出國報告（出國類別：其它-參訪交流）

出席 **SPing-8** 啟用 **10** 週年相關活動及進行台日合作交流

出國報告

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派赴國家：日本

出國期間：**99** 年 **12** 月 **21** 日至 **12** 月 **25** 日

報告日期：**100** 年 **3** 月 **14** 日

目　錄

壹、目的

2010 年 12 月 21 日至 22 日國家同步輻射研究中心舉辦在日本兵庫縣播磨 Spring-8 台灣 beamlines 10 週年慶祝活動，訪團代表本會出席本項活動以祝賀並瞭解 Spring-8 台灣 beamlines 的執行成果；另並轉往東京和駐日科技組就次年業務推展目標和計畫進行討論。

貳、過程與觀察

■主要行程/

1.參與 10th Anniversary Ceremony of Taiwan Beamlines at SPring-8

本次活動主係慶祝台灣在日本兵庫縣播磨建置 Spring-8 台灣 beamlines 10 週年。台灣 beamlines 在 Spring-8 的成立過程大致如下:

1998 年 4 月 國家同步輻射研究中心提出與 JASRI(Japan Synchrotron Radiation Research institute) 簽署 Letter of intent。

1998 年 12 月 簽署 Memorandum of Understanding (合作瞭解備忘錄)。

1999 年 8 月台灣 beamline 辦公室在 SPring-8 成立。

1999 年 10 月安裝 BL12B2 前端。

2000 年 1 月安裝 BL12XU undulator。

2000 年 8 月安裝 BL12XU 前端。

2000 年 9 月 BL12B2 完成。

2000 年 10 月 BL12B2 第一條光線試運轉。

2000 年 12 月正式營運典禮。

本次慶祝活動在訪問團抵達當晚先與日方舉行會前餐敘，次日(12 月 22 日)上午參訪行程如下：

08:30 - 09:30 Breakfast at SPring-8 cafeteria

10:00 - 11:00 Tour to Taiwan Beamlines and Taiwan Beamline Office

11:00 - 11:20 Tour to BL44XU

11:30 - 12:00 Tour to PTP Lab and NSRRC facilities

12:00 - 13:00 Lunch at SPring-8 cafeteria

13:30 - 14:30 Tour to SPring-8 XFEL

12 月 22 日下午慶祝活動典禮在 SPring-8 公共關係中心中央講堂舉行，議程如下:

Opening Remarks

15:00 - 15:10 張副主委以國家同步輻射研究中心指導委員會董事長代表台方致賀詞

15:10 - 15:20 國家同步輻射研究中心張石麟主任致詞。

Remarks from JASRI/RIKEN

15:20 - 15:30 Tetsuhisa Shirakawa (白川哲久), President, JASRI

15:30 - 15:40 Hiromichi Kamitsubo(上坪宏道), Special Advisor, RIKEN

Remarks from Former Directors of NSRRC

15:40 - 16:00　國家同步輻射研究中心前主任梁耕三簡報回顧

16:00 - 16:30　Group Photo & Break

Talks on Achievements and Perspectives

16:30 - 17:00　國家同步輻射研究中心黃迪靖副主任以"Achievements and Future Plan of Taiwan Beamlines at SPring-8"為題發表演講

17:00 - 17:30　Tetsuya Ishikawa(石川哲也), Director, RIKEN Harima Institute，以 "Future Perspective of the Third Generation SR & XFEL"為題發表演講

18:00 - 19:30　***Reception dinner at SPring-8 Cafeteria***

2.與駐日本科技組舉行 2011 年台日科技交流活動工作會議

擬訂 2011 年之主要活動規劃:

(1) 為解決財團法人日本交流協會自 2011 年 4 月起因該單位外交一貫政策及預算所限，將停止與我國共同辦理台日雙邊研討會乙案，為避免影響台日科研社群交流合作之溫度與動力，將暫由國科會視預算規模補助學術研究機構(學者專家)在台或在日本舉辦雙邊研討會。

(2) 在去(2010)年 9 月與日本科學技術振興機構(JST)續簽合作備忘錄後，2011 年國科會與 JST 主要合作活動計畫，預訂共同補助專題研究計畫、在日本舉辦以「奈米元件研究計

