Alembic

ICYS Training Program for Newly Hired NIMS Researchers(*1)

Another Attempt to Hone Internationality and Self-reliance at ICYS

In a bid to develop a system to promote international research activity and effort to nurture young scientists more efficiently, NIMS's ICYS project is undertaking unique activities that are world-firsts. One of these includes a training program for freshmen, in which young scientists hired by NIMS are assigned to ICYS, where they work with ICYS research fellows(*2) hired from 21 countries around the world. They hone their internationality and self-reliance in an environment comprising 67% foreign researchers and with English used as the official language in the first year at NIMS. It is a notable program in which the ICYS research fellow system (researchers themselves formulate and execute research plans at their own discretion with no manager supervising them) is applied to newly hired NIMS researchers for a one-year period.

At ICYS, newly hired researchers are given their own rooms and provided with research funds they can spend at their own discretion as well as services facilitating their research work rendered by research support coordinators, patent preparation assistants and various refreshers such as a weekly seminar (all young scientists belonging to ICYS and guests such as invited advisors), a coffee break (casual conversation meeting), and interview and social meetings with famous research scientists from overseas.

In this April, nine researchers having completed their one-year training at ICYS in FY2004 were assigned to research groups within NIMS.

We know that there were some researchers who found this program embarrassing or doubted its significance, since it started only recently and has only just completed the initial one cycle. However, as far as observation of the actual scenes is concerned, we have no doubt of the positive responses and apparent effect.

Having received 10 freshmen by May 2005, we now have a total of 18 NIMS researchers belonging to ICYS. Hopefully the program will be accepted by newly hired researchers in future without any incongruous impression and we believe that the sense of internationality, collaboration and self-reliance developed in ICYS will take root in the organization and steadily make a contribution to revolutionize members' mindsets at NIMS itself.

The following are frank opinions and impressions given by "graduates" from ICYS in a questionnaire survey.

■Sense of internationality

●It improved my English ability, both in research work and communication.

●The weekly seminars and workshops conducted in English were meaningful.

●I would like to give a presentation actively at an international convention in future.

●Since famous research scientists visited ICYS from overseas, they have become less formidable figures to me.

●Since I share a laboratory with an ICYS research fellow to conduct my experiments, I am happy to engage in research activity in an internationalized environment as I experienced.

■Self-reliant research ability

●Since I was allocated with research funds I could spend at my discretion, I could develop the sense necessary to promote research in a self-reliant manner; based on my own ideas.

●It was very nice that I was allowed to perform the research of my choice without any constraint from group objectives and direction.

■Collaboration and joint research effort

●As I could learn research fronts and phenomena extensively through ICYS seminars and coffee breaks, I could broaden my view on research.

●I could find the opportunity for interdisciplinary collaboration or joint research efforts.

●As I could ascertain the progress status of other members, I received good stimuli from productive rivalry.

●I found many potential partners for joint research, such as researchers working in and outside ICYS.

■Network of researchers

●Since I had many opportunities for exchange, I could promote research and discuss actively with other people.

●I could find a chance to discuss or negotiate personally for collaboration in the field I was interested in.

●The bond among newly hired NIMS researchers was strengthened because of the development of a sense of union as contemporaries.

■The following opinions were also raised as points to consider when executing the program in future.

●Because of the distance between the Sengen area, where my research activities were usually performed, and the ICYS headquarters (Namiki area), the time spent in my room (within ICYS) decreased as my experiment progressed and I could not find much time to exchange with other members.

●If I had the English ability to make conversation smoothly in my daily life, I could have deepened my exchanges.

