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**WE INVENT THE FUTURE**

## **2 WE AND THE FUTURE**

### **4 FRAUNHOFER: WE INVENT THE FUTURE**

- 4 We reward success!
- 6 We solve problems!
- 8 We never give up!
- 10 We push back the frontiers!
- 12 We conduct research for industry!
- 14 We turn ideas into breakthroughs!
- 16 We set the agenda!

### **18 CONTACTS**

- 18 Fraunhofer-Gesellschaft
- 20 Editorial notes

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# FRAUNHOFER – WE INVENT THE FUTURE

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Fraunhofer is a successful enterprise. Founded in 1949, the organization consisted of just a handful of employees in the early years. Today, some 17,000 employees generate revenues of 1.6 billion euros.

This impressive development reflects the ascendancy of Europe as it evolved into a key location for business and science. But it is also intimately tied up with the nature of Fraunhofer itself: Our organization boasts various "traits" that have enabled us to excel in the market for contract research.

And so we promote good ideas on all levels, placing collaboration with business and industry firmly center stage and consistently rewarding success, be it on an individual level or vis-à-vis our institutes.

This brochure aims to show who we are, how we work and why we manage to achieve our targets time and again. It also explains why we are more determined than ever to be involved in shaping the future of technology development in Germany and Europe.

Applied research is a lucrative and, indeed, fulfilling task. So if you're interested, we'd be more than happy to have you onboard.

Let's join forces to invent the future!

Sincerely,



Hans-Jörg Bullinger  
President of the Fraunhofer-Gesellschaft

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# WE AND THE FUTURE

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## What do we understand by future?

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Very few things are as intriguing as the future. Everyone wants to know what the next five minutes will bring, wants to be prepared for tomorrow's weather, and some questions we'd much rather have the answers to now, as opposed to years from now. Will we enjoy the kind of success at work that's so important to us? What will my future home look like? Will our children do well at school? Our hopes and fears rest on what the future holds.

The philosopher Karl Jaspers summed up his thoughts on the future as follows: "As the realm of our possibilities, the future constitutes the realm of our freedoms." He derives something entirely positive from our contemplation of the future. The unknown can be exciting: it can make us curious, awaken our interest in discovering new options and give us new freedoms.

All of which contrasts starkly with the musings of U.S. industrialist Charles F. Kettering: "My interest is in the future because I am going to spend the rest of my life there." So, is the future, this unknown entity, slightly disconcerting, something we need to worry about?

Hopes and fears are there in equal measure when we think about the future. Both fuel our desire to look at least somewhat into the future.

But is that really feasible?

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## Can we look into the future?

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People have always wanted to know what the future holds. The ability to predict accurately what will happen gives you an advantage over the competition, ensuring you're prepared.

And so people have been constantly trying to intellectualize the notion of the future. Thomas More set out his vision of an ideal society in his work "Utopia", which was published in 1516. Its title has shaped our notion of an ideal community ever since. The kind of scenarios dreamed up in the works of technology visionaries such as Jules Verne also demonstrate extraordinary foresight.

Even the so-called experts have been caught out by predictions which proved entirely off the mark, testimony to just how unreliable these kinds of predictions actually are and a source of many a wry smile today. "Television won't be able to hold on to any market it captures after the first six months", said the U.S. film producer Darryl F. Zanuck in 1946. "People will soon get tired of staring at a plywood box every night." Likewise Ken Olsen, CEO of Digital Equipment Corporation, couldn't have been more wrong in 1977: "There is no reason for any individual to have a computer in his home."

But of course we are also familiar with many correct predictions. Moore's law, formulated in 1965 by Gordon Moore, co-founder of Intel Corporation, is just one example. It still largely applies today and will probably do so through 2020. In essence, Moore's law states that the number of transistors in an integrated circuit will double approximately every two years. The entire IT industry is geared to this continual evolution.

Predictions can only be really useful if you're aware of their basic limitations: The simpler and more short-term they are, the more they're likely to be right. One person on their own seldom comes up with the right answer; and there are broad development lines whose path can be effectively predicted. Globalization, worldwide networking and demographic change, for example, are powerful drivers that are discernibly reshaping our industrial society into a knowledge society.

So if you really want to look into the future, you need to ask sensible questions, examine the factors involved and talk to lots of experts. And that's just what Fraunhofer scientists do in their Delphi studies.

Ultimately you can't and don't have to know every last detail of the future. An understanding of the general framework that will underpin our lives in the future is sufficient. Pericles, the statesman in ancient Greece, summed it up thus: "It is not a matter of predicting the future, but of being prepared for it."

