

Ultraclean Technology and Micromanufacturing

Extremely

clean and detailed.



Fraunhofer Institut
Produktionstechnik und
Automatisierung

Established in 1984 with the aim of supporting the semiconductor industry.

60 patents registered to date,
the world's cleanest cleanroom put into operation,
over 1,800 projects
realised for around 750 customers from 30 sectors,
Mars landing.

Extreme profile

In the beginning,
our world
was a disc.

It was 1984 when the German Federal Ministry of Education and Research realised that Germany had deficits in the up-coming area of semiconductor technology. With the aim of developing, expanding and retaining technical expertise for Germany as an economic location, the "Cleanroom Technology" Department was established at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA. The wafers, i.e. those flat silicone discs which form the basis of all semiconductors, formed the focus of our activities during the first few years.

The Wafer and Chip Department

Preoccupation with wafers meant that it was inevitable that the new "Cleanroom Technology" Department was obliged to come to grips with clean working environments. This evolved into an enormous wealth of knowledge which numerous companies representing a wide variety of sectors benefit from today. Even during the early years, we were preoccupied with developing and optimising equipments, material flows and logistics in the cleanroom, particle measurement technology and new cleanroom and manufacturing execution concepts.

Ultraclean Technology and Micromanufacturing opens up to new sectors

Thus, cleanroom technology evolved over the years to become the Ultraclean Technology and Micromanufacturing Department with more than 70 employees. Even today, emphasis is still put on the issues with which everything began. Our customer base has, however, changed dramatically. And not only because we have positioned ourselves

at the international level. Producers of semiconductors and semiconductor devices were joined by the photovoltaic industry as well as the Automotive, Life Sciences, Aviation, Aerospace and Microsystem Technology sectors. Customers from other sectors have also followed in their wake.

From micro to nano

Our motto remains unchanged: the future evolves here. Accordingly, ongoing development and improvement of technical manufacturing solutions for production subject to contamination remains one of our focal areas. Another challenge is represented by transferring microsystem techniques into the area of nanotechnology – a development which is in line with the trend towards miniaturisation.

The Ultraclean Technology and Micromanufacturing Department: Facts and figures

Employees:

40 scientific employees, and increasing
30 junior scientists

Patents:

60 patents have been awarded since its establishment

Research and development activities:

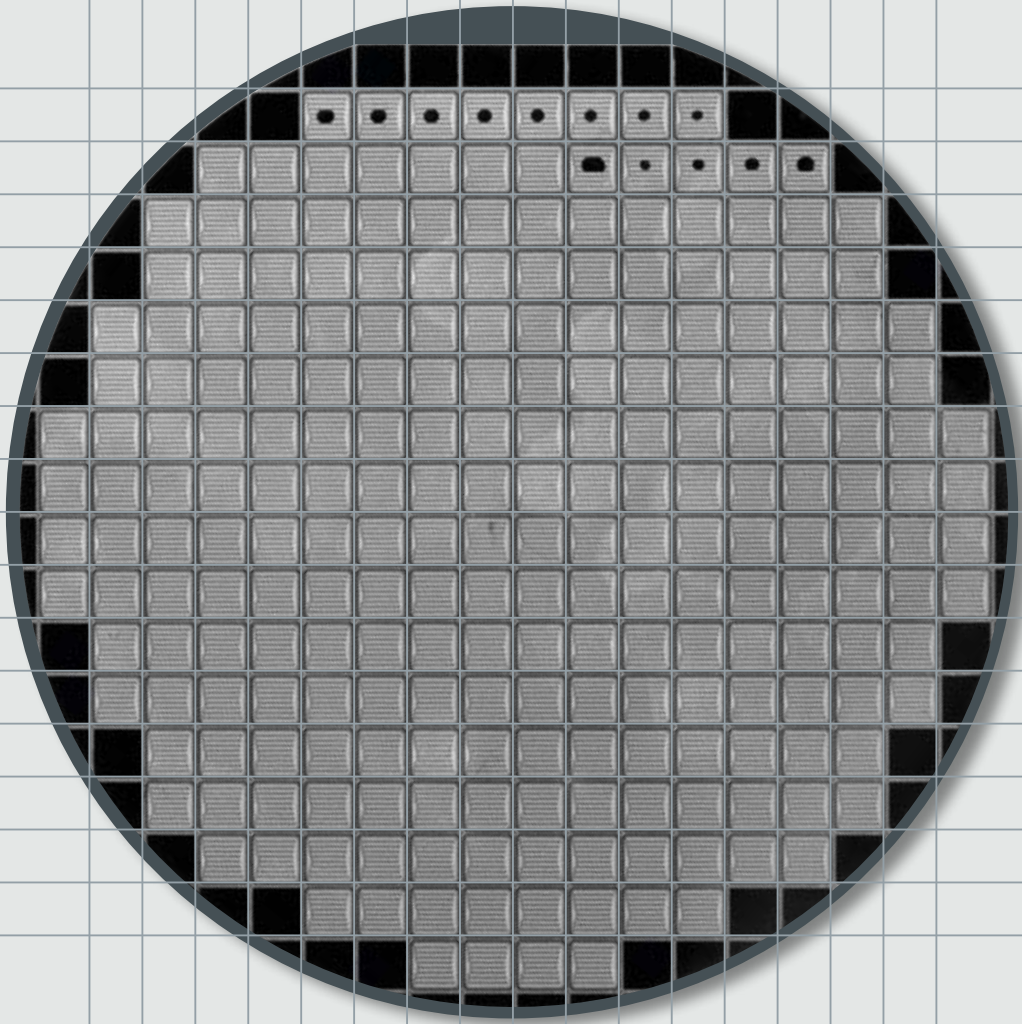
60% of projects realised are commissioned
by industrial companies

