Technology transfer to China

A new home for ABB Greenhouse Gas Laboratory

Six months – that's all it takes for greenhouse gases to migrate from wherever they are produced to the four corners of the globe. But it is not only global climate change that knows no frontiers; the search for a recycling process for carbon dioxide emissions also spans continents. As a contribution to this worldwide effort, ABB has recently relocated its Swiss greenhouse gas (GHG) research facilities to China, more precisely to Beijing's Tsinghua University and Tianjin University.

ABB recognized the need for GHG research very early on and, from small beginnings, built up a dozen-strong team to spearhead work in this area. The Swiss laboratories became a pivot of world GHG research, attracting universal respect and admiration from scientists around the world – many of whom came to Switzerland to collaborate. However, with ABB's decision to reduce its activities in power generation, it was seen that the time was ripe to hand over the GHG research facilities.

Baldur Eliasson, ABB Corporate Research Ltd's Head of Energy and Global Change, had mixed feelings as the ten large crates full of equipment left the ABB Corporate Research laboratories in Switzerland. On the one hand, he has invested much of the last ten years in bringing the technology to such an advanced stage, while on the other hand the fruits of his labor will be in good hands – amongst the recipients are many Chinese friends and colleagues who have collaborated with him over the years. Further, the laboratory is now located where the results can be effectively used.

'Hands-on' technology transfer

The major aim of the research remains the same – the use of methane to convert carbon dioxide emitted by coal-fired power stations into liquid fuels, mainly methanol, which can then be used as fuel. China, currently the world's second largest producer of GHG, will take over the number one spot in 10 to 15 years as its economy rapidly grows and it consumes ever-larger amounts of energy. Besides reducing the GHG emissions, the technology will also provide a valuable source of fuel to supplement other, scarce, resources.

Beijing's *Tsinghua University* will continue with research into the manufacture of methanol fuel (CH_3OH) by 'thermally mixing' carbon dioxide (CO_2) with hydrogen (H_2) or a hydrogen 'carrier'. Providing the hydrogen can be won with renewable energy, such as windpower, hydropower or biomass, this catalytic process has no negative impact on the environment, since the CO_2 is a recycled product. Methanol won in this way could be used in place of gasoline. The challenge for the scientists is to find a way to optimize the reaction, ie to find catalysts that will maximize the yield.

How to produce methanol from natural gas (which has methane, CH_4, as its main component) and CO_2, will be the main field of GHG research at *Tianjin University*, located in the city of the same name, some 150 km from Beijing. The challenge here is to dissociate the methane (the hydrogen carrier) with the carbon dioxide and to enable the syngas that is won – a mixture of hydrogen and carbon monoxide (CO) – to change, through reaction, into liquid fuel. This takes place in the form of a silent discharge.

The science behind the process has been successfully proven, but more effort is needed to make it more efficient and cost-effective (currently, the cost of methanol so produced is twice that of commercial supplies).

The facility is the first greenhouse gas plasma chemistry laboratory in China and will be run in cooperation with China's State Key Laboratory for C_1 Chemical Technology. The part of the lab that will be set up in Tianjin University will be led by Prof. Chang-jun Liu. The Tsinghua University lab will be headed by Professor Qiming Zhu. ABB, apart from donating the equipment from Switzerland, will also continue its collaboration by providing research funds over the next three years to assist the scientific research personnel in China.

Dr. Eliasson will continue to be closely involved in this program, both as consultant and as guest professor for GHG Chemistry at Tianjin University.

R&D awards for BODNAP and fiber optic teams

At a ceremony held recently near Zurich, Switzerland, two teams of scientists received prestigious R&D awards for key ABB technologies that have been creating ripples – one of them quite literally – in their respective industries during the past year.

One of these technologies, called BODNAP, has been dubbed a 'laboratory on a chip'. No larger than a football, the ABB-invented device can be put into wastewater – hence the ripples – to measure various parameters, such as Biological Oxygen Demand (BOD).

The other key technology comes in the area of fiber optics, more precisely in its application for downhole monitoring of oil reservoirs.

The team of scientists behind each of these technologies were presented with their awards by Markus Bayegan, head of ABB Group R&D and Technology.

The award for Best ABB Scientist in 1999 was shared by Hubert Brändle and Klaus Bohnert for their research and inventions in the field of fiber optic sensors. The two scientists invented a new way to accurately measure large voltages with optical fibers, resulting in a prototype which was tested up to 1.4 MV. This approach is the world's first full fiber voltage sensor, using only standard, inexpensive components (telecom fibers and quartz crystals). The measuring effect is based on the deformation of small quartz crystals when they are exposed to the electric field produced by the voltage. This so-called 'inverse piezoelectric effect' is measured using a novel fiber optic interferometer.

They also invented a new 'gas-insulated' fiber optical current sensor for HV, serial production of which will start this year. In this new approach, the coating of the optical fiber has been replaced by an inert gas. This has solved all the accuracy problems and standard optical components can now be used. The sensor consists of just a few grams of glass, replacing hundreds of kilograms (or even tons) of copper and iron.

