CSCST-UK

旅英中国学人化学科技与技术协会

The Chinese Society of Chemical Science & Technology in the UK

NEWS LETTER

Issue 1

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CSCST-UK

旅英中国学人化学科学与技术学会

The Chinese Society of Chemical Science and Technology in the UK

From the Editor

The Chinese Society of Chemical Science and Technology in the UK (CSCST-UK) launches its long-planned Newsletter after it passed its 18th birthday in April 2011. CSCST-UK has seen itself evolving from a small society first initiated by a few aspiring researchers at Oxford University to a *UK*-wide large professional network linking Chinese students, researchers and academicians in the broad field of chemistry, chemical engineering and biochemistry over the past eighteen years. During the course of providing excellent service to its members, it has partnered with the Royal Society of Chemistry, the Society of Chemical Industry, and a number of international chemical companies to increase its capacity, to strengthen its influence and to sustain its growth.

Nowadays, research is about collaboration. Most, if not all, research projects are to tackle complex problems that require multi-disciplinary approaches or efforts from various parts of the world such as climate change. To turn research into practical actions, collaboration could only become more imperative and necessary. That is the primary reason for CSCST-UK to launch its Newsletter. We feel that introduction of outstanding laboratories and research teams of both our members in the UK and our counterparts in China and elsewhere in the world is key to capturing potential collaborative opportunities. It would also serve as an excellent platform to showcase the excellent work and research strengths of our members and their partners.

In this issue, we put together entries from three top universities: Oxford University, Cambridge University and Tsinghua University. Dr Xiao Tiancun tells his story about how a Chinese educated scientist turned into an entrepreneur who cofounded a catalyst research company listed on the London Stock Exchange. At Cambridge University, the research group that Dr Gu Yunfeng works for sheds some light on an interesting technology that produces solar energy using living organisms. As part of our series of introduction of high-profile laboratories in China, we present a whole picture of the research activities of the Key Laboratory of Thermal Science and Power Engineering of Ministry of Education.

I hope you will find this issue of Newsletter interesting and useful. Please feel free to contact me should you have any queries or suggestions. I am also happy to assist you in getting in touch with researchers introduced in each issue.

Yours sincerely,

Nigel S Dong

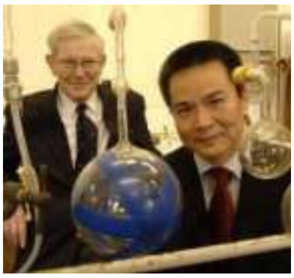
Nigel S Dong

Research Changes Life

A story of Oxford Catalyst and its founder Dr Xiao Tiancun

An inspirational story of how a Chinese researcher at Oxford University embarked on a successful entrepreneur career, by Hu Jingping and Wang Yan.

As a leading catalyst innovator for clean fuels, Oxford Catalysts designs and develops specialty catalysts for the generation of clean fuels from both conventional fossil fuels and certain renewable sources such as bio-waste. As the 55th company spun out from Oxford in 2004, it is now listed on the AIM of London Stock Exchange with a market capitalisation of about £95 million.



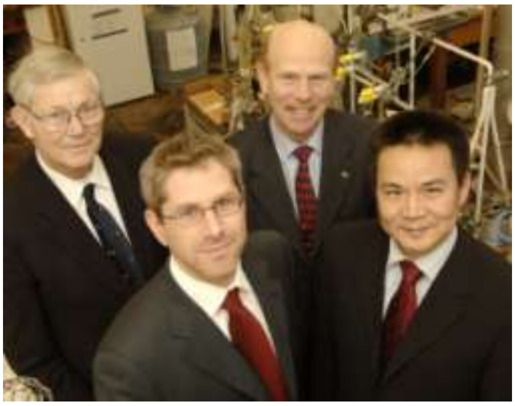
Its initial core technologies were those developed by its founders, Dr Tiancun Xiao, and Professor Malcolm Green at Oxford University. The company pioneered the development of cheap metal carbide catalysts that have proved to be excellent for a variety of important hydrocarbon reactions and for hydro-desulphurisation, the removal of sulphur from fuel. All the development was based on a discovery by Dr Xiao in early 2000s that a cheap transition carbide catalyst was capable of achieving same yield as the conventional, expensive ruthenium catalyst, and was just as fast. These metal carbide catalysts could have several potential markets including Fischer Tropsch for future fuel synthesis, and hydroprocessing and green energy.