畫」為主題之研究成果發表會，在台灣舉辦以「生物電子」為主題之研討會。

(3) 邀請日本重要科技人士來台訪問並預訂於今年 11 月於日本京都地區舉辦以「生物科技」為主題之學術研討會，以展現台灣在該領域之研究成果。

(4) 規畫我國生技醫藥國家型科技計畫訪問團，訪問日本重要科研機構與瞭解日本如何評估、建置生物 Science Map 的策略與落實。

參、心得與建議事項

1. 日本科學研究和基礎設施長期累積的實力，均有值得我國科研機構借鏡學習，甚或若能共同合作，無疑更能發揮加值與互補效益，獲得具體豐碩的成果，在國際科研影響力均有重大突破的進展。國家同步輻射研究中心在 10 年前，能在日本建立台灣 beamlines 推展我國與日本在同步輻射的合作，並提供國際學術界使用該項設備，以獲得研究成果，這是在 10 年後台灣 beamlines 得以有卓越貢獻之處，在爾後台日雙方若能以過去 10 年之合作基礎和經驗，將能再次發揮締造更豐碩的佳績。日本的在基礎研究實力雄厚，不僅研究人員眾多，在特定領域更是居領先及重要地位，日本政府亦投入大量經費並訂定長期發展策略，我們希望能藉由訊息、技術及材料的交換，深化合作。

2. 日本與台灣相關科研領域在研發實力上，互有可借鏡之處；

在部分特定領域，我國的發展實已趨成熟，是我國可以運用既有的科技實力和經驗，以科技為起點，與日本重要科研機構建立穩定的合作機制，俾使台日成為緊密的合作夥伴。在國科會與JST持續推動各項合作計畫後，應再致力開拓建構與日本其他重要科研機構的實質合作，方能增加台日合作活動的廣度和項目，俾能提昇雙方合作的強度和密度。

附件一 (國家同步輻射研究中心張石麟主任於慶祝典禮致詞)

附件二　(Taiwan Beamlines at SPring-8”發展成果，摘自同步輻設中心 Spring-8 10 週年特刊)

BL12B2 end station

The BL12B2 beamline is designed to provide multiple research capabilities for biostructure and materials research at atomic resolution. In order to accommodate a wide range of experimental requirements of X-ray users in Taiwan, this beamline includes several configurations of the optical components and can be switched between the various monochromatic and the white beam modes.

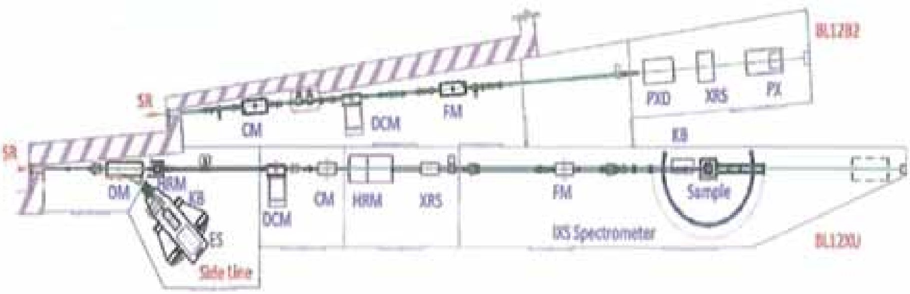
Applications of BL12B2 require mainly the monochromatic beam mode in the medium energy range (from 5 to 25 keV) with energy resolution of $\Delta E/E \sim 10^{-4}$. Four experimental stations have been installed initially in tandem on the beamline, providing research capabilities ranging from X-ray absorption spectroscopy (XAS), powder X-ray diffraction (PXD), high-resolution X-ray scattering (XRS), to protein crystallography (PX).

