to sites where it has occurred several times before, and the new infection becomes visible.

To date the skin models used for drug testing and to detect the virus have been very simple and unable to simulate the dormancy state of the virus. "We have integrated a neuronal cell line into the certified skin model of the IGB and are able to detect this latency stage for the first time. Just like in the human nerve cells, the particles of the virus itself cannot be seen; only the presence of its DNA can be proven by means of a PCR (polymerase chain reaction) analysis," explains the expert. The researcher and her team then exposed the skin model to ultraviolet radiation at wave lengths of 280 to 315 nanometers (UVB). This reactivated the herpes virus, and there was an infection on the skin model. Proof of this reactivation was also possible on a co-culture. For this, the researchers introduced the latently infected neuronal cell line to a carrier with pores. Subsequently the cells were also irradiated with UVB. The virus was reactivated and penetrated these pores, infecting the cutaneous keratinocytes – the keratinizing cells cultivated previously. To verify the infection, the scientists used a specific antibody that binds to a specific protein on the outer layer of the virus. The coloration of this antibody made it possible to clearly show the infection of the skin cells with the reactivated virus from the nerve cells. "The 3-D herpes infection model therefore simulates an in-vivo situation exactly. Animal experiments will in the future become

largely unnecessary," happily explain Burger-Kentischer and the doctoral candidate, Ina Hogk, who has worked on the development of the model from the beginning.

Research on active ingredients can profit from the 3D herpes infection model of the researchers from IGB, a model that also enables improved study of infection mechanisms. This procedure might also be used to test new medications for shingles, which is also caused by a variant strain of the herpes virus. At the BIO trade fair from June 27 - 30, 2011, in Washington, DC (German Pavilion, Booth 2305), the researchers will answer questions regarding their new development.



The 3-D infection model makes it possible to examine infection mechanisms such as a herpes infection. (© Fraunhofer IGB)

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The fine art of etching

A winding country road. It is dark, and a thick ground fog has settled in. The driver of a car cautiously enters the next curve, when suddenly a caution lamp flashes – a fallen motorcycle rider lies on the street. Thanks to the intelligent assistant, the driver has been warned and is able to brake in time. Infrared cameras see more than the naked eye and could make traffic safer. Indeed, thermal imaging cameras are already used in certain applications – in the construction industry and the military, for example. Such infrared cameras, however, are hardly available in the mobile area, for example in automotive safety systems. The reason: long-range infrared microsensors are currently difficult to produce commercially.

Researchers of the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg, Germany, are now offering a solution. On June 22, they will be opening a new facility in which the production of such micro-system technology, or MST for short, is possible. MST involves minute sensors, valves or other mechanical components that are integrated into semiconductor chips. For instance, in airbags they serve as motion sensors, and they are no thicker than a human hair. If MST is to be applied on semiconductors and integrated, one has to master the art of etching – which is where the researchers at IMS come in.

To apply MST to a semiconductor, one essentially puts three layers on top of each other. The bottom layer is the substrate, namely the silicon wafer; in the center there is a sacrificial layer that serves as a spacer, and this is topped by the function layer. The sacrificial layer is later etched away, leaving only the desired sensor structure behind. The problem: "Traditional etching methods allow us only to etch vertically into the layers," explains Dr. Marco Russ, project manager at IMS. "However, unsupported structures are decisive for the mechanical functions of many items of MST." In other words: the etching must work not only vertically but evenly in all directions. Experts call this process "isotropic etching." This ensures that the etching substance not only eats vertically to the substrate but also digs itself under the function layer, like a tunnel. What remains is an unsupported structure of the function layer that is only one hundred nanometers thin and connected to the substrate only at certain suspension points.

"A conventional technique is etching with liquids", says Russ. However, capillary forces can occur when the etching fluid dries. The result: the filigree membranes are glued to the substrate or are even destroyed. In addition, most etching liquids do not

permit the choice of just any combination of materials for the function and sacrificial layers. "We bypass these problems with our new facility," says Russ. The highlight: "We can use two different gases in the processing chambers of the machine instead of fluids." They are highly selective: hydrogen fluoride (HF) has strong etching properties on silicon dioxide but does not affect silicon. The exact reverse is the case with xenon difluoride gas (XeF2).

"This way, we can select which material is better suited to be the function layer," says Russ. The new facility could revolutionize MST production, since the process works in a highly precise manner on an industrial scale. And: whether thermal detectors, acceleration sensors and pressure sensors or micro machines – a multitude of MST structures can be produced in this way.

MSTs, tiny sensors integrated into semiconductor chips, are produced in the MST laboratory and clean room. A researcher operates the production machine. (© Fraunhofer IMS)

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