The second core technological platform is development of catalysts that can be used to transform waste methane into hydrogen or into liquid fuels. 'There are many sources of waste methane, ranging from agricultural waste and landfill to flare-off from oil production,' said Dr Xiao. 'Capturing the methane is important not only due to its high energetic value, but also because it is a very polluting greenhouse gas - 23 times worse than carbon dioxide - and its presence in the atmosphere contributes to global warming.' Thus their catalysts can deliver good environmental benefits. The key is to find an innovation method for catalyst preparation, which produces very active, selective and also long-lasting catalysts. Further applications of these catalysts include the partial oxidation of natural gas and removal of sulphur from crude oil.

Dr. Xiao also developed catalysts that can produce hydrogen from a liquid fuel containing methanol at room temperatures and instantly generate superheated steam. This is the first time superheated steam can be generated from chemical reaction starting at room temperature. The technology has the advantages of portability, instant startup and high energy density. It can be used for drilling, disinfection and cleaning.

The road to entrepreneur

Dr Xiao joined Professor Green's team in 1999 and a series of exciting discoveries by them led to the emergence of Oxford Catalysts. The first patent was filed in 2001, and Xiao was awarded £124,500 in June 2001 by the University Challenge Seed Fund, which led to equity in Oxford Catalysts Ltd in Dec 2005. In 2003, Dr Xiao was also awarded a Business Development Fellowship, which allowed him to concentrate on incubating the technology and generating commercial interest during 2003-2004. In September 2004, a proof of concept award was granted with funding of £24,500 for building a prototype, which later became "Invaluable for showing to potential investors".



There were many challenges to start a new company. First of all, a management team needed to be established. Will Barton and Roy Lipski joined the inventors to further refine their business plan and continued to file patens for evolving technologies. Another challenge was to secure funding. When the funding from Royal society finished in 2002, Dr Xiao was short of funding to carry on his research in the UK. Fortunately, Dr Xiao met the first key person in his career-Peter Dobson, who was then the director of the Oxford University Begbroke Science Park. With the help of Professor Dobson, Dr Xiao received enterprise fellowship for one year work from the ISIS Innovation via the Begbroke Science Park. In 2004, Dr Xiao went to Saudi Arabia to promote his sulphur removal techniques as his funding of ISIS would soon been run out. However, the money sponsored by Saudi Arabia government was far from enough to expand his research activities. At that moment, Dr Xiao obtained an invaluable advice from ISIS Innovation: why not build up your own company, and raise money from the market? But as Murphy's law suggests, everything is more complex than it sounds. For quite some time, no investors were interested in his business proposal until David Norwood, the general director of the IP2IPO investment firm, injected £400,000 as the start-up capital into Oxford Catalyst. ISIS Innovation and IP2IPO worked in close partnership to launch the floatation of Oxford Catalysts. On 26th April 2006, Oxford Catalyst was finally listed on the London Alternative Investment Market.

When Oxford Catalyst was listed on London Alternative Investment Market, the price of its stock increased gradually from £1.74 to £2.58 in 2 weeks. The total market value of Oxford Catalyst was always more than £50million, and Dr Xiao owns 8% of it, approximately £5million at that time, now because of the world stock market is not so good, his share valued much less than before, but at least he has some fund to build his future. "I finally have enough money to construct my own laboratory." Dr Xiao rented a building on the outskirt of Oxford and purchased a full range of experimental equipment. Currently this company has had a dozen of employees, and 3 of them are Chinese scientists. "This is a great experience and lots of fun. UK has the fertile soil for entrepreneurship. Getting a professorship is probably a career success, however becoming entrepreneur will definitely bring a better life", said Dr. XIAO. □

Dr Hu Jingping *is currently a Ramsay Memorial Trust Research Fellow in the Department of Chemistry, University of Oxford, working on electrochemistry and nano-materials, esp. in the area of electrochemical bio-sensors and fuel cell catalysts. He currently serves as the vice-president of CSCST-UK.*

Wang Yan *is a PhD student in the Department of Chemical Engineering, Imperial College London; his current research interests include cantilever design and particle synthesis for carbon capture*.

