Twenty-First NSRRC Users' Meeting and Workshops

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Twenty-First NSRRC Users’ Meeting and Workshops

The Twenty-First NSRRC Users’ Meeting was held at the Activity Center of the National Synchrotron Radiation Research Center (NSRRC) in Taiwan from September 9 to 10, 2015. At the same time, celebration of the first light of the Taiwan Photon Source (TPS), achieved at the end of 2014, highlighted the prospective scientific frontiers marked by the TPS storage ring. Jointly organized by the UEC Chair Ying-Hao Chu (National Chiao Tung Univ.) and Cheng-Maw Cheng (NSRRC), the meeting consisted of two plenary sessions and three featured workshops. Nearly 30 distinguished scholars, both domestic and international, were invited to present their research achievements. This highly anticipated event attracted an enthusiastic crowd of more than 370 synchrotron experts, users, and potential users.

Plenary Sessions

The meeting began on the morning of September 9 with an address from the NSRRC Director Shangjr Gwo, who briefed the current status and future developments of NSRRC’s light sources, beamlines, and the key research that had taken place during the year. The Keynote Speech, titled “Crystallography and Synchrotron Radiation,” was delivered by Yu Wang (Academia Sinica and National Taiwan Univ.). She elaborated on the importance of synchrotron radiation to crystallography and demonstrated several examples where chemical reactions in a crystalline state were monitored using synchrotron radiation. Additionally, some recent results in single-crystal chemical dynamics were presented in this talk. Later, Ming-Chyuan Lin and Yu-Shan Huang, division heads of the Light Source Division and Experimental Facility Division of the NSRRC, respectively, outlined the progress of NSRRC synchrotron light sources and synchrotron experimental facilities.

The afternoon sessions were filled by four presentations covering recent scientific accomplishments using NSRRC facilities. Mnn-Tsong Lin (National Taiwan Univ.) applied a combined study of scanning tunneling microscopy (STM) and X-ray photoelectron spectroscopy (XPS) on emergent materials. By combining these two complimentary techniques, the surface of the semiconductor BiTeI, a material with strong spin-orbit coupling, has been investigated for exploiting the Rashba effect in spintronic devices. Spatially resolved tunneling microscopy confirmed that the lateral boundary between Te and I terminated BiTeI exhibits p-n junction-like discontinuities in its electronic structure. These findings realize an important step towards the exploitation of the unique behavior of the Rashba semiconductor BiTeI for new device concepts in spintronics.

Based on polymer characterization through small-angle X-ray scattering, Wen-Chang Chen (National Taiwan Univ.) demonstrated the potential of nanostructured polymeric materials such as nanowires, nanofibers, and nanoparticles in making floating gates for memory devices and organic field-effect transistors. He developed a molecular nanofloating gate in pentacene-based transistor memory devices using conjugated polymer nanoparticles (CPN) as the discrete trapping sites embedded in an insulating polymer, Poly(methacrylic acid) (PMAA). Nanoparticles of polyfluorene (PF) and polyfluorene-alt-benzo thiadiazole (PFBT) with average diameters of 50–70 nm were used as charge-trapping sites, while hydrophilic PMAA served as a matrix and a tunneling layer. Transistor memory devices using PF nanoparticles as floating gates exhibited a controllable threshold voltage shift, indicating effective electron-trapping by the PF CPN. The electron-storage capability can be further...
improved using the PF BT-based nano-floating gate to lower the lowest unoccupied molecular orbital level, so that the trapped charges are more stabilized, leaving a large memory window (35 V) and retention time longer than $10^4$ s with a high ON/OFF ratio of $>10^4$. He concluded that these superior memory characteristics are due to the presence of discrete polymer nanostructures.