PXD

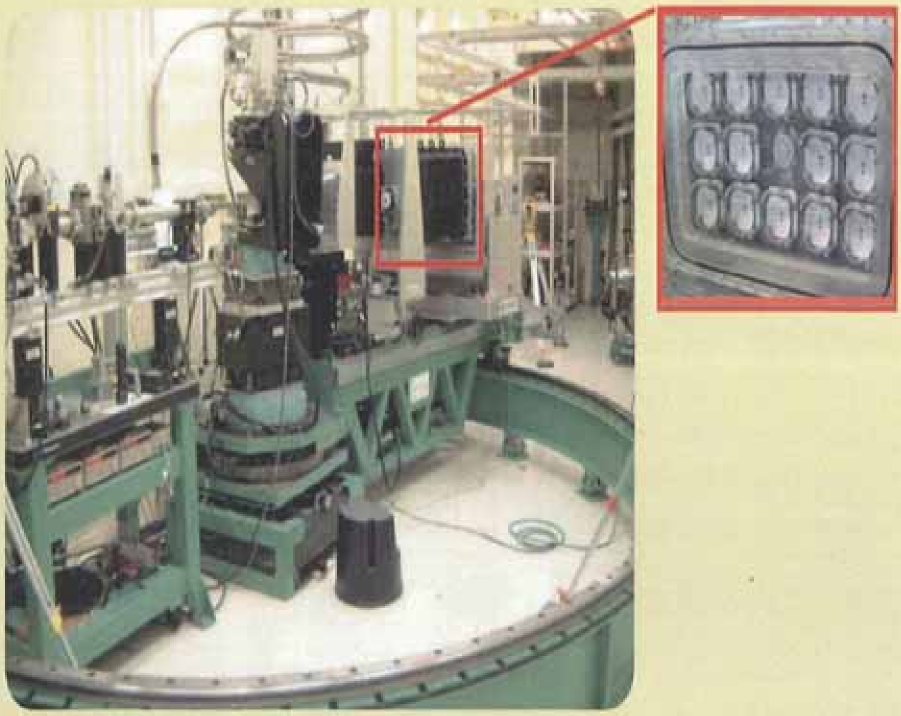
XRD

EXAFS

PX



BL12XU end station

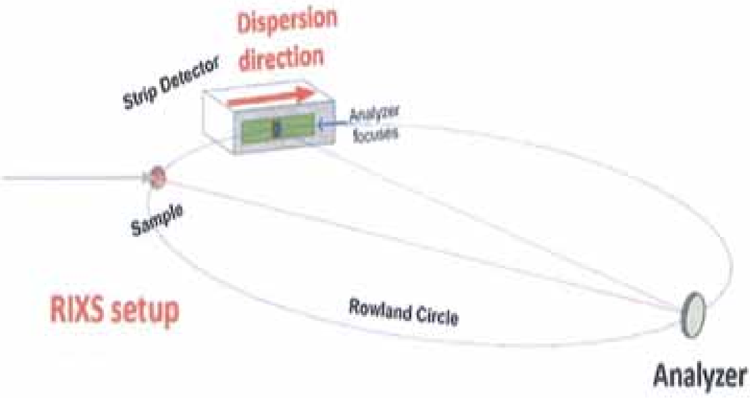


The BL12XU mainline is designed primarily for inelastic X-ray scattering (IXS) experiments with variable energy resolution to explore frontier research in correlated electron systems and the electronic structure of materials under high pressure.

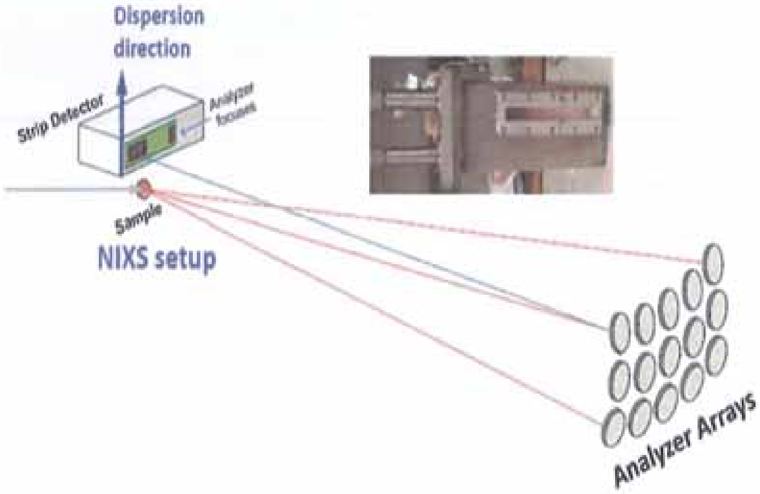
For non-resonant inelastic X-ray scattering (NIXS), the spectrometer is basically a Rowland circle instrument with a 3-m horizontal arm covering a scattering angle range of 0-140 degrees. A pulse-tube cryostat and a precision XYZ carrier are specifically designed for the spectrometer to provide vibration-free sample cooling down to 4 K.