Biophotovoltaics

An interesting novel technology that can produce solar energy using living organisms, currently under development by Alistair McCormick, Alex Driver, Paolo Bombelli and Yunfeng Gu at Cambridge

The sun is the ultimate source of life on Earth. It supplies us with vast amounts of energy and is the source of all traditional fossil fuels used today. However, fossil fuel usage has several drawbacks: it is considered environmental unfriendly (burning fossil fuels is the main contributor to the greenhouse effect), usage is subject to political risk and fossil fuel resources are destined to run out. Therefore there is an urgent need to develop new energy technologies that can provide a renewable, carbon neutral source of power. Directly harnessing solar energy is an attractive option. As such development of efficient solar cell systems to capture even a small fraction of our enormous solar reserve is currently an important scientific and engineering challenge.

Nature has been harvesting energy from the sun for millennia through the process of photosynthesis. However, botanical species have a notorious reputation for photosynthetic inefficiency - most plants only convert about 0.25% of the sunlight that falls on them into biomass. Despite this seemingly meagre effort, it is estimated that photosynthetic organisms (including algae and plants) together harvest ten times as much energy from the sun as we utilise through fossil fuel consumption.

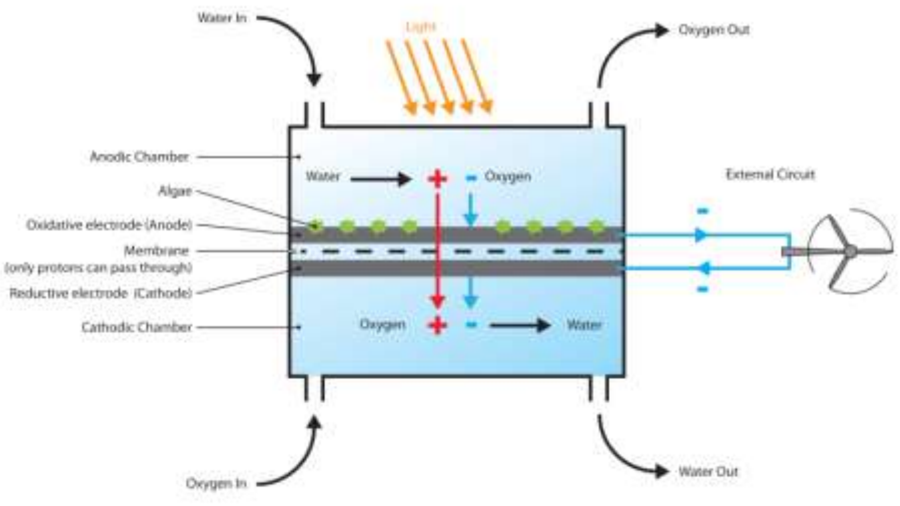


Figure 1. Biophotovoltaic cells are a new hybrid technology that uses photosynthetic organisms to produce electricity. Living algal cells can be placed inside the anodic chamber of a two electrode system separated by a membrane that allows only protons to pass through. Electrons produced during photosynthesis flow through an external circuit and then re-combine with protons and oxygen in the cathode chamber to form water. The resulting current flowing in the external circuit can be used for electrical power.

Several technologies have been developed to emulate the photosynthetic process. The most successful of these are synthetic solar cells based on the photovoltaic effect (e.g. silicon solar cells). Unlike photosynthetic organisms, these devices are able to convert energy with a much higher efficiency (10-15%). However, those technologies are based on the use of expensive, high purity semi-conductor materials. An ideal solar energy technology would attain the high energy conversion efficiency of synthetic systems whilst keeping the inherent merits of a low-cost biological approach. With this aim in mind, a recent collaboration between four departments in the University of Cambridge has led to the development of a new hybrid technology for harnessing solar energy, called Biophotovoltaics (BPV).