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### **What influence do we exert?**

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Knowing what the future holds can be a double-edged sword. There might well be something unpleasant down the line we can do absolutely nothing about, yet such a realization may overshadow everything else we do. So the concept that you can influence your future is much more reassuring!

Not everything is within our control. There are the inescapable laws of nature, not to mention the overwhelming element of chance. And so an increased sense of the openness of development is substituting the notion that the future can be planned as a whole. And with it the notion that every individual can also influence his or her own fate. Which partner we choose, which profession we go into or even the countries we visit:

We ourselves take these decisions. Certain roles even allow individuals to steer the way society develops: Politicians, entrepreneurs and the media do occasionally move the world.

Researchers and inventors have an enormous, in many ways underestimated influence. How totally different would today's world be without the car, telephone, computer or antibiotics? Can we imagine life without the technical breakthroughs such as the television, aircraft and mobile phone? And why would we want to?

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### **Fraunhofer: We invent the future**

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If you want to shape the future, then you need to act in the present. Scientists and engineers sit at important interfaces, exerting a direct influence on the shape of tomorrow's world through their work.

What can we at Fraunhofer do for the future?

Fraunhofer is Europe's largest organization for applied research. Our areas of research are geared directly to the needs of people: Health care, security, communication, mobility, energy, environment. And that's why the work undertaken by our researchers and developers also has a huge influence on people's future lives. We are creative, we shape technology, we design products, we improve processes, we break the mold.

So if you're looking to help shape tomorrow's world, then you've come to the right place: We invent the future.



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## WE REWARD SUCCESS!

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Success is rewarded – a simple principle, but without it Fraunhofer wouldn't be where it is today. According to the "Fraunhofer model", every euro the institutes earn from contracts is matched by a euro from the government as basic funding. So government funding ends up exactly where it's most effective, i.e. in projects with a strong industry focus.

This model of success-driven, flexible financing was revolutionary when it was introduced. 25 years ago, when a few Fraunhofer Institute Directors stepped up to the plate:

"Yes, let's measure ourselves against our success!", many believed it just wouldn't work with research. In a world of fixed budgets and job quotas, you'd have to be made to embrace such an insecure future. The Fraunhofer researchers rose to the challenge – and reaped the rewards. Performance-based rewards gave rise to a highly dynamic business that is still there today. And success is used as the benchmark to determine the next steps: Successful ideas are allowed to grow; ideas that don't catch on are allowed to fall by the wayside.



Today the Fraunhofer model is used as a model for applied research around the globe. And the model offers further potential. Getting rid of the inflexible remuneration system is one way of bolstering performance even further.

The model works best in day-to-day practice. Take for example, the numerous milestones in the development of LEDs, such as the first white LED, which all came from Fraunhofer.

This research area receives sufficient funding by generating practical applications, which in turn generate revenue, completing this virtuous circle: The combination of LEDs with micro-optics extends the associated applications enormously – a groundbreaking approach for which Fraunhofer researchers together with OSRAM Opto Semiconductors GmbH received the German Future Prize 2007. Organic LEDs are currently being developed in Fraunhofer laboratories for a wide range of future scenarios. Flexible displays are one possibility or even luminous wallpaper as a glare-free light source.





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## WE SOLVE PROBLEMS!

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Find a problem and you'll also find a need for research: Does the lack of innovation put a brake on revenue? Does production use too much energy? Is there a lack of manpower for certain services? Whatever technical or organizational problem a company may face, Fraunhofer researchers will come up with a solution.

The Fraunhofer specialists never lose sight of financial implications and technical feasibility before they provide a company with an offer. Because they are used to deploying or developing new technologies further, to the point where they can be used for practical industrial applications. Problems are seen as challenges, spurring them on to find the solution where others may well have long since given up. Interdisciplinary teams and extensive experience add up to unrivalled problem-solving expertise. All the specialists can also turn to a Fraunhofer-wide network of experts for support, with collaboration encouraged across institutes and various disciplines.





What the researchers develop can be of great benefit to many people. Even with the onset of old age and restricted mobility, most people prefer to stay at home. But to do so they need assistance. For the well-off the answer used to be perfectly simple – cue the trusty servant. Fraunhofer is working on a new option: the service robot. These machines can already relieve people of unpleasant or even hazardous jobs within the home or in the workplace. Cleaning is often seen as tedious.

