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A FLIGHT TO REMEMBER

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X-ray photoelectron spectroscopy at the forefront of biomedical science

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Shimadzu Europa aiming to spur growth

With new products opening up new markets, the future looks bright for this precision equipment manufacturer, despite the dim economy.

News & Topics from Shimadzu

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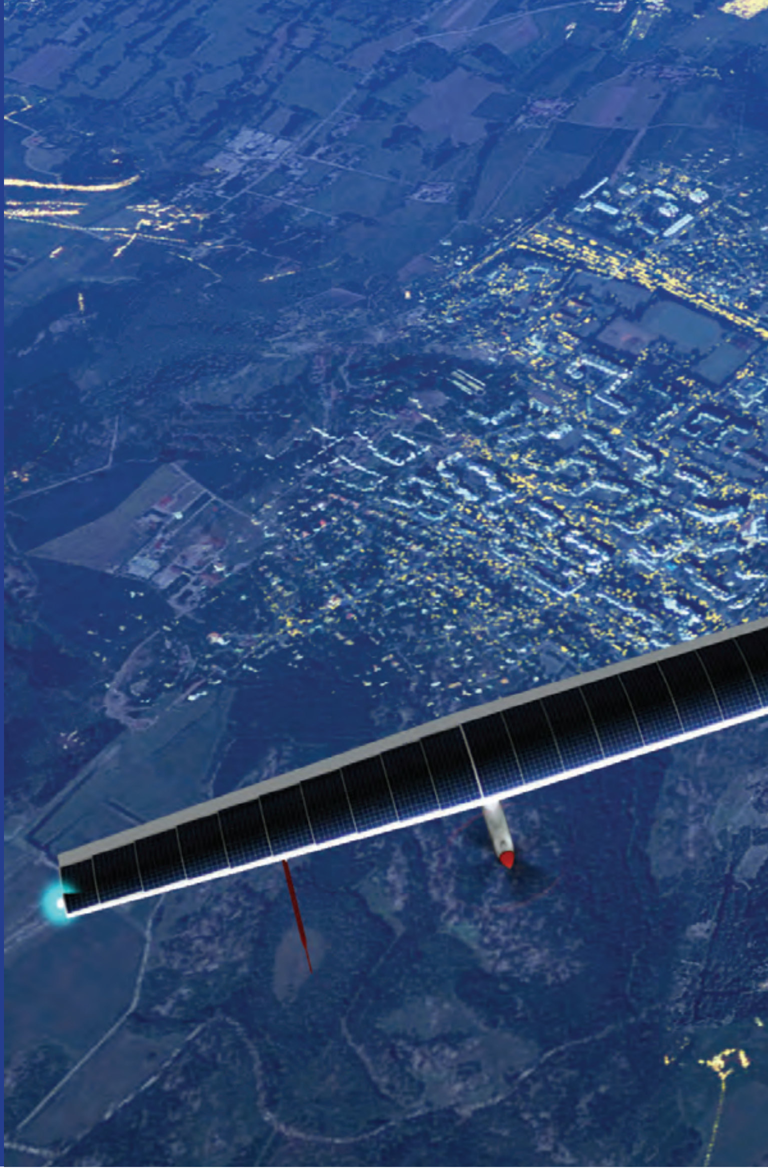
The dream of perpetual flight without fuel has inspired pilots to take to the skies in solar-powered planes. Vicki Cleave looks at a mission to fly a solar plane through the night — and around the world.



A FLIGHT TO

When the Wright brothers made their maiden flight in a powered aircraft on a windswept beach in 1903, it was a short hop, skip and jump into the record books. More than a century later another single-seater aircraft is on its way to making its own recordbreaking hops, skips and jumps around the globe. Each of *Solar Impulse*'s wings will cover more distance than Orville Wright's first flight; but the plane's 80-metre wingspan is not what's truly impressive about it. The remarkable thing is where it will get its power — and how little it will need. Driven solely by energy from the Sun, the plane will be carried aloft by solar cells that generate a total of around 9 kilowatts— roughly the same power available to the Wright Flyer from its single engine.

In the Wright era, aircraft were dubbed 'heavier-than-air machines', reflecting the disbelief that they could leave the ground, let alone be successfully piloted. The history of manned solar aviation fosters similar scepticism (see 'Solar aviation highs and lows'). Most solar planes move so slowly through the air, their ungainly frames buffeted by weather, that they challenge our expectations of modern-day flight. Yet the pilots who wish to fly *Solar Impulse* around the world plan on staying aloft for up to five days at a time, and flying through the Sun-starved night.

The US$91-million *Solar Impulse* project is the vision of Bertrand Piccard, a Swiss aeronaut already in the record books as one of the pilots of the first non-stop round-the-world balloon flight in the Breitling Orbiter 3 in 1999. Piccard, who will also be one of the pilots on *Solar Impulse*'s trip around the world, comes from a family of adventurers. His grandfather Auguste made a record-breaking balloon ascent to 23 kilometres in the 1930s and his father Jacques was one of two people to have reached the Challenger Deep in the Mariana Trench, the deepest surveyed point in Earth's oceans.