BPV devices are biological solar cells that can generate electricity. This is achieved by harvesting energy from the photosynthetic activity of living organisms, such as algae. When light falls on algae cells, a series of internal reactions take place which split water into protons, electrons and oxygen. These three products are vital ingredients for transforming carbon dioxide and other inorganic materials into food for the algae to grow. BPV exploits this process to generate electrical energy in a system very similar to a battery (**Figure 1**). The first BPV devices have recently been constructed and tested in the laboratory. So far, they have shown great promise for powering small electronic devices (**Figure 2**).

Figure 2. Current BPV prototypes produced at the University of Cambridge. Algae (top left and right) and moss (bottom left) designs can presently produce enough energy to power small electronic devices.

Although preliminary results are exciting, there is still a great deal of research required before Biophotovoltaics can be developed into a commercially viable technology. For example, currently no one fully understands the biological pathways involved in power outputs. Solar conversion efficiencies are also still much lower than those for synthetic solar cells. To tackle such problems, the BPV consortium in Cambridge uses a unique interdisciplinary approach. A wide range of techniques and skills from a variety of fields are employed including electrochemistry, micro-fabrication, chemical synthesis, molecular biology, and mathematical modelling. Their work is currently focussed on developing a better understanding of the processes occurring within these 'biological batteries'.

The long term target for BPV research is to produce an economical device with low manufacturing costs and competitive energy conversion efficiencies within the next two decades. Although BPV cells may be destined to remain less efficient than synthetic silicone cells, their biological advantages, such as renewability and ability for self-repair, may lead to BPV systems becoming a highly useful alternative energy resource. Other possible uses of BPV technology include the co-generation of chemicals (e.g. formic acid which can be used as a fuel) and the production of hydrogen.

Figure 3. Futuristic designs for BPV technology include a floating sea water desalination generator (right). BPVs do not require land and thus could be up-scaled as off shore power stations (centre). A moss-powered table that stores solar energy is currently under construction (bottom left).

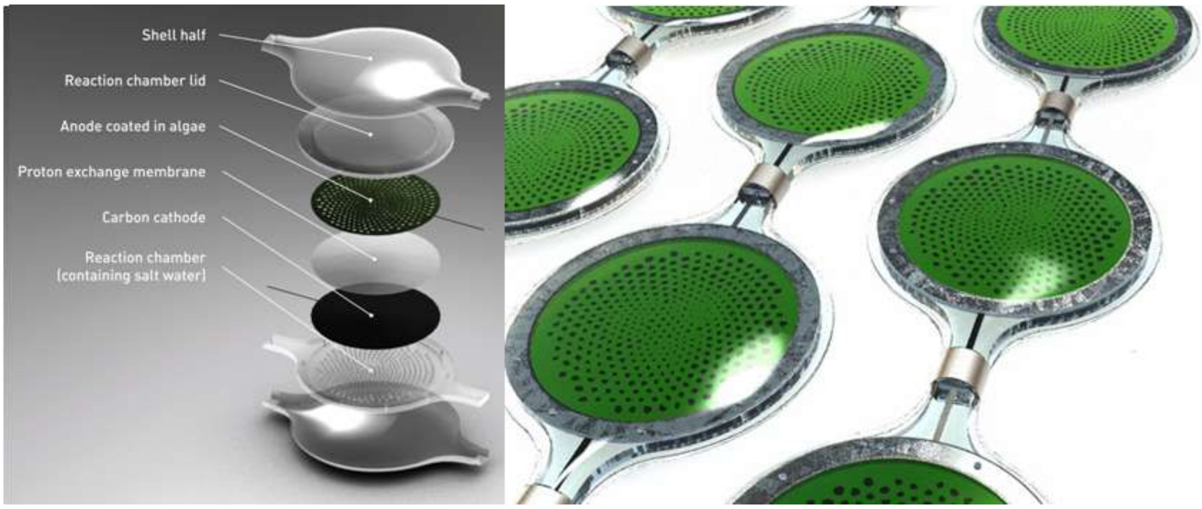


Figure 4. A BPV solar panel array (right) could be a useful household power supplement. Based on designs from the Cambridge Institute for Manufacture (left), prototypes are currently being tested (see Figure 2).