For resonant inelastic X-ray scattering (RIXS) experiments, the setup uses a single bent analyzer of either 1-or 2-m radius respectively for the low-resolution (LR) or high-resolution (HR) mode. The HR mode couples to a 4-bounce channel-cut high resolution monochromator (HRM). For medium-resolution (MR), 2-bounce HRM is also employed.

Upgrade of the IXS spectrometer



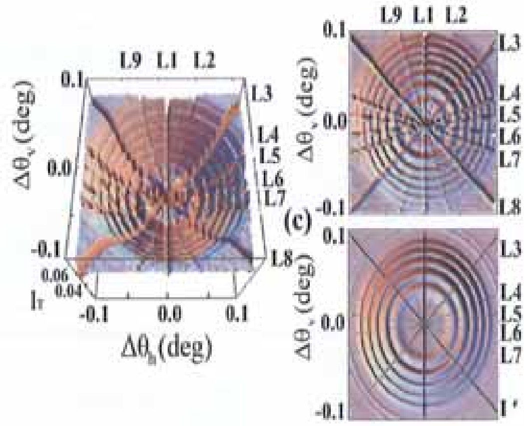
A position sensitive detector (PSD) could enhance the energy resolution for IXS spectrometers by dividing the footprint of focused X-rays from a diced analyzer on a detector into several blocks so as to count the photons of slightly different energies on each independently.

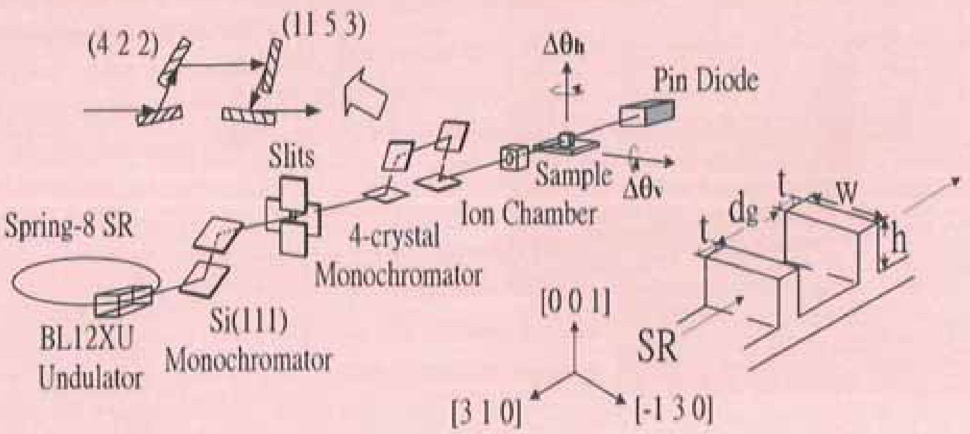


For NIXS, a PSD independently counts spots from analyzers having slightly different diffractive conditions due to small changes in lattice parameters. Summing signals of different analyzers after alignment minimizes the deterioration of overall energy resolution. A multiple analyzer system increases detection efficiency for the best energy resolution of 70 meV.

X-ray cavity

Another purpose of BL12XU is for high Q-resolution scattering, X-ray physics and optics development. S. L. Chang *et al.* have successfully observed cavity resonance fringes in silicon crystal cavities and realized for the first time Fabry-Perot resonators for hard X-rays. This cavity resonance results from the coherent interaction between the X-ray wave fields generated by two plates with a gap smaller than the X-ray coherence length. This finding opens up new opportunities for high-resolution and phase-contrast X-ray studies, and may lead to new developments in X-ray optics. [S. L. Chang *et al.*, PRL 94, 17481, (2005)]