Piccard says he first thought of the solar project after he stepped out of the Orbiter. "The press was saying that my balloon flight around the world

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“I thought it would be great to have a vehicle that would fly day and night with no fuel.”— Bertrand Piccard

SOLAR IMPULSE / EPFL CLAUDIO LEONARDI

REMEMBER

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in 1999 was the last adventure that was still possible because everything else had been done,” he says. “I was 41 years old at that time, and I thought ‘it’s a pity if everything has been done.’”

He was also disappointed that the roundthe-world balloon trip had used such massive amounts of fuel: having taken off with almost four tonnes of liquid propane, it landed with just 40 kilograms. “We were really limited in fuel, in duration, and if the wind had been slower on the Atlantic we would have ditched and not made it,” he says. “I thought it would be great to have a vehicle that would fly day and night with no fuel, with no limit of duration.”

Piccard was not the first to be attracted by the notion of fuel-free flight. More than 25 years ago, US aeronautical engineer Paul MacCready from AeroVironment in Monrovia, California, built a plane light enough and slow enough to fly on the low power output of solar cells. His *Gossamer Penguin* weighed less than 31 kilograms without a pilot and its speed over ground was slower than a bicycle. The planned *Solar Impulse* will have a maximum weight of 2,000 kilograms, including the pilot, almost one-quarter of which will be from batteries for storing energy to fly through the night. If all goes well, the plane will fly at speeds of 50–100 kilometres per hour on its round-the-world trip, landing five times along the way to swap pilots.

The trip will be a no-frills experience for the solitary pilot. Inside his snug cockpit, which will protect him from temperature extremes of 80 °C to – 60 °C, the pilot will endure the same cramped position for up to five days at a time. “We are not sure how we will sleep or cope with maintaining alertness,” says André Borschberg, the other pilot and chief executive of the project.

They will need to be at their most alert when flying the slow-moving craft through the hours of darkness. Although unmanned solar aircraft have made night flights before, no piloted solar plane has stayed aloft for more than 6 hours at a time. The *Solar Impulse* team plans to get through the nights with

SOLAR IMPULSE / STÉPHANE GROS

André Borschberg (left) and Bertrand Piccard will pilot Solar Impulse on its round-the-world attempt.

"We are not sure how we will sleep or cope with maintaining alertness." — André Borschberg

a mixture of gliding down to lower altitudes and using batteries for power. After dusk, the plane will descend from its maximum daytime altitude of 12 kilometres to just 1 kilometre. The air is denser at lower altitudes, slowing down the plane and reducing the amount of power consumed.

Handle with care

But the biggest challenge will be the weather. Because of its light weight and slow speed, the craft can't handle strong winds or turbulence."This aircraft is the size of the largest transport aircraft, but it follows any gust that you have," says Borschberg. And despite having a wingspan slightly bigger than that of an Airbus A380, he expects *Solar Impulse* to fly a bit like a hang glider — rather like the Wright Flyer.

When taking off, the pilot can choose the best weather window, but during the crucial overnight descent the plane will be at the mercy of winds and turbulence. "If we have headwinds at night, the night gets longer. If the night is longer the batteries might not be sufficient any more," says Borschberg. Each dawn will look sweeter than the last, as pilot and plane run low on energy.

Fellow solar-aviation experts — many of them pilots themselves — are upbeat about the project's chances. Piccard discussed his plans with MacCready before beginning the project, and his verdict was: "It will take an elegantly crafted vehicle, flown in meteorological conditions that are hard to find, but it's doable." "I'm just very sad he died before we could make our first flight," says Piccard.

MacCready's view is echoed by Chris Kelleher, technical director of the Zephyr project, the record-holder for the longest unmanned solar flight. "It's doable," he agrees."The issues are the altitudes and the speeds that it would fly at, and the weather conditions." As the on-the-ground pilot for the much smaller Zephyr, Kelleher explains that handling isn't a problem once Zephyr is high enough, above about 18 kilometres. "At altitude, it handles like a big, commercial airliner because the gust sizes tend to be big features, and the aeroplane flies very slowly into the parcels of air."

Because it will be manned, *Solar Impulse* won't be able to fly as high as Zephyr. So Kelleher thinks that weather forecasting will be crucial for achieving the mission. "With stable conditions it's possible to predict the weather and come lower," he says.

But how often will the team be able to count on stable conditions? The planned flight path will follow the Tropic of Cancer, which maximizes the plane's exposure to daylight while hopefully avoiding the worst tropical weather. Borschberg agrees that weather prediction is going to be one of the most important aspects of mission planning. "At take-off it's not too difficult, because you decide when to take off. For landing it's more difficult because you cannot always plan exactly what happens."

To test its weather-prediction systems, the *Solar Impulse* team has been conducting virtual flights since last May. The researchers used a simulator that mimics the performance of the aircraft and allows them to introduce meteorological data. "You can have this aircraft basically flying in real conditions," says Borschberg.

They have learnt some valuable lessons from the simulations."We learned that the flight could be longer than expected," says Piccard, and "that we cannot just take off with the absolute certainty that the next five days will be OK." Avoiding bad weather systems means more unplanned diversions. "When we made simulations from Hawaii to Miami, we had to land in Phoenix, Arizona, because there was a big thunderstorm on the Gulf of Mexico," says Piccard. "So we learned to be more flexible."