With this in mind, scientists in the BPV consortium agreed to take part in a collaborative project with designers from the University's Institute for Manufacturing to look into the future and examine some possible applications for BPV technology (**Figure 3**). A brainstorming session led to a range of concepts for potential products, including a BPV solar panel array, a near-shore generator that harvests desalinated water, and a garden table that generates and stores energy during the day that can be used in the evening (the latter is currently under construction). The team also considered the idea of an off-shore BPV power station consisting of several vast floating 'lily pads' coated in algae. The power output per unit area of such a BPV power station would ideally match that of an equivalently sized offshore wind farm (5-6 W/m^2), which will be enough to exploit this technology at a commercial level. Such a power station would even generate energy during the night as a result of the natural excess energy stored inside the alga cells during daylight hours.

Following this, the scientific team asked the designers to build a prototype for the BPV solar panel array. A 3D computer model was produced which was then used to manufacture and assemble the components in the engineering department's workshop (**Figure 4**). The working device is shown in **Figure 2**, and has proved invaluable in communicating the potential of the technology to colleagues, potential investors and members of the public. An array of these devices could be placed on a rooftop to provide a portion of the building's power requirements. The advantages of this device are that it is environmentally friendly and easy to manufacture compared with conventional solar panels. Furthermore the algal bio-electrical catalysts require only water and sunlight to survive and generate energy. The oxygen produced at the anode escapes into the atmosphere whilst the water produced at the cathode could either be harvested or left to evaporate. No harmful chemical wastes are produced during the process and once exhausted the devices are easy to recycle. Our green future has certainly never looked brighter. □

Dr Gu Yunfeng is currently a postdoctoral researcher in the Department of Chemical Engineering and Biotechnology at Cambridge University. His current research interest is focused on microfluids.

The Key Laboratory of Thermal Science and Power Engineering of Ministry of Education at Tsinghua University

By Professor Yuqun Zhuo and translated by Wang Yan

The Key Laboratory of Thermal Science and Power Engineering of Ministry of Education (KLTSPE-ME), previously known as the State Key Laboratory of Clean Coal Technologies, was formed by combing the research group for thermal science and that for gas turbine at Tsinghua University in May 2004 and started running as a key laboratory for power engineering and thermal science of Tsinghua University. Following the integration of Education Ministry's Key Laboratory of Heat Transfer Enhancement and Energy Conservation in June 2005, KLTSPE-ME started to run under its current title since August 2005. It was rated as A-Class in the laboratory appraisal by the Ministry of Education in September 2007, and was recommended for the 2008 state key laboratory appraisal achieving a good evaluation.

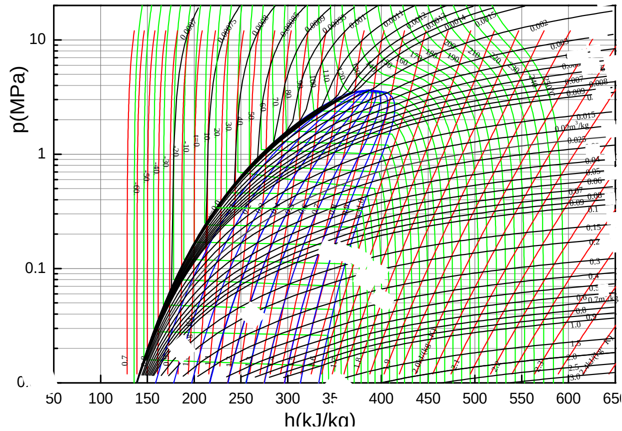
Currently there are 67 staff in this laboratory, including 2 fellows of Chinese Academy of Sciences (CAS), 3 fellows of Chinese Academy of Engineering (CAE), 22 professors and 21 associate professors. Amongst the staff, 57 have doctorate degrees, 2 are holders of the Outstanding Youth Foundation Prize, 4 are Yangtze River Scholars and 2 hold China's Science & Technology Awards for Young Researchers.

The laboratory undertakes fundamental theoretical and applied research in efficient transformation and clean use of energy, with approaches rooted in Heat Transfer, Thermodynamics, Fluid Dynamics, Combustion and System Science. It aims to provide scientific innovation and development of advanced technologies to address issues facing China regarding efficient and safe use of energy resources, particularly fossil fuels.