So Fraunhofer researchers developed a vacuum cleaner which moves independently through the home, returning to its base station once the job is done. Nonetheless, the researchers are still not entirely satisfied. Every improvement to the robots adds new capabilities which can solve even more problems for people.



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## WE NEVER GIVE UP!

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A good idea is one thing, but anyone looking for genuine research success needs something more: A visionary goal – and the perseverance to see it through no matter how tough things get. The development of mp3 is a case in point. In the early 1970s, the Fraunhofer researcher Dieter Seitzer was looking for ways of transmitting voice over telephone lines with high quality. However, his attempts to patent the process came to nothing, and the rollout of ISDN and fiber-optic cable soon put paid to the original research aim. But the scientist believed in the success of his idea and decided to extend the option of audio encoding to music data.

Many researchers contributed to the ongoing development of the process over the next few years. They focused on removing all the data the human ear could not detect or process. And so they ultimately managed to reduce the volume of a music file more than ten-fold, without losing any of the quality of the listening experience. The breakthrough followed in the 1990s, giving rise to what we now know as mp3 – the technology that is used worldwide for digital radio, electronic devices and Internet broadcasting.



And the success of this single-minded approach ultimately rubs off on other research areas: Licensing revenue from the mp3 process paved the way for the Fraunhofer-Zukunftstiftung (Fraunhofer Future Foundation), which gives other visionary projects the opportunity to succeed.

Despite the initial setbacks, the decision to persevere with the original idea of audio encoding and look for new applications paid off. And the work on the encoding process continues, with new fields opening up, such as video encoding. Here too, Fraunhofer researchers are at the cutting edge of development.



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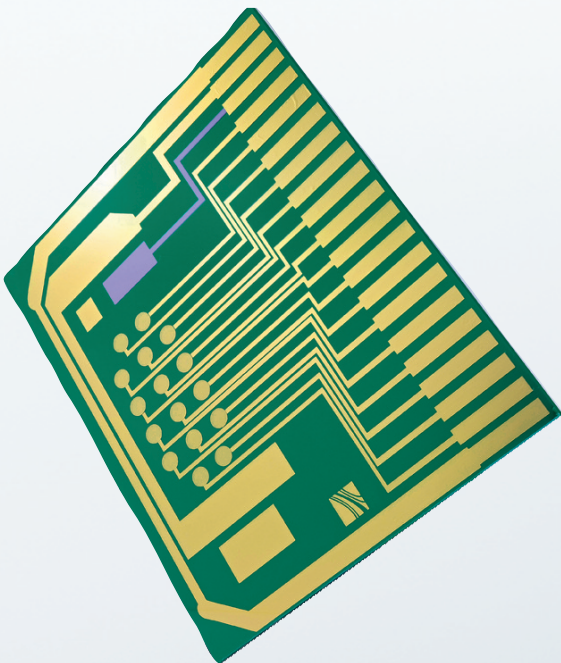
## WE PUSH BACK THE FRONTIERS!

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Specialists are the backbone of science, not least because research depends on their technical know-how and their experience. This expertise can best be exploited by having researchers from various disciplines collaborate – an approach that overcomes the confines of individual disciplines, thus spawning new ideas which a specialist alone would often not come up with. And, occasionally, we may even end up redefining physical boundaries.

Fraunhofer researchers are showing just how this process works with miniaturization. Ongoing miniaturization of components is one of the key technology trends – a development that opens up the prospect of huge boosts in performance and ultimately also helps conserve resources. Here collaboration between various experts is extremely important. The design and manufacture of biochips, for instance, requires expertise in the fields of microelectronics, biology and medicine, with the analytical capabilities of entire laboratories being reduced down to a tiny format. The result is impressive: Portable, highly sophisticated analysis which costs far less than conventional technology.





The “handkerchief laboratory” is one of the researchers’ goals: Autonomous biosensors built into the handkerchief could detect straightaway whether it’s just a common cold or the first signs of a more serious bout of flu.

But research doesn’t simply stop there. In the Fraunhofer laboratories they are thinking about miniaturizing a wide range of technologies. Projectors that fit in your pocket, clothing with integrated electronic functions and implantable independent measuring devices are just some of the many ideas the scientists are working on. And their overriding goal is to come up with low-cost production methods. Because even cost is sometimes an obstacle between idea and application – an obstacle that has to be overcome.



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## WE CONDUCT RESEARCH FOR INDUSTRY!