30% are publicly funded projects

10% are independently financed initiatives

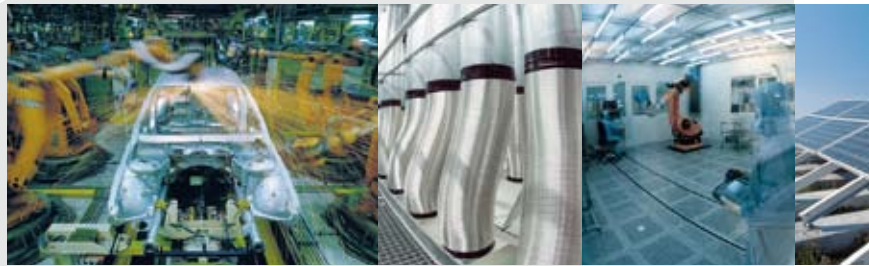
Operating internationally in Europe, Asia and
North America

Annual turnover: €5 million



Extreme stand-alone features

Welcome to the
cleanest cleanroom
in the world.



Researching ultra-clean working environments has preoccupied us for the past 25 years. Meanwhile, we can undoubtedly be regarded as the cleanest competence centre in the world. After all, our know-how has not only led to international cleanroom standards – it has also been incorporated in many binding norms. But that's not all: we can call the cleanest cleanroom in the world our own. Considering it is at least ten times cleaner than required by Cleanroom Class ISO 1, this means that one cubic metre of air may contain a single particle 0.1 micrometre in size. On an area spanning more than 150 m², these conditions enable us to perform contamination control tests even for heavy-duty equipments. This is where we comment on all relevant technical manufacturing aspects for industries and products subject to critical contamination.

Squeaky clean consulting for industry

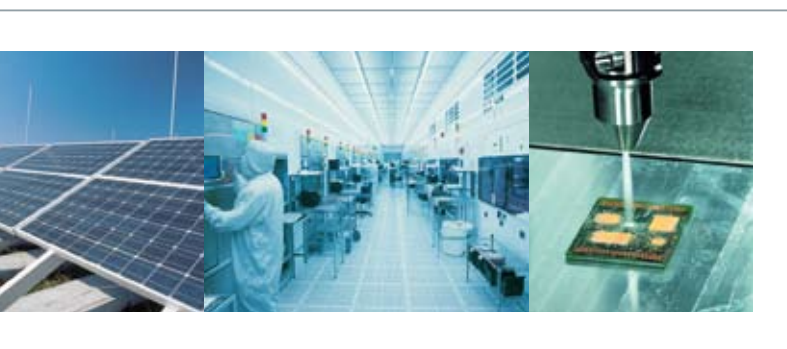
We are delighted to pass on our experience in the cleanroom sector. With the result that we offer consulting services to our customers from the concept phase through realisation to commissioning of equipments or entire production systems. Our research and development services cover issues such as production planning, production optimisation, clean technology, cleaning technology, measuring technology, micro-assembly, equipment design, production IT and logistics.

State-of-the-art infrastructure for high-end results

Clean results are achieved thanks to test and laboratory conditions featuring state-of-the-art technology. This includes a 300-mm measuring machine for wafers, an automated Raman spectrometer, CNC counters, high-precision dispensing systems, and much more. We even develop our own test equipment if existing systems fail to meet our requirements.