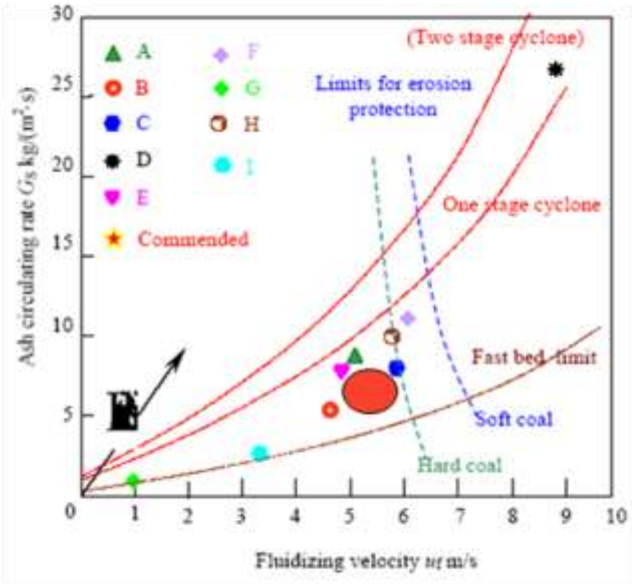
The Laboratory has purchased, designed and fabricated a large number of precision instruments and large-scale experimental rigs, worth more than 59 million RMB in total, and most of the purchases were made in recent 5 years. Its facilities are relatively more fledged and advanced compared to other Chinese universities. In particular, it is a leading research institute for its research instruments and equipment in China. The Laboratory is now an important base for fundamental research, technological innovation and education in the area of thermal science and power engineering in China.

Main Research Interests:

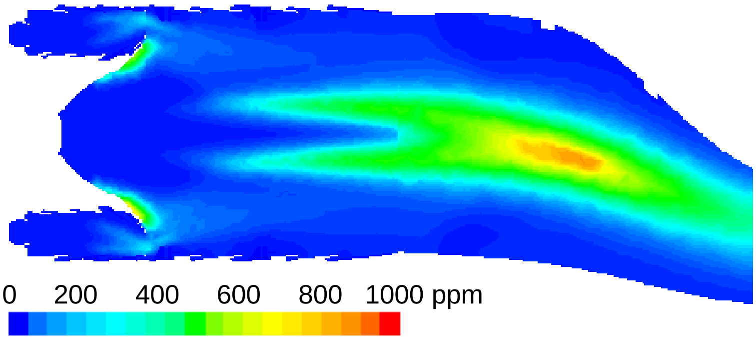
1) Heat transfer and thermodynamics: micro-scale heat transfer, porous media heat transfer, phase-change process and mechanism, specific heat transfer problems in power engineering and high-tech application, nano-scale heat transfer, heat transfer enhancement and optimisation, biological thermophysics and biological heat transfer, fluid engineering thermophysics;



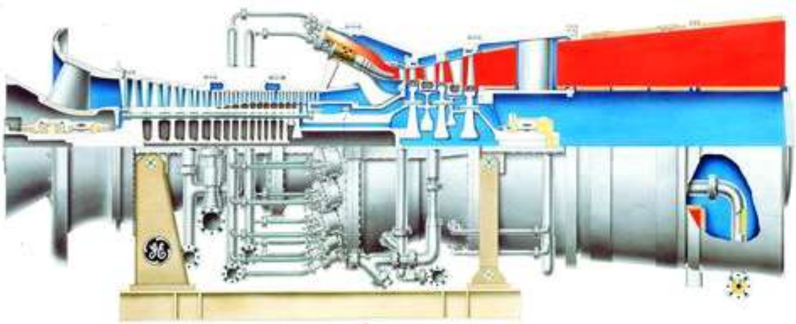
2) Combustion science and technology: fluidised combustion of solid fuels, pulverised coal combustion, combustion chemical reaction kinetics, catalytic combustion, combustion limits, turbulent multiphase flow and combustion, combustion kinetics of nonlinear phenomena;