(*1) Newly hired NIMS researcher: full-time employee with a fixed-term contract or non-contract (permanent)

(*2) ICYS research fellow: special researcher with an annually renewed contract (applicant qualification: no more than 10 years after receiving a doctorate)

Craftsmen in the Mesoscopic World

ICYS Research Fellows' Research Achievements

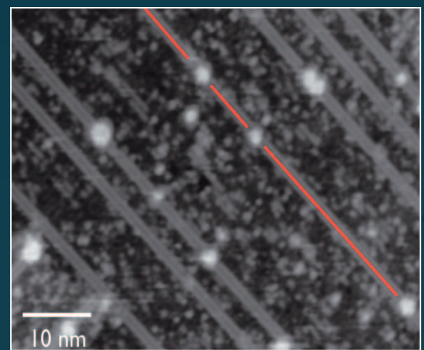
The mesoscopic world is full of unexpected structures and characteristics, which are exploited as a target of nanotechnology. I will introduce some research achievements made by ICYS research fellows, who elucidate their secrets and pave the way to their application, as follows:

Promising Future of Bi (Bismuth) Nanolines

James H. G. Owen, UK

My research goals are in the area of nanotechnology, a broad area of science which involves the design, fabrication and use of components which have one or more dimensions measured on the nanometer scale. In particular, I am interested in making use of self-assembled components which are single-nm in dimension, as this is considerably smaller than anything which can be fabricated via lithography. At ICYS, I am working on the use of self-assembled Bi nanolines as nanoscale 1D templates for other materials, such as metal to make conductive wires, magnetic or optically-active nanoparticles, active molecules etc.

Here I show an STM image of a template sample. The dark background is the ammonia-terminated silicon. Potentially, ammonia could be used to make a thin layer of silicon nitride on the surface and isolate the nanowires from the substrate. It also breaks up on contact with the surface, passivating the substrate so that when I deposit metal, it does not stick to the silicon, but diffuses to the Bi nanolines, forming nanoclusters there. The grey lines are the Bi nanolines, which are about 1.5 nm wide. The Bi nanolines form by annealing a Bi-covered surface at about 570°C for 10-15 mins. They are very long, up to 500 nm, absolutely straight, and without defects.

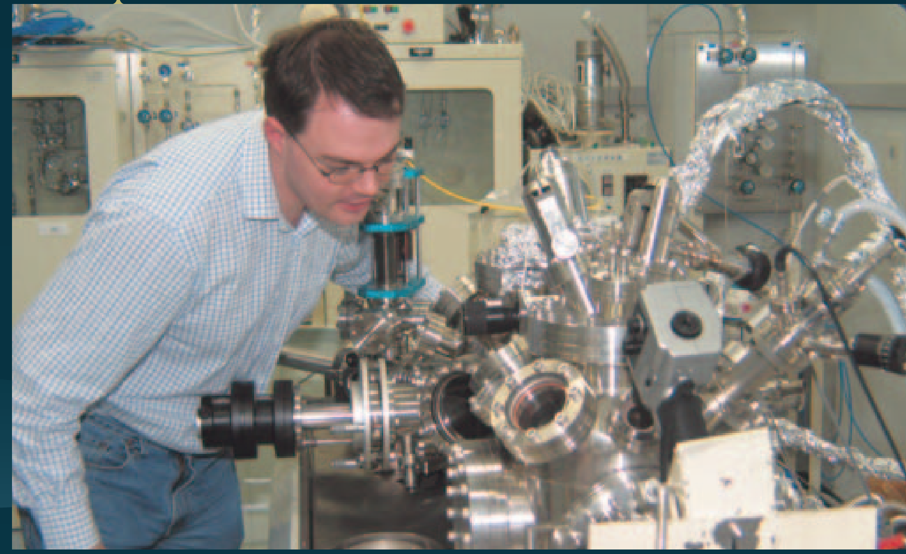


Bi nanoline STM image
The dark background is silicon with an ammonium-treated terminal. The gray line is a Bi-nanoline of approximately 1.5 nm width. It can be a structure reaching a maximum length of 500 nm and is straight without any fault. One of the Bi-nanolines is marked with a red line so that a silver nanocluster approximately 0.5 nm high (corresponding to about 20 atoms) may clearly show up. Silver and platinum show little affinity with bismuth, so they tend to produce a nanocluster rather than a continuous nanoline.

One Bi nanoline is picked out by the red line, to show the Ag nanoclusters which are about 0.5 nm in height, (which corresponds to about 20 atoms). Ag and Pt do not wet the Bi, and so they form clusters rather than continuous wires. I am trying a variety of metals, so as to form not only arrays of nanoclusters, but also nanowires.

The formation of these nanostructures has a large variety of potential applications. Deposition of magnetic materials or spin-active molecules such as metallofullerenes, may result in arrays of spin-active particles, which would have potential applications in spintronics or quantum computing.