Fair-weather flyer

Earlier solar planes also faced turbulent weather — with mixed results. *Gossamer Penguin*'s successor, *Solar Challenger*, completed its flight across the English Channel in 1981 on a sunny day with white puffy clouds. But Bob Curtin, who has worked at AeroVironment since the 1980s, recalls that "it was fairly turbulent actually, there were lots of clouds in the sky". However, *Solar Challenger* handled more like a small, light aircraft compared with the giant *Solar Impulse*.

The ultralight unmanned Helios craft, built by AeroVironment and NASA, didn't handle turbulence so well on its final flight. Its huge 'flying wing' structure was designed to flex into a curved shape when flying, and

Solar aviation highs and lows

The first recorded solar-powered flight was on 4 November 1974, when Robert Boucher of Astro Flight launched his remotely controlled Sunrise I by catapult in the Mojave Desert.

The first manned solar aircraft was *Gossamer Penguin* (pictured below, left) — a smaller version of the human-powered *Gossamer Albatross*, which crossed the English Channel in 1979. Designed by Paul MacCready of AeroVironment in Monrovia, California, *Gossamer Penguin* flew a distance of more than 3 kilometres and had a wingspan of 22 metres. Its solar panels provided just 541 watts of power.

Gossamer Penguin's successor, *Solar Challenger* (pictured below, centre), crossed the English Channel, covering 262 kilometres, in 1981. Despite its small wingspan of just 14 metres, its solar cells provided about 2,600 watts and the craft reached an altitude of 4.4 kilometres.

AeroVironment went on to collaborate with NASA to design unmanned solar planes for satellite replacements and reconnaissance missions. Together, they launched Helios (pictured below, right), an ultralight 'flying wing' with 14 motors and a 75-metre wingspan. Helios's prototype reached an official world-record altitude for non-rocket powered aircraft of 29.5 kilometres in 2001 and sustained flight above 29 kilometres for more than 40 minutes. Helios broke up over the Pacific Ocean in 2003.

Civilian exploits include *Sunseeker*, a manned combination of a glider and solar-powered plane, in which Eric Raymond crossed the United States in 21 stages over almost two months in 1990. In 2005, Alan Cocconi's remote-controlled solar plane, SoLong, stayed aloft for 48 hours. Raymond is part of the team working on *Solar Impulse*, and Cocconi is a key adviser.

Cocconi's record for the longest unmanned flight was broken in 2007 by Zephyr, a plane from the British defence company QinetiQ, which flew for 54 hours. **V.C.**

B. RHINE/NASA; J. READER / TIME LIFE PICTURES / GETTY IMAGES; N. GALANTE / PMRF / NASA

> **"The real future is probably in an unmanned vehicle." — Bob Curtin**

was able to handle moderate turbulence. As part of NASA's mission to build high-altitude and long-endurance craft it flew at altitudes above 29 kilometres. But during an attempt to set a longer flight record in 2003, the curved wing started oscillating uncontrollably, and the structure broke up over the Pacific Ocean. Unlike Helios, *Solar Impulse*'s design follows a classic rigid-wing structure, so rather than oscillate, the craft will get knocked around by the wind. Piccard says that the main reason for choosing this design, however, was the need to incorporate the cockpit.

Given the unpredictable nature of the weather, the multinational team building *Solar Impulse* is perhaps wisely sticking to known technologies for the final design. A feasibility study done in 2003 predicted the technology improvements that were likely to be available in 3–4 years time, but didn't plan on any technological breakthroughs.

For instance, the study predicted that mono crystalline solar cells would have efficiencies of 20% — they now provide around 22%. At just 130 micrometres thick, the solar cells are flexible enough that they can be integrated into the upper surface of the wings without shattering. The team also correctly predicted that the energy storage density of rechargeable lithium batteries would reach 200 watt hours per kilogram.

The design is now frozen with these technologies, so the challenge is one of engineering rather than science. "The technology is given, so you have to reduce energy consumption,"says Borschberg.

Testing times

Now that the project has three of four major sponsors in place, and two-thirds of the funding it needs, the team has started to build a smaller prototype. Test flights with the 61-metre prototype, scheduled for later this year, should give a better idea of how feasible overnight flights are. Once the lessons learned from the prototype have been fed back into the overall design, the team plans to build the full-size plane during 2009–10, with the round-the-world mission slated for 2011 if all goes well.

When *Solar Impulse* finally gets airborne, its progress will be watched carefully. "We're very interested in *Solar Impulse*," says Kelleher, who, as a stunt pilot himself, would love a chance to fly the plane. In its quest for energy efficiency and low weight, he sees *Solar Impulse* as "the art of the possible". But his company is more interested in unmanned solar planes as an alternative to satellite technology for the communications industry. Because of the cost of transmitting data from Earth to satellites, for example, Zephyr could provide a cheaper way to relay information. "We don't expect it to replace satellites, but it may be able to do many of the jobs that satellites can't do so well, or do them much more cost effectively," Kelleher says.