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Nice to know, and we'll leave it at that? Not at Fraunhofer. We don't just want to know how something works; we also want to show that it works. And we want to use it. Whatever they do, Fraunhofer researchers are driven single-mindedly by the overriding goal of practical application. Sometimes this involves direct contracts from businesses that have asked us to solve a specific problem; at other times we promote a technology that we believe is extremely promising. Or we pursue first-class ideas which we expect will turn into new applications. But the goal is always to come up with a beneficial application.

Cell phones are perhaps an example of a technology that has gained acceptance virtually overnight, providing a constant source of new applications. In the early 1980s, the cell phone was more of a novelty, but within a matter of years mobile telephony had been revolutionized, offering the kind of price and performance that enables almost everyone to have a cell phone nowadays. And accompanying enormous increase in personal convenience and safety, handset manufacturers and wireless telecommunications providers now rank among the world's most dynamic companies.





Fraunhofer picked up on this trend early on, energetically promoting development through its own research. Handsets are morphing into multimedia all-rounders, and many of the services are based on Fraunhofer research: Location-based services, purchase of bus tickets, access to customized weather reports and identification of songs are just some of the very latest features. Fraunhofer is also behind a range of technical innovations which work away merrily in the background without the user being aware of them. Such innovations include autonomous energy systems for repeaters, which work inde-

pendently of the power grid, or ultra-powerful antenna systems. And so, Fraunhofer has contributed substantially to the rapid and lucrative development of the mobile communications segment.



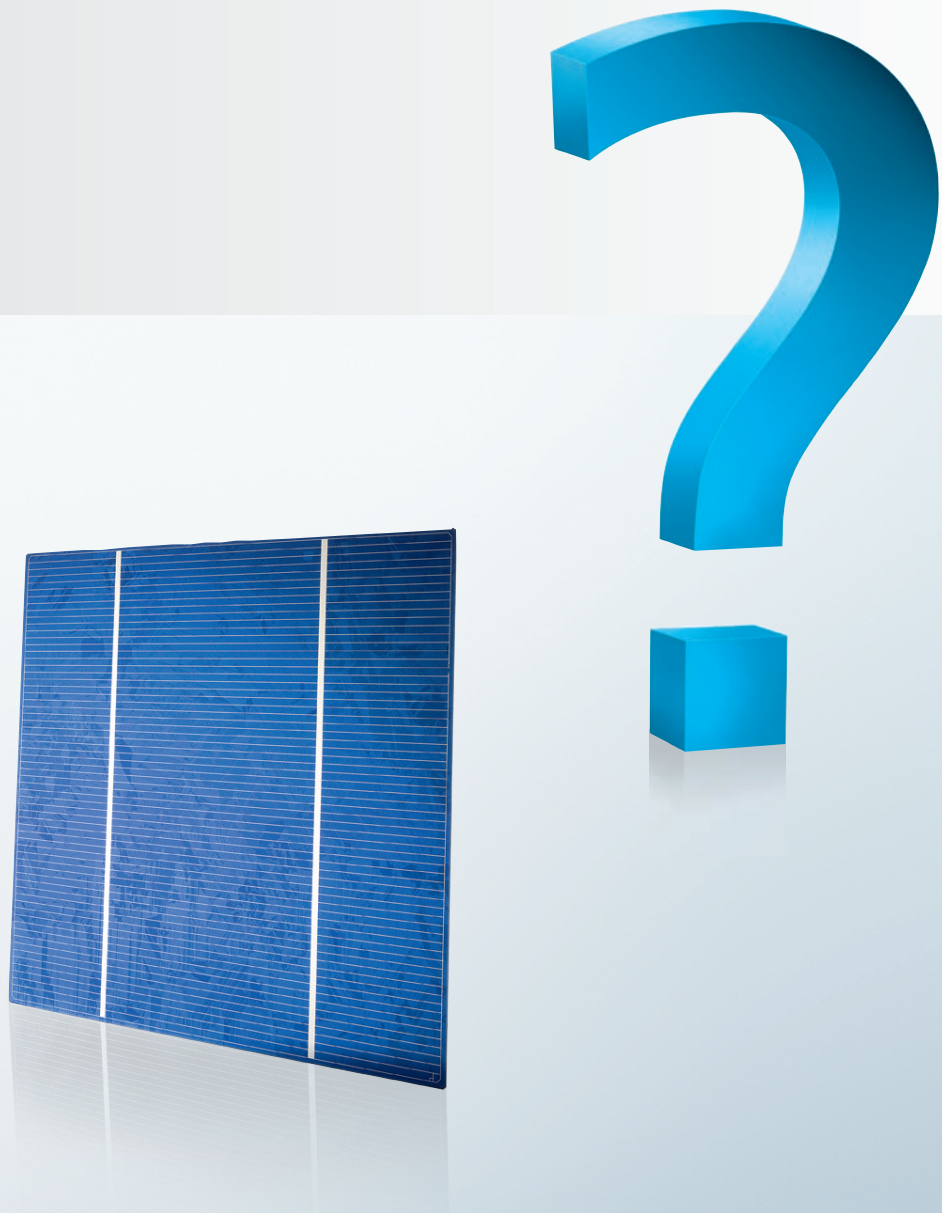
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## WE TURN IDEAS INTO BREAKTHROUGHS!