One advantage of this technique over methods is the high uniformity of the templates. The nanoparticles which are shown here are constrained by the template, and so have a maximum diameter of about 1.4 nm. Formation of nanowires on this template would produce an array of 1 nm nanowires of highly uniform width, which forms the basis for a number of nanoelectronics architectures, such as the cross bar architecture.



Synthesis and Structure Analysis of Mesoporous Nitrides

Ajayan Vinu, India

The area of my research in the ICYS is the synthesis, characterization and application of novel mesoporous nitride materials such as carbon nitride, boron nitride, boron cabon nitride, gallium nitride, aluminum nitride and indium nitride molecular sieves(*1).

Mesoporous(*2) carbon materials with nanoscale pore sizes prepared from periodic inorganic silica templates have been receiving much attention because of their versatile uses in size and shape selective adsorption media, chromatographic separation, catalysts, nano-reactors, battery electrodes, capacitors, energy storage and biomedical engineering. Metal nitride (MN) that structurally resembles with carbon, is chemically inert and stable upto 1600°C. It has very interesting properties and is an excellent candidate for high temperature and protective coating applications. Especially, mesoporous carbon nitride material (MCN) with two dimensional pore systems promises access to an even-wider range of application possibilities because of their unique properties such as semi-conductivity, intercalation ability, hardness, etc. Until now no such materials have been reported. However, here I present a general strategy for the preparation of the highly ordered mesoporous carbon nitride material, designated as MCN-1, having uniform pore size distribution through the simple polymerization reaction between ethylenediamine and carbon tetrachloride. The ordered mesoporous carbon nitride MCN-1 structure was investigated by powder X-ray diffraction and nitrogen gas adsorption measurements. The XRD pattern of MCN-1 material shows three, clear peaks, which can be assigned to (100), (110), and (200) diffractions of two dimensional hexagonal lattice (space group $p6mm$) with a lattice constant a_{100} = 9.52 nm, similar to the XRD pattern of parent mesoporous silica template SBA-15 which consists of the hexagonal arrangement of cylindrical pores and the pores are interlinked by the micropores present in the walls, as shown in Figure1 and 2. The MCN-1 material exhibits high specific surface area, specific pore volume and uniform mesopores size distribution, could offer great potential for the applications, such as catalytic supports, gas storage, lubricants, biomolecule adsorption and drug delivery. We believe that its existence opens other possible path for the preparation of various mesoporous carbon nitrides with different dimensional structures using different inorganic mesoporous silica templates and carbon and nitrogen precursors.

(*1) Molecular sieve: to separate molecules into different size groups according to the mesopore aperture size.

(*2) Mesoporous: porous materials that have mesopores measuring 2-50 nm in diameter.

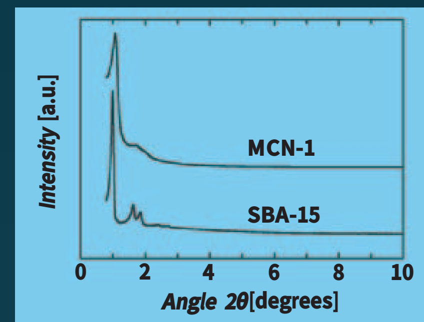


Figure 1 X-ray diffraction curves of MCN-1 and SBA-15 (= silica template). The diffraction curve (above) of mesoporous carbon nitride (MCN-1) shows three peaks. They resemble those found on the X-ray diffraction curve (below) of a mesoporous silica template (SBA-15), which has hexagonally arranged cylindrical mesopores.

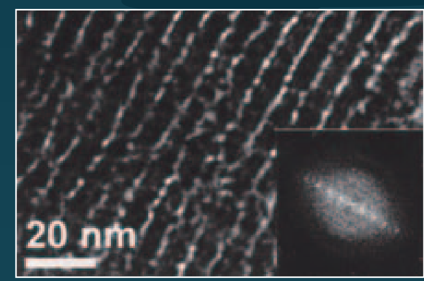


Figure 2 A high-resolution transmission electron microscopic image of MCN-1. MCN-1's mesopores are connected with each other through ultra small pores developed on walls.