Curtin, now vice-president of business development at AeroVironment, also sees a future for solar-powered planes, although the company's solar research has been on hold since the Helios crash. He says that everything the firm learned about low-powered flight is being applied to its Global Observer project, an unmanned highaltitude aircraft for communications relay and observation. Global Observer will be fuelled by liquid hydrogen in an internal combustion engine, and will fly for a week at a time.

The reason the company decided to go for hydrogen and not solar on this project, says Curtin, is that the payload of the Global Observer is large — around 181 kilograms— much bigger than the 30-kilogram Zephyr. Another limitation of solar-powered flight is that current technology requires long days and short nights — restricting the range of the craft to lower latitudes.

But Curtin doesn't rule out a return to solar power as solar cells and battery technologies improve."The real future is probably in an unmanned vehicle," he says,"because you're trying to make something fly perpetually, and if you do that, it doesn't make sense to have a human on board."

Piccard is optimistic that his dreams of fuel-free flight, like MacCready's before him, will inspire others to change their thinking about energy consumption. When asked why they pursue such missions, both Piccard and MacCready cited the example of Charles Lindbergh's solo Atlantic crossing in 1927. "Lindbergh was alone because the rest of the payload had to be gasoline," notes Piccard, yet 35 years later aircraft crossing the Atlantic were able to carry 300 passengers. This solo pilot is gambling he won't be alone forever.

Vicki Cleave is a senior editor for *Nature Materials*.

Shimadzu provides powerful support for nanotechnology by applying advanced measurement, control, and analysis capabilities

The application of MEMS to measure and analyze on a nanoliter to picoliter scale, increasing analytical instrument throughput and separation accuracy for energy, environmental, and medical applications

Hiroaki Nakanishi
General R&D Manager
Technology Research Laboratory
Shimadzu Corporation

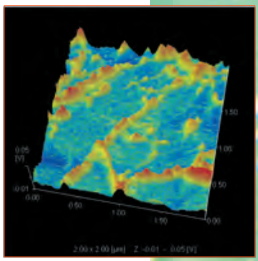
Shimadzu Corporation, whose core businesses are analytical and measuring instruments, medical systems, aircraft equipment, and industrial equipment, is expanding its product portfolio into the nanotechnology field. The term "nanotechnology" refers to technology for exercising full control over substances at the nanometer (1 nanometer = 10^{-9} meters) level to realize materials and devices that offer new capabilities.

Shimadzu has contributed to the development of the nanotechnology field by providing instruments and applications to evaluate these materials and devices. One example of an instrument for handling material at the nanolevel is the scanning probe microscope (SPM), which can perform atomic-level observation of three-dimensional images by scanning sample surfaces using a minute probe, making possible measurement of even local properties of samples. Shimadzu has also developed an instrument (the IG-1000) capable of measuring the diameter of single nanoparticles using Shimadzu's unique "*induced grating methods*". This instrument is used in nanoparticle research in a number of fields, including semiconductors and electronic materials, fuel cell materials, and pharmaceuticals and cosmetics.

Shimadzu also offers various analytical instruments that support the assessment of carbon nanotubes (CNTs), Fullerenes, and other carbon-based nanotech materials. These instruments include thermal analysis instruments (thermogravimeters) for assessing CNT purity, gas chromatograph mass spectrometers (GCMS) for measuring evolved gas components, absorption spectrophotometers (UV) for assessing chirality distribution, photoluminescence measurement instruments, and X-ray photoelectron spectrometers (XPS) for analyzing the chemical state of the surfaces of substances.

In addition, the scope of application of inkjet devices is broadening: they are used not only for printers, but also for LCD television colour filters, printed circuit boards, seal materials, plasma display phosphors, and organic electronics. One important aspect of inkjet technology is droplet control. As inkjet droplets are a few picoliters in size and are discharged at high speed, their observation requires ultra-high-speed filming of the order of a million frames per second. Shimadzu's HPV-2 high-speed video camera is the only camera capable of observing the trajectory of inkjet droplets.

Scanning Probe Microscope [SPM-9600]



Surface-potential Images of SWNT in Polymer

Material supplied by Aida Nanospace Project, JST (Japan Science and Technology Agency)

Applying MEMS to produce a critical component of future analytical instruments

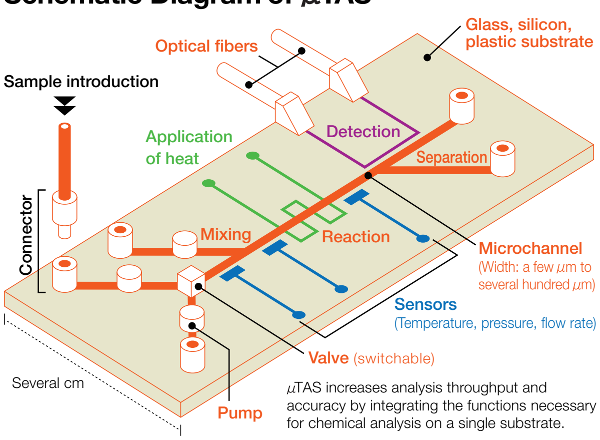
According to Hiroaki Nakanishi, General R&D Manager of Shimadzu's Technology Research Laboratory, the laboratory applies MEMS (microelectromechanical systems) technology in the R&D of µTAS for handling liquids of infinitesimal volume ranging from picoliters to nanoliters and applying them to future analytical and measuring instruments (Figure 1). In MEMS technology, semiconductor fabrication techniques are used to form minute micron-level flow channels or grooves.