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Ideas form the bedrock of innovation. Innovative research therefore relies on promoting new ideas on all levels. Not every idea will ultimately succeed. Nonetheless, we are prepared to take risks when it comes to research.

The risk, indeed the time and money involved in the search for a groundbreaking solution, may be too great for an individual researcher or even for an institute to assume. This is where a strong community comes in and, thanks to the huge success of mp3, Fraunhofer now also has a new tool at its disposal. We used the licensing fees from audio encoding to set up the Fraunhofer-Zukunftstiftung (Fraunhofer Future Foundation) whose aim is to provide the necessary research capital so that promising ideas can be transformed into successful products.



One of these projects tackles the issue of energy supply – a fundamental problem faced by our modern world. We know that ultimately only renewable energies such as solar power can ensure a sustainable energy supply. Yet the production of solar power is still hampered by the high cost of the modules. Financial funding from the Fraunhofer-Zukunftsstiftung is helping advance the use of metallurgical silicon for photovoltaics. The researchers expect significant cost savings with only minimal efficiency losses.

Sometimes the ideas and developments from the Fraunhofer laboratories are so compelling that researchers are reluctant to hand over commercial exploitation to others. You need to be adventurous to start up on your own, but anyone willing to take the plunge can rely on support from Fraunhofer. The dedicated Fraunhofer Venture Group can provide advice and sometimes even arrange funding and startup capital.





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## WE SET THE AGENDA!

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Fraunhofer researchers are used to looking into the future: Applied research is measured in terms of market success, and therefore we need to know what tomorrow's customers expect of us. Our aim is always to offer an up-to-date portfolio of research and development services. In many areas we are the pacesetters at the cutting edge of technology.

What's more, government and industry trust our advice. We put together technology forecasts, define the research fields that are set to become increasingly important in future, and we assess the impact of new technologies. And so we are able to predict and broaden the potential applications, and tackle the drawbacks, such as excessive resource utilization, right from the outset.



Technology forecasts are an ongoing process. As part of an intensive dialog, Fraunhofer identifies research fields that are set to play an important role in future, while at the same time being involved in their implementation. This dual role as trend scout and trendsetter often gives rise to some first-class results. For instance, Fraunhofer not only predicted the rapid development of LCD screens but its dedicated research also helped support and promote innovation. Numerous patents in this field help ensure such a commitment pays dividends while paving the way for future research.

Television has an exciting future ahead. Fraunhofer is decisively involved in the development of 3-D screens which do not rely on stereoscopic glasses. In just a few years, our normal way of watching movies will seem just as antiquated as the original black-and-white television does to us today. The future is already here – in the Fraunhofer laboratories.

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# CONTACTS

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## Fraunhofer-Gesellschaft

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

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 59 Fraunhofer Institutes. The majority of the 17,000 staff are qualified scientists and engineers, who work with an annual research budget of €1.6 billion. Affiliated research centers and representative offices in Europe, the USA and Asia provide contact with the regions of greatest importance to present and future scientific progress and economic development.

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

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## **Fraunhofer Groups**

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The Fraunhofer Institutes are grouped in seven working alliances devoted to specific broad research areas in order to bolster scientific cooperation and offer customers a joint, coordinated service:

Fraunhofer Group for Defense and Security VVS  
[www.vvs.fraunhofer.de](http://www.vvs.fraunhofer.de)

Fraunhofer ICT Group  
[www.iuk.fraunhofer.de](http://www.iuk.fraunhofer.de)

Fraunhofer Group for Life Sciences  
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Fraunhofer Group for Microelectronics  
[www.mikroelektronik.fraunhofer.de](http://www.mikroelektronik.fraunhofer.de)

Fraunhofer Group for Production

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