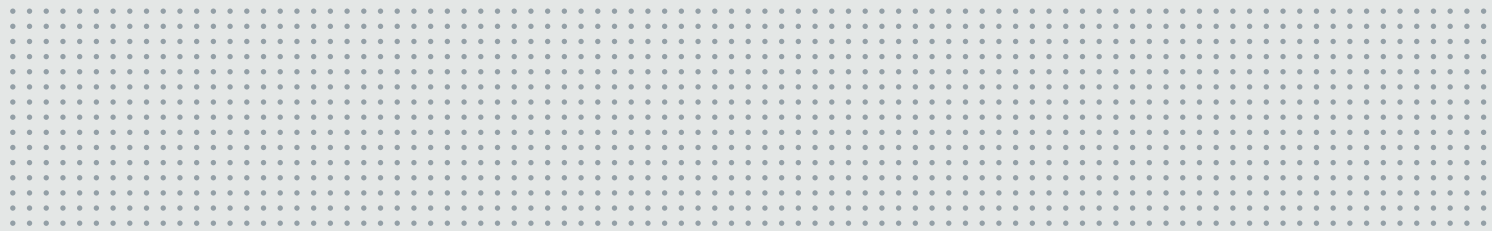
Practical research

Our orientation towards application forms the basis for unique cooperation with industry. We identify with our customers' goals as, after all, we are motivated by their success. We therefore develop and optimise production equipments and working environments in collaboration with research and industrial partners. And we are also committed to developing platforms for merging decision-makers and opinionleaders representing industry and research.



Extreme success factors

We employ the toughest contamination critics in the world.



Four horizontal rectangular boxes, likely representing input fields or a list, arranged vertically.

The discoveries of Ultraclean Technology and Micromanufacturing often lay the initial foundations for new products or production methods. Whether because progress has been achieved in miniaturisation or because more stringent sterile conditions can be maintained. The work we contribute to such innovative developments is something of which we are deservedly proud.

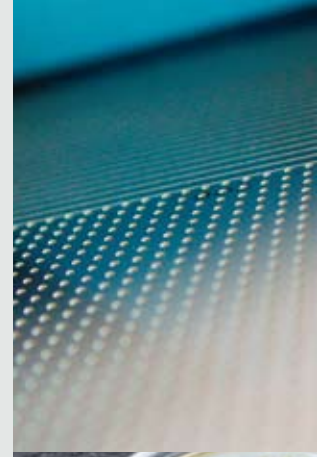
Linking research and industry

Powered by continuous innovations, companies are constantly developing new products. They increasingly integrate more and more components representing electronics, microtechnology, mechatronics, sensor technology and nanotechnology. New products often demand changes to production or even the development

of new production techniques. Companies see us as an ideal research partner when it comes to entering new technical production territory. But what makes us capable of this? We avail ourselves of extensive industry knowledge, and are eminently familiar with the methods applied. Thanks to numerous projects for industrial clients, we operate in an extremely practical and production-oriented manner. We realise the latest research findings and transfer know-how gleaned to other companies. This involves corporations of international renown and medium-sized German and European companies alike.

Accustomed to treading new paths

The development of innovative products places maximum demands on everyone involved in a project. For this



reason, we have developed a major network which we can rely on – device manufacturers for realising equipments or experts from other areas, for example. But it goes without saying that it is primarily our own team which makes us so successful. We employ many young and motivated people who hope to make a difference, who are thirsty for knowledge and display extreme commitment. By working with us, they probably become the most “contamination-critical employees” around. We enjoy cooperation with the Institute of Industrial Manufacturing and Management (IFF) and the Institute for Control Engineering of Machine Tools and Manufacturing Units (ISW) at the University of Stuttgart. By promoting thesis projects and interdisciplinary knowledge transfers among biologists, engineers, physicists, economic scientists, etc., our research activities remain constantly up to date.

Independence generates confidence

One key reason for the confidence placed in us by companies is represented by our independence. As an institute of the Fraunhofer-Gesellschaft, we have the task of conducting application-oriented research for the direct benefit of companies and to the advantage of society in general. This task and our innovative power, our willingness to take on risks and the wide range we offer mean that we enjoy a high degree of respect and acceptance in the industry. In many cases, we even act as a mouthpiece for the economy – when drawing up standards and guidelines of international validity, for example.

Extreme range of services

Tried and tested in extreme situations: our special units.