A part of the technology has already been practically applied in the MCE-202 MultiNA microchip electrophoresis system, which can quickly and simply perform

Microchip Electrophoresis System for DNA / RNA Analysis [MCE-202 MultiNA]

(Figure 1)

Schematic Diagram of μTAS

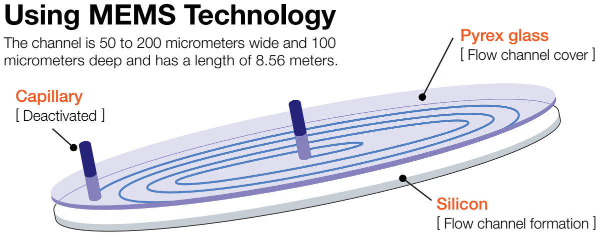


μTAS increases analysis throughput and accuracy by integrating the functions necessary for chemical analysis on a single substrate.

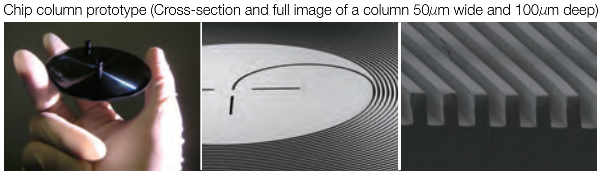
(Figure 2)

Micro Gas Chromatography Column Using MEMS Technology

The channel is 50 to 200 micrometers wide and 100 micrometers deep and has a length of 8.56 meters.



Chip column prototype (Cross-section and full image of a column 50μm wide and 100μm deep)



size confirmation and rough quantification of DNA and RNA nucleic acid samples. The MCE-202 MultiNA uses quartz electrophoretic chips produced using μTAS technology. Shimadzu also offers the DeNOVA-5000HT BioMEMS DNA sequencer, an instrument that uses a large glass plate with 384 flow channels and reservoir holes formed using MEMS technology to make possible the decoding of a maximum of four million base pairs (a base pair is a unit of measure of the length of a DNA segment) per day.

Applying μTAS technology to produce gas chromatography columns

Shimadzu is also prototyping gas chromatography columns using this μTAS technology. Gas chromatography analyzes gas components by channelling a gas consisting of various components together with a carrier gas into a separation column. The gas is introduced through an inlet and passes through a flow meter to enter a narrow tube called a column, where it is separated into its components. The outlet leads to devices such as a thermal conductivity detector that uses differences in the thermal conductivity of the substance.

As a participant in the Development of Systems and Technology for Advanced Measurement and Analysis, a national project of the Japan Science and Technology Agency, Shimadzu has developed the micro gas chromatography system for on-site environmental analysis in a joint effort with several other companies. In this project, Shimadzu produced a column by using MEMS technology to form on a three-inch silicon substrate a long, thin minute tube 50 to 200 micrometers wide and 100 micrometers deep that has a length of 8.56 meters (Figure 2). The longer the column, the greater the detection resolution is. Following formation of the channel, the substrate was covered with Pyrex glass, and the glass was directly bonded to the silicon by anodic bonding.

Prototyping of ion chromatography suppressors

Ion chromatography is a type of liquid chromatography used to separate and measure ions in liquid samples. Participating in the Ministry of Economy, Trade and Industry's Project for the Development and Practical Application of Advanced Analytical Instruments, Shimadzu uses MEMS technology to prototype suppressors. In ion chromatography, ions eluted from a separation column are measured using a conductivity meter. Ions contained in the eluent act as background noise, and the component that removes these ions is the suppressor.

This national project concludes in 2009. As it is a national project conducted for the purpose of promoting the commercialization of results, Nakanishi wants to move ahead with commercialization. He would like to improve performance in gas chromatography and liquid chromatography through the development of devices for use in next-generation instruments.

Micro Petri dishes are also feasible

Shimadzu is also prototyping MEMS-based analytical devices for bio-related applications. To examine cell response to outside stimuli, the company has prototyped ultra-small Petri dishes using MEMS. If Petri dishes are very small, biological experiments can be performed using small quantities of reagents. For instance, if there are 1,000 low-quantity cell samples, the production of MEMS-based micro Petri dishes that confine 10 cells will make it possible to simultaneously conduct 100 experiments under different experimental conditions.

Nakanishi anticipates that MEMS microfluidics will be a good fit for the analytical and measurement instruments of Shimadzu, which also focuses on the energy, environment, and medical fields. The company aims to support R&D activities grappling with energy, environmental, and healthcare issues and contribute to the creation of new industries by engaging in the full-scale commercialization of analytical devices using MEMS microfluidics.