Tsung-Lin Li (Academia Sinica) showed that structural enzymology led to novel lipoglycopeptide antibiotics. He demonstrated that cohorts of new lipoglycopeptide antibiotics could now be made using the engineered biocatalysts Orf2*, Orf11*/Dbv8, NahK, and Dbv29, by means of structure-based protein engineering. Crystal structures of these enzymes in free forms or in complex with ligands allow researchers to investigate both enzyme catalytic mechanisms and substrate plasticity microscopically, thus enabling a revamp of old compounds with new functionalities.

Tsai-Te Lu (Chung Yuan Christian Univ.) reviewed the electronic structure of Fe-NO complexes by using Fe K-edge XAS, S K-edge XAS, and Fe valence-to-core XES (V2C XES). The comparable energy levels of NO $\pi^*$ orbitals and Fe 3d orbitals complicate the bonding interaction within Fe-NO complexes and the quantitative assignment of NO’s oxidation state. The relative d-manifold energy derived from S K-edge XAS, as well as the Fe K-edge XAS, suggested that the electronic structure of the $\{\text{Fe(NO)}_2\}^{9}$ core of mononuclear DNICs was best described as the resonance hybrid between $\{\text{Fe}^{\text{III}}(\text{NO}^-)_2\}^{9}$ and $\{\text{Fe}^{\text{II}}(\text{NO}^-)(\text{NO}^\bullet)\}^{9}$. V2C Fe XES study of DNICs revealed that the $\Delta E_{\sigma_2s^* - \sigma_2p}$ of NO is derived from NO $\sigma_{2s}^* \rightarrow \sigma_{2p} \rightarrow \text{Fe}_{1s}$ transitions. He pointed out that the quantitative assignment of NO oxidation state would correlate the feasible redox process of nitric oxide and Fe-nitrosylation biology.

In this meeting, 182 posters featuring NSRRC research projects and activities from users were displayed, including 11 registered for the exciting Oral Presentation Contest. In a close competition, there was a three-way tie for first place in the Poster Contest between Hsiung Chen (NSRRC), Chun-Chang Ou (National Taiwan Univ.), and Jen-Iu Lo (NSRRC). The first prizes for the Oral Presentation Contest for Material Science, Physical/Chemical Science, and Biological Science went to Bo-Wei Chen (National Tsing Hua Univ.), Chih-Yu Lin (National Tsing Hua Univ.), and Jing-Hua Tzeng (National Chung Hsing Univ.), respectively.

Three workshops promoting novel scientific topics and techniques of the phase-II beamlines and neutron facility in energy materials and condensed matter physics were held the following day. The workshops provided many opportunities to explore specific sciences and technical areas related to the TPS phase-II operation.

**Workshop I: Quick-Scanning EXAFS**

*Organized by Chih-Wen Pao and Jyh-Fu Lee*

The main theme of this workshop was to introduce the technique of quick-scanning ex-
Meeting Reports

Synchrotron radiation news and trends in X-ray absorption fine structure (QEXAFS) spectroscopy and corresponding scientific opportunities to users in Taiwan. The world’s leading experts presented the most recent technical developments and scientific research using QEXAFS spectroscopy in several synchrotron facilities, such as PETRA III, SLS, NSLS, and SOLEIL. As the key component of QEXAFS, many aspects related to the quick-scanning monochromator (Q-mono) were discussed in detail, such as the drive mechanism, stability, and achievable temporal resolution. The latest design of Q-mono can provide time resolutions of 10 and 20 milliseconds in XANES and EXAFS, respectively, with excellent data quality. Moreover, this new Q-mono is able to run in a step-scanning mode so that its installation will cost less and require less space for beamline construction. In this case, the control system becomes more compact, and switching between different operation modes is easier. Data acquisition systems such as detectors (gridded ionization chambers), current amplifiers, and analog-to-digital converters were presented, as was the relevant software. Invited speakers shared their results from recent research on energy materials, as well as heterogeneous and homogenous catalysis, demonstrating the QEXAFS applications of great potential. They also provided the designs of in-situ/in-operando measurement systems. QEXAFS investigations are of particular importance in many fields. For example, the short-lived intermediate states in a chemical reaction can be probed effectively using time-resolved in-situ measurements. In addition, quick scans lead to short measuring time, enabling the investigation of radiation-sensitive samples such as proteins and biological polymers.

