**Diamond-Anvil Cell Infrared Facility (NSLS-U2A) at the National Synchrotron Light Source**

2014 COMPRES Annual Report

November 2013 – October 2014

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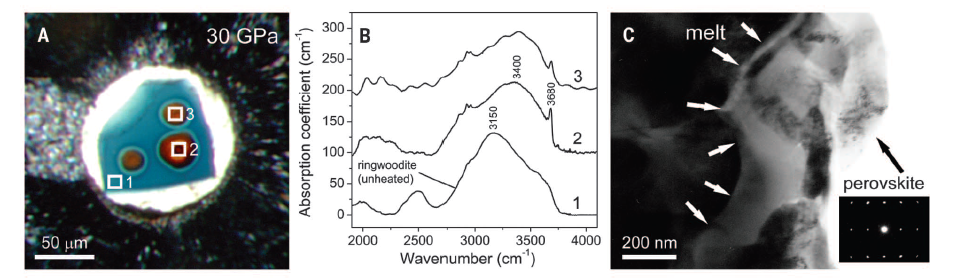
**Overview**

The diamond anvil cell (DAC) infrared (IR) beamline at the National Synchrotron Light Source (**NSLS-U2A**) is an integrated and dedicated facility with the capacity for synchrotron infrared microspectroscopic techniques, Raman scattering, and visible spectroscopy combined with diamond-anvil cell methods for the measurement of far- to near-IR and visible spectra of materials from ambient to ultrahigh pressures at variable temperatures. The NSLS-U2A facility was the first dedicated high-pressure IR beamline in the world, and it is a COMPRES showcase for the worldwide earth science and high-pressure research communities. The presence of an IR beamline together with x-ray facilities for high-pressure experiments is one of the unique features of the NSLS for general users. We continue to provide convenient access for users from the COMPRES community and to broaden our user base. In addition, we promote our users’ research projects on problems relating to high-pressure geoscience and planetary science, complemented by studies in materials science, condensed-matter physics, and chemistry (many of which are also carried out by the COMPRES user community). The major beamline upgrades completed during 2009-2011 provided by the support of COMPRES and the Carnegie-DOE Alliance Center (CDAC) have not only significantly improved the beamline performance but also made it available for users to address problems ranging from outer solar system bodies to the Earth’s core. The U2A beamline also remains an important testing ground and bridge for the Frontier Synchrotron Infrared Spectroscopy (FIS) Beamline, one of the eight NxtGen beamlines for NSLS II. It is therefore crucial to provide continued access for the COMPRES user community to the brightest and most stable synchrotron infrared source.

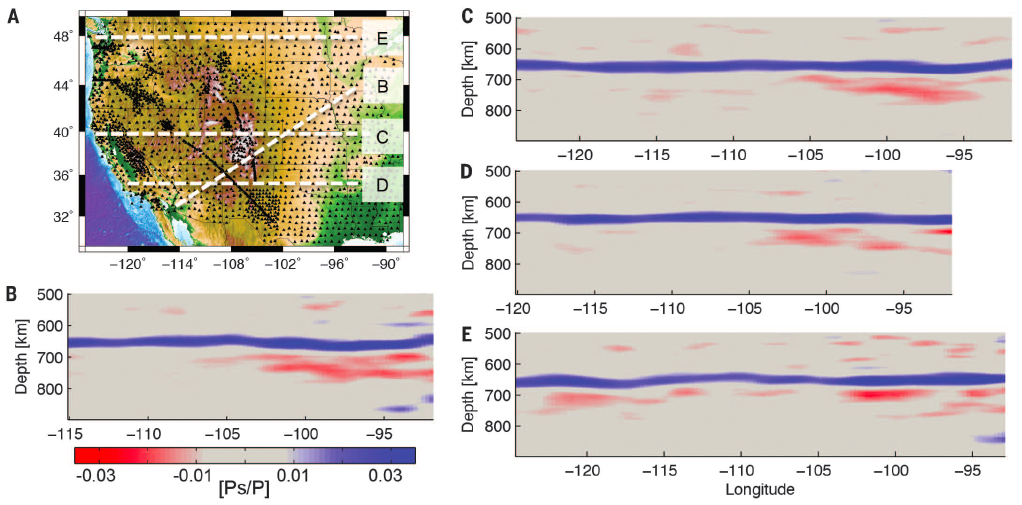
**Scientific Highlights**

**a. *Dehydration Melting at the Top of the Lower Mantle***

The high water storage capacity of minerals in Earth’s mantle transition zone (410- to 660-kilometer depth) implies the possibility of a deep H2O reservoir, which could cause dehydration melting of vertically flowing mantle. A synergetic effort led by **B. Schmandt** (University of New Mexico) **and S. Jacobsen**(Northwestern) to employ multiple techniques includingsynchrotron infrared spectroscopy, TEM, seismic P-to-S conversions recorded by a dense seismic array in North America, and numerical modeling to examined the effects of downwelling from the transition zone into the lower mantle. In experiments, the transition of hydrous ringwoodite to perovskite and (Mg,Fe)O produces intergranular melt. The advanced synchrotron infrared microspectroscopy with high spatial resolution up to the diffraction limit provided key diagnostic of the water content in laser-heated sample area quenched from extreme high P-T conditions equivalent the lower mantle environment. Detections of abrupt decreases in seismic velocity where downwelling mantle is inferred are consistent with partial melt below 660 kilometers. The discovery suggests water from the Earth's surface can be driven to such great depths by plate tectonics, eventually causing partial melting of the rocks found deep in the mantle. These results will aid scientists in understanding how the Earth formed, what its current composition and inner workings are and how much water is trapped in mantle rock.