X-ray photoelectron spectroscopy at the forefront of biomedical science

With the SHIMADZU / Kratos Axis Ultra^{DLD}, scientists are shining the light of a 100-year-old discovery on cutting-edge biomaterials surfaces.

From stents and catheters, artificial hips, hearts, and knees to orthopedic screws and contact lenses, scientists and engineers are building devices to replace body parts that are worn, injured, or just need repair. The devices make possible new medical procedures, improve lifestyles, and save lives. But problems of chemistry arising at a device's surface often undo any benefits its physical structure achieves.

Physics based on discoveries made more than 100 years ago is offering solutions. In 1905, Albert Einstein startled scientists by explaining how light, in discrete quanta that we now know as photons, could be used to eject photoelectrons from the surface of a material. His Nobel-prize winning work paved the way for Kai Siegbahn who, in 1981, earned his own Nobel Prize for using the photoelectric effect to study the chemistry of material surfaces. The technique, which examines the emitted photoelectrons to gain knowledge about the material's outer layers, became known as X-ray photoelectron spectroscopy (XPS).

High resolution XPS has since taken off. The instrument at the XPS forefront, offering great resolution and broad applications, is the Axis Ultra^{DLD} produced by Manchester, UK-based Kratos Analytical Ltd. Kratos Analytical was incorporated in 1956 and developed the first XPS instrument in 1969. In 1989, it was purchased by Kyoto, Japan-based Shimadzu Corporation, a multibillion dollar enterprise with manufacturing bases in six countries and more than 7000 employess worldwide. The relationship has given Kratos Analytical a strong, international foundation to carry out its highly innovative work. The SHIMADZU/Kratos Axis Ultra^{DLD}, a prime example of this collaborative power, is taking XPS into new areas of biology and bringing implantable medical devices to higher performance levels.

Keeping bacteria at bay

The University of South Australia's Hans Griesser is training XPS on the problem of microbial infections.

Bacteria often attach to the surfaces of implanted medical devices and form a film against which antibiotics and the immune response are ineffective. The device can break down. Replacement surgeries, especially for older patients, can be debilitating if not fatal.

Griesser aims to cover devices with an antibacterial coating that will prevent the bacteria from latching on in the first place. He starts with extracts from the native Australian plant, *Eremophila*. Molecules in the extract of *Eremophila*, which was used by aboriginal Australians as topical medicine, covalently bind to the material surface.

The antibacterial activity of the extracts was borne out in *in vitro* studies. But how can you tell if the same happens on a medical device? "A surface is different from a solution, and often the reactions are incomplete. It is important to confirm that the reaction has occurred on a surface," says Griesser

He correlates XPS data about the top 10 nanometres of the material with the observed biological response. "XPS gives us confidence about how many bioactive molecules are on a surface and how they are reacting. It also shows which intended reactions don't work," he says.

He has enjoyed dramatic improvements since he started using the SHIMADZU/Kratos Axis Ultra^{DLD} four years ago. Previous devices were non-monochromatic. Stray radiation would break bonds, especially the sensitive bromine-carbon bonds, in samples. "The sample would degrade while we're trying to measure it, it would degrade too fast to get good data in useful form," he says. "Previously the data looked second-rate."

The highly sensitive electron collection optics of the Axis Ultra^{DLD} changed everything. "This is not just an improvement, this is a quantum jump. It made life so much easier," he says.

Antibacterial coatings in the US alone will be worth an estimated US$250 million in 2012, and Griesser is now gearing up for pre-clinical trials.

Biochemical compatibility, DNA microarrays, and beyond

David Castner, a chemical engineer at the University of Washington, has had similar success with the SHIMADZU/Kratos Axis Ultra^{DLD}

The ultimate question for Castner is how biomaterials, such as those used to make vascular grafts and hip implants, and biomolecules interact.

The body typically recognizes implants as foreign materials, "walling

them off" and diminishing their functionality, he says. "We want to make a surface that the body looks at and says, 'Oh, I can interact normally with that.'" The task is even more challenging because ideally the device's surface chemistry should change during the healing process.

For example, polyurethanes have physical properties that are great for an artificial heart, but their surface chemistry often contributes to the formation of blood clots. So the idea is to retain the desirable bulk mechanical properties of the device but change the outer few atomic layers. As candidate materials emerge, the question remains: Do these materials really have the right surface properties?

David Castner with the SHIMADZU/Kratos Axis Ultra^{DLD} at the University of Washington

Castner tests them by using the Axis Ultra^{DLD} to understand what elements are present at the surface of the candidate materials and how those elements are arranged.

The most exciting application during his 4 years of using the instrument, however, has been his effort to improve DNA microarrays. These small chips with thousands of DNA microspots can reveal, for example, how genes are expressed. Until now, microarrays have been qualitative—if something lights up more, there's probably more gene expression, he explains. "We haven't been able to use the microarray to reliably quantify gene expression," he adds.

DNA microarrays are also handicapped by their use of fluorescence tagging, a costly procedure requiring a chemical reaction. The chemical reaction may affect the molecule's ability to bind, thereby making some DNA that is present appear with less frequency or even be absent.