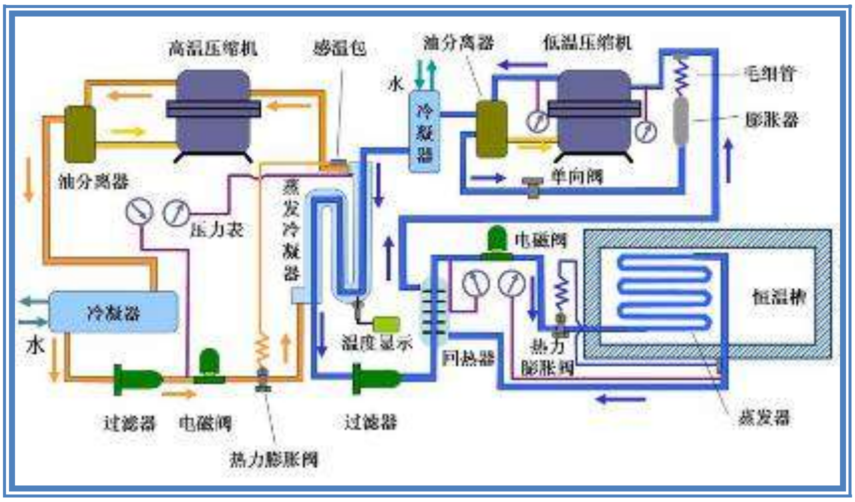
3) Gas dynamics and multiphase fluid: gas dynamics, turbulent multi-phase fluids and combustion, dynamic studies of non-linear phenomena in combustion, gas-liquid two-phase fluid dynamics and heat transfer;



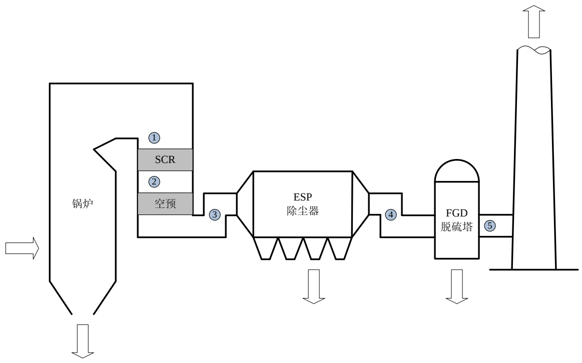
4) Key technologies of gas turbine: aerothermodynamic design, low emissions combustion, advanced cooling, automatic control methodology, structural strength and vibration, multi-disciplinary optimisation of gas turbine design;



5) Energy conservation: Thermal science of energy conservation, thermal system optimization and heat management, heat transfer enhancement technology and novel heat exchanger, environment-friendly and energy-saving air conditioning technologies, industrial waste heat recovery and use, thermophysical issues of renewable energy utilisation;



6) Pollution control theory and technology: formation and removal of sulfur dioxide, NOx, and particulate matter, greenhouse gases mitigation, control of trace elements and other contaminants from combustion processes, formation and control of toxic substances in fires.□



Zhuo Yuqun *is a professor in thermal power engineering in the Department of Thermal Engineering at Tsinghua University,Beijing,China, and currently the head of KLTSPE-ME. His main research interests include combined removal of SOx, NOx and other pollutants from flue gas, transport and transformation of heavy metal trace elements and their emission control. He received his PhD from Imperial College London in 1999.*

Collaborative Partner & Sponsors

上海浦景化工技术有限公司
PUJING CHEMICAL INDUSTRY (Sha) Limited

上海浦景化工技术有限公司，成立于 2005 年，致力于化工技术投资、开发、转让及技术服务，重点为各科研院所技术创新提供孵化平台，为各项成熟技术提供中试平台，在技术市场上为化工企业用户提供先进可靠的工艺技术。

公司拥有多项煤基路线制化学品的专利技术，如**煤制醋酸**技术已经成功应用在“河南顺达 20 万吨-40 万吨扩产技术改造项目”、“云南云维 20 万吨开车项目”、“山西焦化 40 万吨项目”、“宁夏国电英力特 30 万吨项目”等，**煤制醋酸乙烯**技术已成功应用于“宁夏国电英力特 30 万吨/年项目”。

目前公司所开发的**煤制乙二醇**技术在 2010 年已成功进行千吨级/年乙二醇的中试开车，打通了全流程，并取得了符合 GBT-4649-2008 标准的聚酯级乙二醇产品。该技术具有独有的再生方式和提纯技术，以及性能优良的羰化催化剂和加氢催化剂，目前在国内外都处于领先状态。

PUJING Chemical Industry (Sha) Limited, founded in 2005, is devoted to investment on, research &development of and transfer of chemical technologies. It aims to bridge the institutes and industrial plants, scales up the innovative and creative scientific results, and offers the customers advanced technologies.