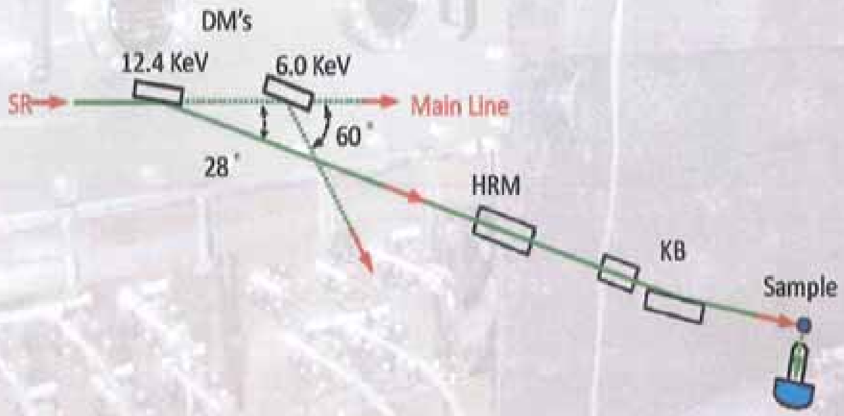




Probing deeper with photoelectrons

The BL12XU sideline is designed specifically for performing hard X-ray photoemission spectroscopy (HAXPES) which has a potential to probe bulk electronic structure as well as buried interface. Due to small photoionization cross section, HAXPES requires X-rays of high flux and brilliance. The overall energy resolution combining efficient X-ray optics and an electron energy analyzer with high performance is a fraction of a tenth of eV to several tenths of eV, suitable for both core level and valence band photoemission. The HAXPES end station was developed by the University of Cologne and Max Planck Institute in Dresden, Germany.

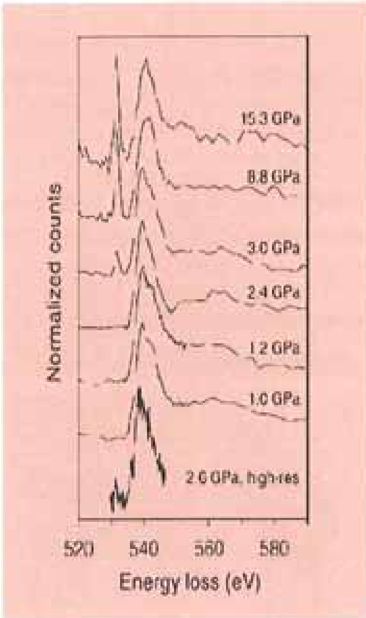
The main idea is to be able to change the photoelectron detection direction between two orthogonal geometries, parallel (horizontal) and perpendicular (vertical) to the polarization vector of incoming photons. The horizontal geometry yields spectra with enhanced sensitivity to the s-orbitals, while the vertical one was found to produce spectra with minimal s-contributions. These findings are crucial for valence band investigations. For instance, studies on the nature of the chemical bonding would profit from the s-sensitive geometry, while studies on strongly correlated electron systems will need the s-insensitive geometry.



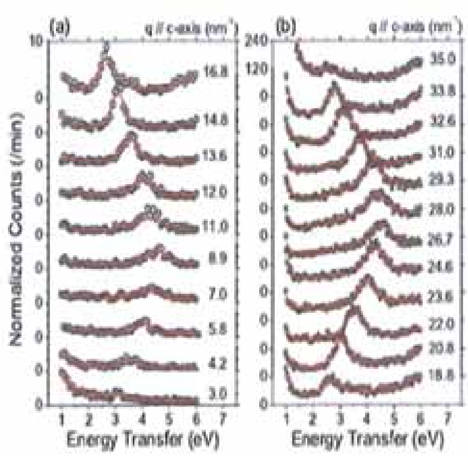
H_2O under pressure

When subjected to high pressure and extensive X-rays, water (H_2O) molecules cleaved, forming O–O and H–H bonds. The oxygen (O) and hydrogen (H) framework in ice VII was converted into a molecular alloy of O_2 and H_2. X-ray diffraction, the K-edge X-ray Raman scattering (XRS), and optical Raman spectroscopy demonstrated that this crystalline solid differs from previously known phases.