Castner is using XPS for "label-free" DNA detection, which would avoid tagging and offer precise quantitative data about reaction levels. "The overall goal is to decrease the variability of microarrays, allowing precise quantification of detected DNA," he says.

It is the high resolution offered by the SHIMADZU/Kratos Axis Ultra^{DLD} that makes it possible. It "gives a new level of detail that we didn't have previously, and that's crucial if you want to use microarrays in the clinic," he says.

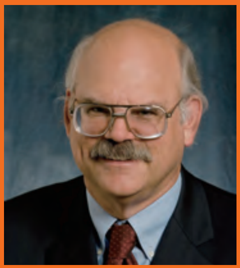
Both Castner and Griesser share their SHIMADZU/Kratos Axis Ultra^{DLD} with colleagues in fields such as catalysis, paint adhesion, lubrication, and even forensics and mineral science. "It's a real workhorse," says Castner.

It is also adaptable. For example, one group at Griesser's institute has attached a vacuum chamber to cleave minerals and insert them directly into the XPS chamber. The group can thus study sulfide minerals, a very important commercial product in Australia, which would otherwise oxidise immediately in air. The Axis Ultra^{DLD} "is running more than 15 hours a day," says Griesser. "It's done everything it was expected to do."

The number of new materials with promising application is rising dramatically. So is the demand for detailed biochemical information about them. "XPS citations in the scientific literature are increasing at a rapid rate," says Castner. Both XPS and the SHIMADZU/Kratos Axis Ultra^{DLD} look to have bright futures.

The SHIMADZU/Kratos Axis Ultra^{DLD} at the University of South Australia

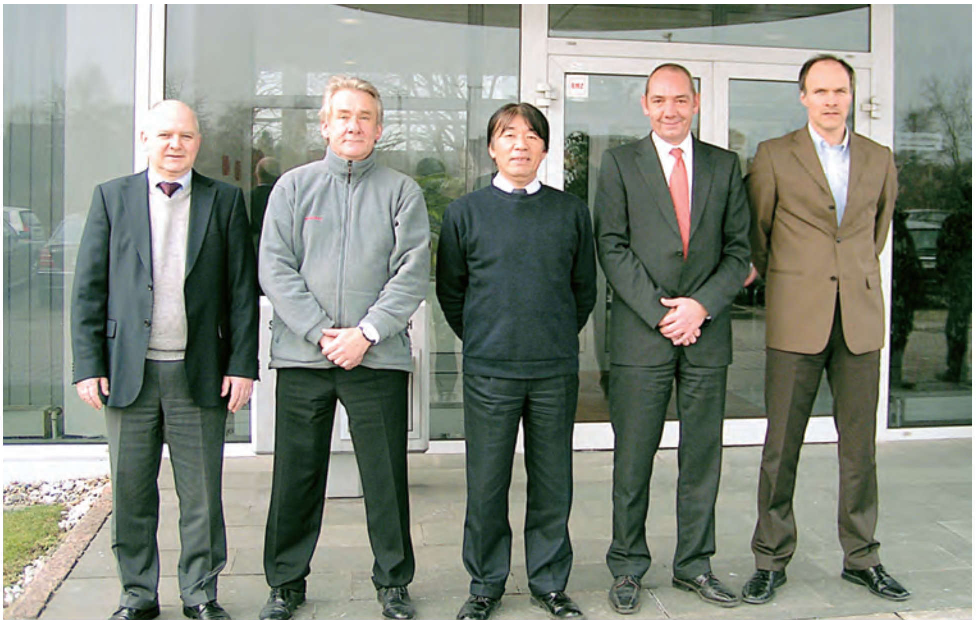
Hans J. Griesser
Professor of Surface
and Deputy Director,
Ian Wark Research Institute,
University of South Australia



David G. Castner
Director,
National ESCA
& Surface Analysis Center
for Biomedical Problems
and Professor,
Department of Bioengineering
& Chemical Engineering,
University of Washington,
Seattle

Shimadzu Europa aiming to spur growth

With new products opening up new markets, the future looks bright for this precision equipment manufacturer, despite the dim economy



After celebrating its 40th anniversary last year by chalking up further increases in sales, Shimadzu Europa GmbH (SEG) is cautiously optimistic about its business prospects in 2009, even though the economic outlook is gloomy. Established in Düsseldorf, Germany in 1968, SEG is a subsidiary of Japan's Shimadzu Corporation, a leading worldwide manufacturer of scientific instruments and medical and industrial equipment. The European operation has three major divisions: analytical instruments, medical diagnostic equipment and industrial equipment. It has grown from an initial five-man team into an enterprise servicing more than 60 major European cities.

The reason for SEG's confidence going forward is the introduction of new products and technologies the company believes will help expand its markets.

"Last year we began offering a new identification system for micro-organisms called AXIMA@SARAMIS," says Michael Kaul, manager of SEG's analytic product and marketing support. Typically, micro-organisms like bacteria, fungi and yeasts are friends of mankind. But some can cause diseases, making their identification critical in certain industries.

"In high throughput mode our new system can identify a clinical sample in less than a minute," says Kaul. "This greatly reduces hands-on time and so dramatically cuts costs." The system can be applied across a wide range of industries and the company placed several systems within months of its launch.