Research and development into ultra-clean and technical microproduction processes, methods and equipment is an extensive and very dynamic field. So many aspects need to be taken into consideration that only declared experts are truly successful – and then only if they cooperate with each other in an interdisciplinary manner. For this reason, the area of Ultraclean Technology and Micromanufacturing at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA is broken down into the following “special units” which are interlinked:

Manufacturing technology

- Full solutions concerning the requisite technologies for the development of microtechnical hybrid systems
- Analysis of requirements associated with handling and assembly of micro- and contamination-critical components
- Feasibility studies
- Process developments and adjustments
- Realisation of technical devices and know-how transfer
- Acceptance and implementation in manufacturing

Development of equipment and plants

- Development of need-oriented economical equipment and plant concepts
- Development of equipment components and tool systems for automated applications
- Consulting concerning cleanliness suitable design of equipment and plants
- Development of adapted plant control systems
- Support in procuring components, optimising processes and commissioning

Manufacturing optimisation

- Logistical and clean optimisation of equipment and plant technology
- Optimised material flows, thanks to automated transport systems
- Implementation of cleanroom technology for optimum manufacturing environments

Production ramp-up

- Research and development consulting as regards the competitive opportunities and technological feasibility of microtechnical and/or contamination-critical products
- Planning and selecting production systems adapted to the target piece numbers
- Design and implementation of cleanliness techniques, coordinated to individual requirements
- Organisational and technical support in developing serial production

Equipment and manufacturing automation

- Potential analysis
- Logistical design of equipment and manufacturing as a whole
- Scheduling and dispatching in semiconductor and photovoltaic factories
- Planning and designing equipment and plant technology, incl. for automated transport and handling
- Support in procuring equipment, optimising processes and commissioning

Cleanliness technology

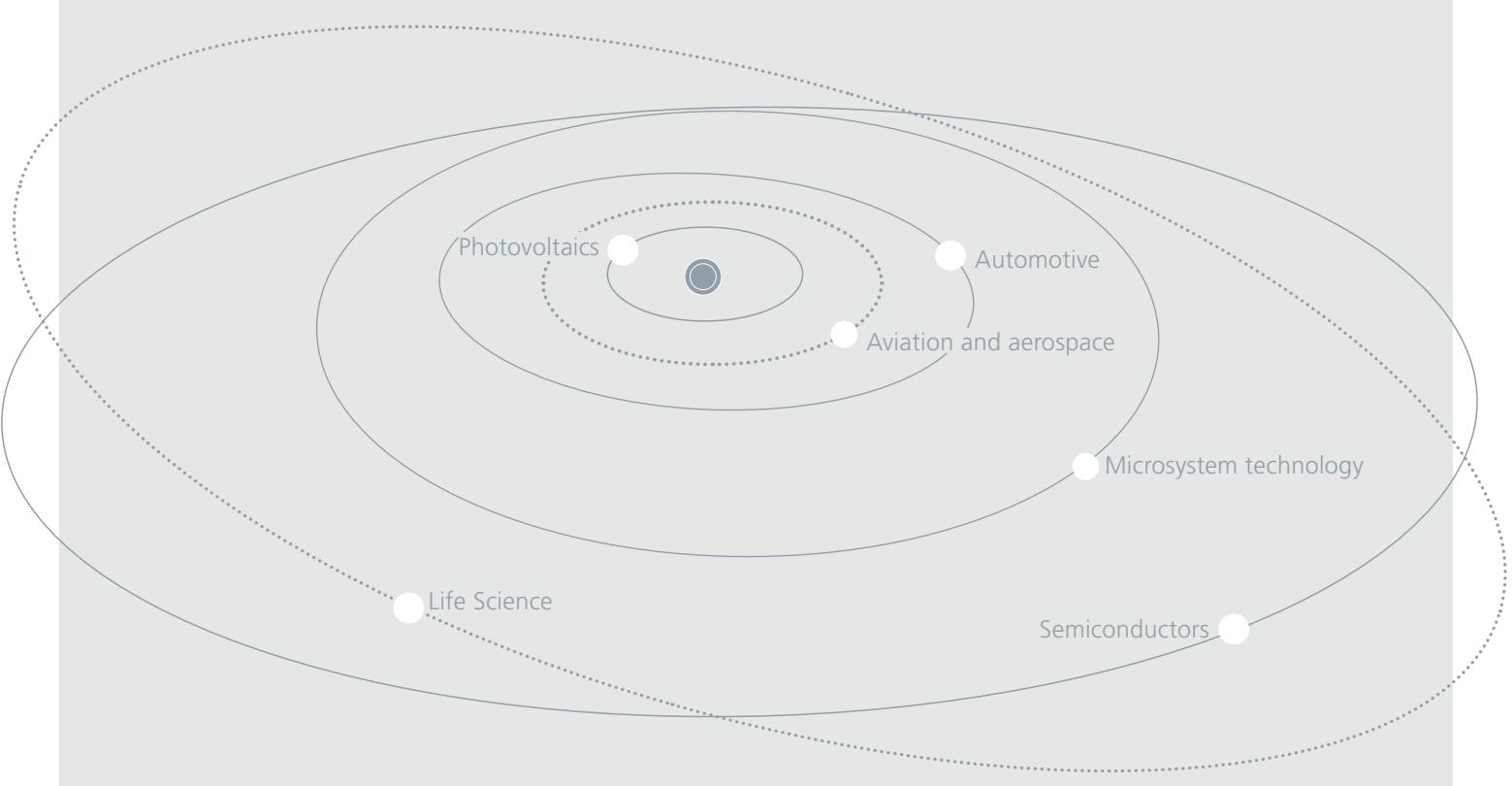
- Planning and designing ultra-clean production, clean manufacturing methods, equipment and processes
- Testing the cleanliness of ultra-clean systems, equipment, components and materials
- Analysing contamination, establishing the causes of contamination and drawing up optimisation measures
- Developing adapted cleanliness, handling and measuring systems
- Training personnel for deployment in cleanrooms