Nowadays, the company is in possessions of the know-how to manufacture coal-based chemicals. Taking, for example, coal-based acetic acid technology was successfully applied in “Plant Expansion of Acetic Acid from 200kt/a to 400kt/a in Henan Shunda”, “200kt/a Acetic Acid Synthesis in Yunnan Yunwei Group”, “400kt/a Acetic Acid Synthesis in Shanxi Coking”, and “300kt/a Acetic Acid Synthesis in Guodian Younglight Energy Chemical Group”, and coal-based vinyl acetate technology in “300kt/a Vinyl Acetate Synthesis in Guodian Younglight Energy Chemical Group”.

Currently, another kind of advanced technology of “coal-based ethylene glycol” was successfully scaled-up to 1000t/a from labs in 2010, and polyester-grade ethylene glycol product that meets the requirements of GBT-4649-2008 (China) was directly obtained from such pilot plant. PUJING owns the exclusive regeneration and purification technologies, and has developed well-performed DMO (dimethyl oxalate) synthesis catalyst and DMO hydrogenation catalyst, all of which help it take the lead in such know-how in the world.

AkzoNobel is the largest global paints and coatings company and a major producer of specialty chemicals. AkzoNobel is also a Global Fortune 500 company with a range of well known brands such as Dulux, Sikkens, International and Eka. With operations in more than 80 countries, AkzoNobel's 55,000 people around the world are committed to excellence and delivering Tommrrow's Answers Today.

Where Science meets business

The Society of Chemical Industry (SCI) is a unique international forum where science meets business on independent, impartial ground. The Society offers a chance to share information between sectors as diverse as food and agriculture, pharmaceuticals, biotechnology, environmental science and safety. Originally established in 1881, SCI is a registered charity with individual Members in over 70 countries. Its international headquarters are in London, UK, and it also has offices in India. The Society provides an important interface between industrial, academic and other interests. Although the majority of SCI's activities still take place in Great Britain, a large percentage of current Members live in other parts of the world.

The Royal Society of Chemistry is the largest organisation in Europe for advancing the chemical sciences. Supported by a worldwide network of members and an international publishing business, SCI's activities span education, conferences, science policy and the promoting of chemistry to the public.

Events

The CSCST-UK, in partnership with SCI, organises a conference every year. The 18th annual conference was held at Cambridge University on 17 September 2011. With a theme of ***The New Generation of Chemical and Biological Technology***, this year's conference reviewed current research developments in chemical and biological technology and highlight future challenges. There were two plenary talks, 6 keynote talks, 17 oral and 12 poster presentations, covering energy and sustainability, advanced materials, bioresources and biotechnologies, and advanced processing and modelling. SCI's executive director, Joanne Lyall, and Mr Li Hong from the Chinese Embassy in the UK addressed the conference. To encourage research students, SCI has granted prizes for best oral and poster presentations at the end of the conference.

SCI Prizes for Best Oral and Poster Presentations

	First Prize	Second Prize	Third Prize
Oral	**Yuxuan Hu** University of Strathclyde	**Luyun Jiang** University of Oxford	**Chunlei Pei** University of Birmingham
Poster	**Jiexun Di** University of Oxford	**Chunyan Ma** Chinese Academy of Sciences	**Haiping Shen** University of Nottingham

There are more than 100 people from academic and industrial institutions in UK and China attending this conference, including 53% doctors or professors and 41% students. The conference website (http://www.cscst.org/2011/) has attracted 1291 visits from 122 cities in 14 countries, in line with the statistics of CSCST-UK official website with 6099 visits from 607 cities in 76 countries in the past one year.

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(2010-present)

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Scientific Committee

(2010-present)

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