The K-edge XRS spectra are dominated by a cluster of peaks around 540 eV. At pressures above 2.5 GPa, however, X-rays induced pronounced, irreversible changes in the XRS spectra. A distinctive, sharp peak appeared at 530 eV that was characteristic of O–O bonding in O_2 and grew with time, reaching a plateau after 6 hours of exposure to the incident X-ray beam. [Mao *et al.*, Science 314, 636 (2006)]

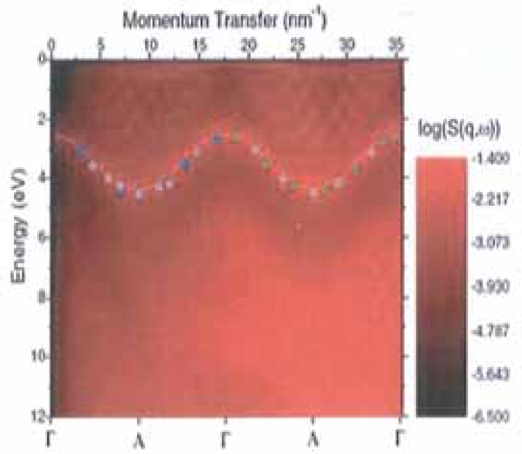


Charge excitations in MgB_2



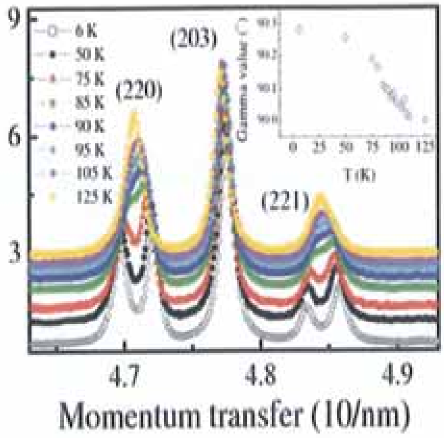
The discovery of superconductivity in MgB_2 at a critical temperature T_C~ 39K, the highest among simple binary compounds, has stimulated extensive theoretical and experimental studies worldwide. Cai et al. reported the first measurement of the dynamical structure factor S(q,ω) of electrons in single-crystal MgB_2 at the BL12XU. The presence of strong electron-phonon coupling between the flat σ bands and the in-plane vibration of the B layer dominates the superconducting properties and is largely responsible for the unusually high T_C. [Cai *et al.*, PRL 97, 176402 (2006)]

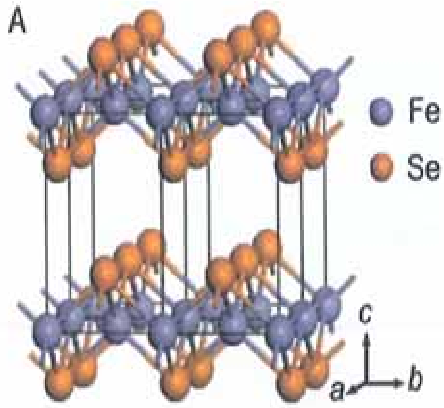
Periodic cosine like excitation along c-axis. Comparing to ab initio TDDFT theory reveals its origin to strong coupling between single-particle and collective degrees of freedom, mediated by large crystal local-field effects.



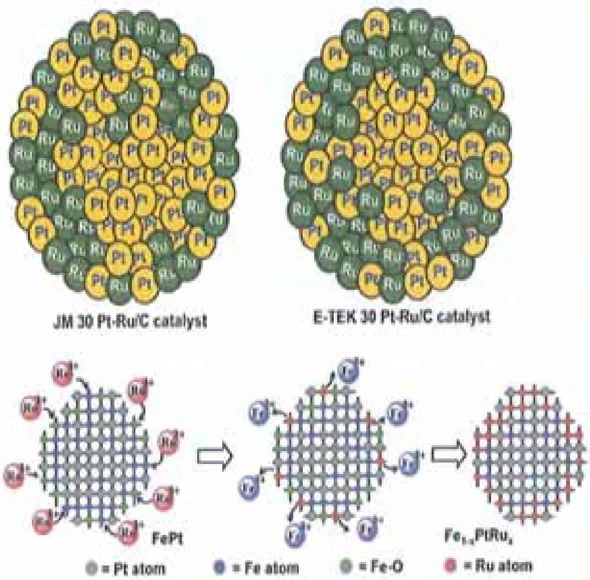
Linking superconductivity with structure

F. C. Hsu *et al.* reported the observation of superconductivity with zero-resistance transition temperature at 8 K in the PbO-type FeSe compound. A key observation is that the clean superconducting phase exists only in those samples prepared with intentional Se deficiency in FeSe. What is truly striking is that this compound has the same, perhaps simpler, planar crystal sublattice as the layered oxypnictides. This result provides an opportunity to better understand the underlying mechanism of superconductivity in this class of unconventional superconductors. [Hsu *et al.*, PNAS 105, 14262 (2008)]