They also succeeded in developing the world's first fiber optic downhole pressure sensor. This sensor is based on the pressure- or temperature-induced deformation of a so-called Bragg grating

Lars Krantz, Senior Vice President, Technology for the Automation Business, between the winners of the Best ABB Scientist Award 1999 (fiber optic sensors): Hubert Brändle and Klaus Bohnert

The recipients of the Best Innovation Award 1999 (lab-on-chip technology, BODNAP): Albrecht Vogel, Dieter Binz and Sean Keeping

structure. The microstructure is created in the fiber using a UV holographic method. This complex, large-scale project, employing some 20 man years of effort, was conceived and executed in just two years. The new sensor has been operating successfully in the South China Sea for almost one year.

Hubert Braendle studied physics at the University of Zurich, receiving his PhD in 1974. Following postdoc work at the University of California in Los Angeles (becoming Assistant Professor)he worked in the world-famous facilities at Los Alamos in the area of nuclear and particle physics. N 1978 he joined BBC as group leader in sensors and instrumentation. He has published more than 50 papers and holds some 30 patents.

Klaus Bohnert received a PhD in physics from the University of Karlsruhe, Germany, in 1981. Before joining BBC/ABB in 1986 as a research scientist in the field of optoelectronics and instrumentation, he did postdoc work at North Texas State University in Denton, focusing on short pulse laser spectroscopy of semiconductors, semiconductor nanostructures, and photorefractive materials. He has published more than 100 papers and holds approximately 30 patents.

Hubert Braendle and Klaus Bohnert are currently working on new fiber laser based pressure sensors and on novel, miniaturized optical sensors for analytical instruments.

The award for Best innovation 1999 (Lab-on-chip technology, BODNAP) was presented to Albrecht Vogel, Dieter Binz and Sean Keeping.

These three scientists invented a radically new way to measure the quality of water in sewage plants using a miniature MEMS-type device which is placed directly in the wastewater and which delivers instant results. Traditionally, BOD measurement, for example, has been done by bringing samples to the lab for an analysis lasting up to three days.

Albrecht Vogel studied electrical engineering at the University of Karlsruhe in Germany, receiving his PhD in microtechnology and chemical sensors in 1991. He joined ABB in 1991 as a project leader in the group Sensors, Instrumentation and Micro-systems, which he has led since 1995 and which in that year kicked off the BODNAP activities. He is now working on an MEMS-type gas chromatograph and on chemical and biosensors.

Dieter Binz received his PhD in physics in 1994 from the University of Heidelberg, Germany. He joined Albrecht Vogel's group as a project leader and immediately became involved in the BODNAP project. His present post is Program Manager for MEMS.

Sean Keeping received his BSc in 1981 from the Ravensbourne College in London and his MSc in 1995 from the Royal College of Art, London. From 1985 to 1990 he worked with Marconi Instruments, winning the British Product Design Award in 1990.

In that year he joined ABB Kent-Taylor and in 1996 he became responsible for R&D in the ABB Instrumentation business unit and project leader of the BODNAP HIP. He is now vice president of technology in Business Unit Instrumentation. He also interfaces with Corporate Research, coordinating and running projects, particularly in MEMS technologies.

eManufacturing

Many ABB companies get their revenues directly from manufactured goods and are therefore dependent upon efficient manufacturing processes. These processes can be substantially improved through the use of recent advances in information technologies. However, just managing information is not enough; information needs to be transformed into physical products faster than ever. New operational structures and eCommerce applications – the very foundations of eBusiness – provide manufacturing with a huge opportunity to improve productivity. At the same time the traditional role of manufacturing is widening. Today, manufacturing has to be considered as a demand-supply network rather than in terms of factories and their suppliers. eManufacturing represents an effective use of information and manufacturing knowledge in the demand–supply network that takes manufacturing to new levels of performance.

Companies with world-class business operations and production control complement their information systems with eManufacturing tools such as ERP[1], SCM[2] software and one-point production control to give themselves the capability that will get a customer's order into production within five minutes of its being placed. Such a production system also allows an order to be typically fulfilled within hours. In other words, the product can be on its way out of the door just a few hours after a customer orders it. Such speedy production is not out of reach for most ABB companies, but the right combination of production system, IT system and interfaces is needed to guarantee it.

ABB has launched an eManufacturing project to improve the flow of material and related information in its businesses. World-class production systems are integrated with IT systems that allow smaller inventories, a reduction in routine tasks such as order entry and material ordering, and information sharing for better transparency in the order flow and production capacity scheduling. EManufacturing will allow substantial savings to be made through improved sourcing and SCM, reduced inventories and optimized use of resources.

ABB plans to implement eManufacturing in an initial phase in the second half of 2001.

[1]ERP = Enterprise Resource Planning (eg. SAP)
[2]SCM = Supply Chain Management