Production IT

- Capacity planning
- Selection, evaluation and adaptation of manufacturing execution systems
- Production sequence planning
- IT equipment and plant integration
- Integration of planning and execution systems

Extreme references

Many others push innovations
to market maturity.
We send them to Mars.





Example 1:
**Cleanliness and contamination control
 on the ExoMars mission**

Within the framework of the ExoMars Project, ESA looks for evidence of life on Mars. For the very first time, this will also entail bringing stone samples back to earth for testing. A decisive factor for success: the extreme cleanliness of the spacecraft, surfaces and above all measuring instruments during all of the mission phases. The Ultra-clean Technology and Micromanufacturing Department contributes to the success of the mission in the form of its know-how in the following areas: local cleaning methods, manufacturing and cleanroom planning, equipment design in line with cleanliness, contamination control and examination of the contamination potential of equipment and spacecraft.

Example 2:
Own equipment developments

Fraunhofer IPA drives the development and realisation of equipment for decontamination and detection of contamination, adapted to the respective problems. For example, with the Particle Guard in 1999 and the CO₂ lance in 2007. The devices are operated in inline or stand-alone applications, and serve towards improving quality and reducing costs in manufacturing environments. With cleaning technology from Fraunhofer IPA, for example, it was possible to support the DESY Research Centre in realising electron acceleration to almost the speed of light.

Example 3:
Tested Device

For the past ten years and in the form of Tested Device, Fraunhofer IPA has offered a certificate for equipment, devices, components and other operating materials suitable for cleanroom applications. Around 600 items have been tested to date which can be researched in the first freely-accessible, Web-based database developed by Fraunhofer IPA.

Example 4:
Micro-dispensing system

Since 2007, the micro-dispensing system has permitted the dispensing of ultra-viscous soldering paste filled with conducting particles which – unlike the current standard of 250 micrometres – can be applied for the first time in a structure width of less than 100 micrometres.

Example 5:
Turnkey photovoltaic thin-layer production lines

By planning and optimising turnkey photovoltaic thin-layer production lines for amorphous and micromorphous® Oerlikon technologies, Fraunhofer IPA supports one of the strongest growing sectors. For customers, this involves drawing up and evaluating logistics and automation concepts for future large-scale production capacities.

Example 6:
**InFrame Syn@pse – an SOA-based manufacturing
 execution system**

Fraunhofer IPA developed InFrame Syn@pse in cooperation with ACP-IT. The system offers extensive functions in the area of production planning and steering for high-tech production facilities:

- Component-based, open and platform-independent system architecture
- Scalability and high availability
- Sustained master data management/configuration concepts
- Machine integration including standardisation and compliance management
- Support for new steering approaches (Advanced Process Control)

Extreme contact

How can we
extremely inspire
you?

Fraunhofer Institute for Manufacturing Engineering and Automation IPA
Ultraclean Technology and Micromanufacturing

Contact person

Dr.-Ing. Dipl.-Phys. Udo Gommel
Head of the Ultraclean Technology and Micromanufacturing Department
Director of the Cleanroom Test Centre

Tel.: +49(0)7119701633

E-mail: udo.gommel@ipa.fraunhofer.de

Nobelstrasse 12
70569 Stuttgart
Germany

www.ipa.fraunhofer.de

www.technische-sauberkeit.de

www.ipa-qualification.com

www.simulation.fraunhofer.de