Engineering bimetallic nanoparticles



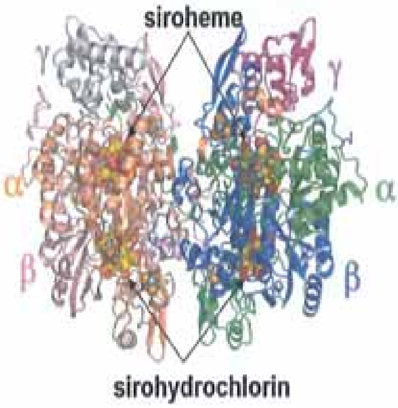
New synthetic approaches have been intensively explored to prepare new types of nanostructures using a chemical replacement reaction in a solution phase. The crystal compositions, structures, and shapes of starting nanocrystals might have been varied after they were chemically transformed into new types of nanostructures.

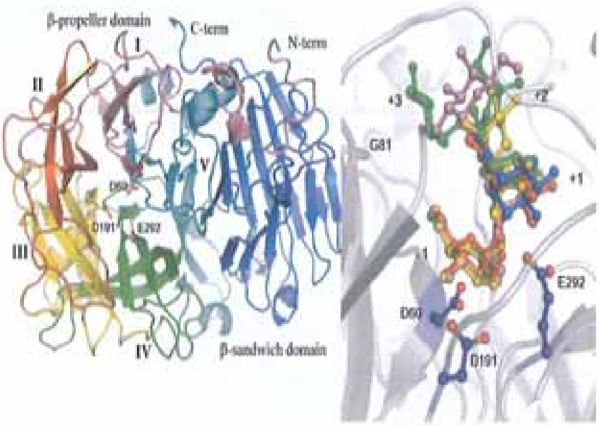
The ratios of coordination numbers obtained from EXAFS helps determine quantatitatively the extent of alloying of bimetallic nanoparticles, opening a new route to easily and rapidly prepare a solid-solution type of ternary metal nanocrystals for catalytic applications. [Wang *et al.*, JACS 129, 1538 (2007)]

Unraveling protein structure

As the user community is expanded and BL12B2 PX facilities are improved, a number of important biological macromolecular structures have been determined. The selected research highlights from Taiwan users are briefly introduced in the following.

Sulfite reductase mediates the reduction of sulfite to sulfide in sulfate-reducing bacteria, strict anaerobes, constitute a particular group of prokaryotes that possess the capacity to metabolize sulfate. The crystal structures of two active forms of dissimilatory sulfite reductase (Dsr) from *Desulfovibrio gigas* reveal dynamic roles played by the individual subunits and cofactors in the different states. These different forms of Dsr offer structural insights into a mechanism of sulfite reduction that can lead to $S_3O_6^{2-}$, $S_2O_3^{2-}$ and S^{2-} with different oxidation levels, which had remained a subject of controversy previously. [Hsieh *et al.*, Mol. Microbiol. 78, 1101 (2010)]





Fructosyltransferases catalyze the transfer of a fructose unit from one sucrose/fructan to another, and are engaged in the production of fructooligosaccharide (FOS)/fructan. The crystal structures of *Aspergillus japonicus* fructosyltransferase (*Aj*FT) complex with donor/acceptor substrates are determined to reveal complete subsites in the active site for catalysis. The results shed light on the catalytic mechanism and substrate recognition of *Aj*FT and other clan GH-J fructosyltransferases for FOS production for food industrial application. [Chuankhayan *et al.*, J. Biol. Chem. 285, 23249 (2010)]

Most organisms use glutathione to regulate intracellular thiol redox balance and protect against oxidative stress; protozoa, however, utilize trypanothione for this purpose. Trypanothione biosynthesis requires ATP-dependent conjugation of glutathione to spermidine by glutathionylspermidine synthetase (GspS) and trypanothione synthetase, which are considered as drug targets. This study constitutes the first GspS structural information on the biochemical features of parasite homologs that underlie their broad specificity for polyamines. [Pai *et al.*, EMBO J. 25, 5970 (2006)]