Workshop II: In-Situ Soft X-ray Spectroscopy Characterization in Energy Materials Research
Organized by Chia-Hsin Wang and Yaw-Wen Yang

This workshop aimed to provide a platform for users to learn and apply in-situ soft X-ray spectroscopy techniques to energy material research. Six invited speakers from overseas and two speakers from Taiwan shared their research results with more than 100 participants in this workshop. William Chueh (Stanford Univ.), Artur Braun (Empa), Wanli Yang (ALS), and Zhi Liu (CAS) presented their studies in batteries, fuel cells, and solar cells by using various in-situ operando soft X-ray spectroscopic techniques such as scanning transmission X-ray microscopy for fluorescence-yield soft X-ray, ambient pressure X-ray photoemission spectroscopy (APXPS), near-edge X-ray absorption fine structure (NEXAFS). During the poster session, students and young scientists presented and shared their research results and progress using NSRRC facilities.

NSRRC director Shangjr Gwo briefed the current status and future developments of NSRRC’s light sources and beamlines.
(NEXAFS) spectroscopy, and resonant inelastic X-ray scattering (RIXS). Hiroshi Kondoh (Keio Univ.) and Jordi Llorca (Tech. Univ. of Catalonia) reported on the gas-solid reaction under near-working catalytic condition on Pt-group metal and bimetallic nanoparticles by APXPS at the Photon Factory and ALBA synchrotron, respectively. In addition, Jong-Liang Lin and Yan-Gu Lin presented their recent research results carried out at the NSRRC using soft X-ray spectroscopy. Before the workshop came to an end, Chia-Hsin Wang reported on a planned design of an APXPS endstation at the NSRRC.

Workshop III: Neutrons for Condensed Matter Scientists
Organized by Jason S. Gardner

This one-day workshop highlighted the power of the neutron as a probing tool for condensed matter. Distinguished scientists from Europe and North America were invited, along with several neutron scientists from Taiwan, to explain the benefits of multiple neutron techniques to the audience.

Neutron scattering is, in some sense, going through a renaissance with billion-dollar facilities being built in the US, Japan, and now in Sweden. Examples of the new, state-of-the-art instrumentation at these facilities were presented, including the Taiwanese cold neutron triple-axis spectrometer, SIKA. Other invited speakers spoke of their scientific studies in superconductivity, interfaces, spin-orbit coupling, engineering materials, and DNA/dendrimer complexes. The morning session concentrated on research in strongly correlated electron systems. Results from inelastic neutron and resonant inelastic X-ray spectrometers were used to highlight the unique features of several interesting magnets. In the afternoon, neutron diffraction studies of high entropy alloys were presented through a demonstration study of functional new engineering materials. During a coffee break, several discussion groups were formed that focused on specific scientific interests; the discussion appeared to be quite dynamic, while the participants enjoyed fruit and obtained information from the experts. The afternoon session concentrated on studies on larger structures. Small-angle neutron and X-ray scattering studies of complex self-assembled systems, as well as neutron and X-ray reflection studies of liquid interfaces, were presented. The NSRRC hopes that this workshop will result in a greater participation in neutron research in Taiwan and closer ties with the international community.

Conclusion

The Twenty-First Users’ Meeting and Workshops provided both synchrotron radiation and neutron users with a forum to communicate and to discuss issues related to experiments, user service, and the future development of the NSRRC with NSRRC management and scientists. The attendees had an opportunity to learn not only about the current status of the NSRRC’s light sources and beamlines, but also about the recent scientific achievements and new capabilities that TPS can offer. All sessions and workshops were well attended, and the presentations encouraged and inspired valuable discussion among the participants.

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