Among SEG's current best-selling analytic products are ultraviolet-visible spectrophotometers, gas chromatography-mass spectrometers and TOC analyzers. "It's the price/performance ratio of these instruments and their leading specifications that makes them so well accepted in the market," says Burkhard Steinert, senior manager of the analytic division.

SEG's scientific instruments business operates via a network of nine subsidiaries throughout Europe, with more than 400 employees in sales, marketing and services. The company also uses 13 exclusive distributors to supplement these efforts.

Another recent product introduction with huge potential, this time from the medical division, is the Safire (Shimadzu Advanced Flat Imaging Receptor) FPD direct-conversion imaging system, which converts X-rays directly into electronic data, making it more efficient and precise than indirect conversion systems.

"Safire's flat panel detector technology provides higher quality imaging than conventional X-ray systems, which helps improve dosage efficiency and speed up diagnosis," says Thomas Nordhoff, senior manager of SEG's medical systems division. "We've already established Safire reference sites in 11 countries. It is going to significantly grow our business throughout Europe."

Among the medical division's most successful products are its mobile X-ray machines, which bring X-ray imaging to the patient, when the patient can't make it to the X-ray room. SEG has long been providing analogue models and more recently it introduced digital versions, which boosted equipment sales by 20% over 2007 shipments.

"Late last year we launched our MobileDaRt Evolution, a next-generation mobile digital X-ray system," says Nordhoff. "In terms of mobile diagnostics, image quality, and easy integration into hospital computer networks, we believe it is more advanced than anything else available. So we expect to further increase overall mobile X-ray sales again this year."

Though SEG undertakes local modification of systems, product development is carried out at the parent company's R&D centres in Japan. Kyoto-based Shimadzu has been making precision equipment since its establishment in 1875. As well as factories in Japan, it has manufacturing plants in China, the Philippines, the UK and in Portland, Oregon, USA. Revenues in fiscal 2007-2008 surpassed $2.9 billion in current U.S. dollar terms.

While no one in SEG is complacent about the economic downturn, Steinert says, "Given our recent new product launches, we believe that in spite of all the negative news, our situation is different from badly hit industries like the car industry. So we remain positive, even though we expect some tough times ahead."

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News & Topics from Shimadzu

Large Scale Applications Development and Support Center Opens at Shimadzu's New Shanghai Branch

Shimadzu has established a new Applications Development and Support Center in Shanghai in order to develop and support analytical instrument applications. In addition to offering conventional service support and training, the center was also established to provide and develop precise analytical techniques to meet the various research and development and quality assurance needs customers may have. In addition, the Shanghai Branch has expanded its premises to 4600m^2 to accommodate a new Applications Development and Support Center in the same building. This move is intended to reinforce Shimadzu's operating base in the Chinese market and to enhance future sales-support activities.

Medical Center-Shimadzu's Renovated Medical Equipment Showroom in Kyoto

The Medical Center features three state-of-the-art digital X-ray diagnostic imaging models equipped with a direct-conversion flat-panel detector for angiography, radiography and radiography/fluoroscopy. It has received about two thousand visitors in the four months since it reopened on October 1st. In addition to offering the most up-to-date information on clinical applications, it also offers facilities for simulating cardiac catheterization and developing technology for clinical applications jointly with users.

IG-1000 Provides Excellent Reproducibility for Sub-10 nm Particle Size Measurements in Liquids

The IG-1000 Single Nano Particle Size Analyzer uses Shimadzu's unique, revolutionary IG (Induced Grating) method technology to provide excellent reproducibility with respect to size measurements and size distribution analyses of sub-10 nm particles in liquids, particles that were difficult to measure with previous systems. The particles are formed into a diffraction grating and the diffusion speeds when it breaks down are used to measure particle sizes in the range of 0.5 nm to 200 nm. The measurements do not require a clean room or other special facilities, and can be performed in a normal environment.

LCMS-2020 Offers Faster and More Sensitive Detection of Drug Impurities and Environmental Pollutants

The LCMS-2020 Liquid Chromatograph Mass Spectrometer is five times faster and three times more sensitive than conventional liquid chromatograph mass spectrometers at detecting drug impurities and environmental pollutants. In addition to enhancing measurement speed and sensitivity, the new design permits easy exchange of the ionization unit between the LC and MS, and reduces the width to just 35 cm, making this system approximately 23% more compact than previous products.

New AA-7000 Spectrophotometer Offers Some of the Best Detection Levels in the World for Measurements of Metallic Concentrations in Solutions

By utilizing a newly developed 3D optical system, the AA-7000 atomic absorption spectrophotometer provides high-sensitivity measurements of metallic concentrations in solutions. In addition to offering two to three times the sensitivity of previous models, the AA-7000 also features the added safety of an automatic extinguisher system with a vibration sensor, a world first for AA instruments. A flame measurement model, furnace measurement model, and a combined full-system model, which are optimal for ppm-level measurements, ppb-level measurements, or all measurement levels, respectively, are available. With this instrument, the lower limits of detection for a number of elements are among the best in the world.

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