***Figure 1.*** *Laboratory experiments on hydrous ringwoodite. (A) Single-crystal of hydrous ringwoodite (blue crystal) containing 1 wt % H2O inside a DAC at 30 GPa. The sample was laser heated to 1600°C in several spots (orange circles) to perform direct transformation to perovskite and (Mg,Fe)O. (B) Synchrotron-FTIR spectra of the recovered sample in three locations: an unheated part of the crystal (spectrum 1) and two locations within laser-heated spots (spectra 2 and 3). FTIR spectra were collected with a 10 μm by 10 μm aperture, illustrated and numbered by white boxes in (A). (C) TEM within a laser heated spot (position 2) shows crystals of perovskite and intergranular amorphous quench (melt).*

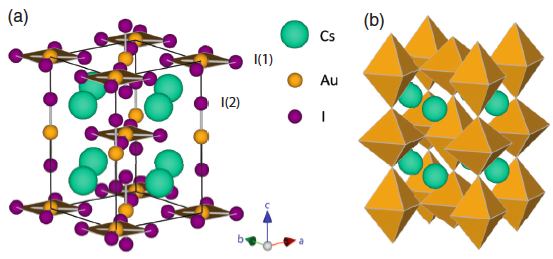
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*Figure 2. Vertical cross-sections through the CCP image. (A) Map of the study region with broadband seismometers denoted by black triangles and the locations of vertical cross-sections shown in (B) to (E) denoted by white dashed lines. (B) Vertical cross-section through the CCP image. The 660, which separates the transition zone and lower mantle, is clearly imaged by 2.5 to 4% amplitude positive Ps/P arrivals in all cross-sections. Negative arrivals beneath the 660 have amplitudes ≤2.2%. (C to E) Vertical cross-sections through the CCP image beneath the three other lines labeled in (A).*

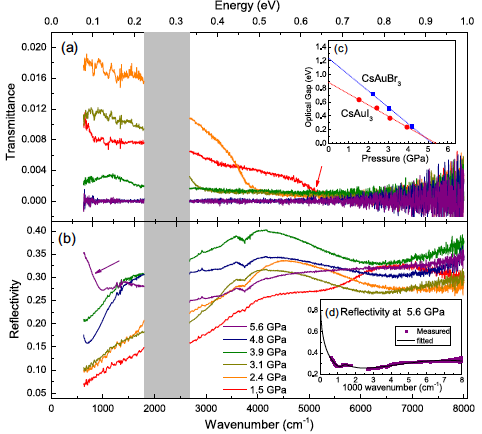
*Reference:* B. Schmandt, S. Jacobsen, T. Becker, Z. Liu, K. Dueker, Dehydration Melting at the Top of the Lower Mantle, *Science*, **344**(6189), 1265-1268 (2014).

# *b. Bandgap Closure and Reopening of a Mixed Valence Compound*

The band structure of a material is determined by the electronic configuration of its components and their arrangement symmetry. Pressure is known to be able to alter the electronic configuration and atomic arrangements, and therefore change the band structure. A team of researchers led by **Shibing Wang** and **Wendy L. Mao** (Stanford University) discovered that in CsAuI3, a mixed valence compound with Au1+ and Au3+, the bandgap first closes with pressure and then opens up again due to a first-order structural transition, a rare occasion in transition metal compounds.



*Figure 3. (a) Ambient pressure crystal structure of CsAuI3 at 300 K, explicitly showing the linear square planar coordination of AuII2 and AuIIII4 respectively: I(1) as I− associated with square planar AuIIII4, and I(2) as I− associated with linear AuII2. (b) Crystal structure shown in alternating elongated and compressed AuI6 octahedra, more clearly revealing the distorted perovskite structur*



*FIG. 4. (a) Mid-IR transmittance and (b) CsAuI3- diamond reflectance below 5.6 GPa. The arrow in (a) points to the onset of the finite transmission signal. The arrow in (b) indicates the Drude-like mode observed for pressure at 5.6 GPa. (c) Fitted gap of tetragonal CsAuI3 and CsAuBr3 as a function of pressure (both obtained in this study). (d) Reflectivity spectrum at 5.6 GPa fitted with the Drude-Lorentzian model. The grey region is opaque due to the multi-phonon absorption from the diamond anvils*

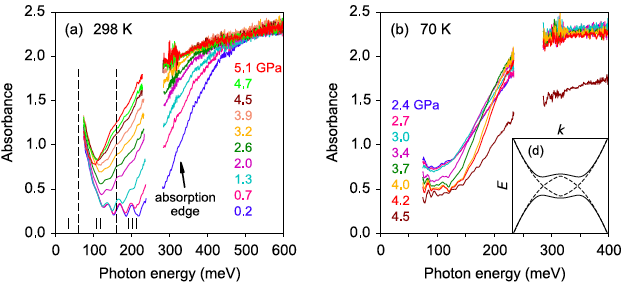
CsAuI3 is a representative of a family of unique 5d transition metal compounds that have a ground state with dn-1 and dn+1 electronic configurations. Pressure induces a mixed-valence to single-valence transition through a structural transition at approximately 5.5 GPa. In their earlier study [S. Wang et al. Phys. Rev. B,**87**, 054104 (2013)], the group discovered that under hydrostatic compression the system undergoes a tetragonal to orthorhombic transition. In their current work, they present how the bonding and band structure of CsAuI3 change at high pressure. Experimental Raman spectroscopy and theoretical calculation provide detailed information on the changes of the bonding along the valence transition. For the first time IR spectroscopy, which was conducted at the U2A beamline shows the closing of the charge-density-wave gap at high pressure, and provides direct evidence of the insulating nature of the high-pressure orthorhombic single-valence phase. The study provides crucial insights into the interplay between atomic arrangements and electronic configuration and reveals how they work together to alter the band structure, offering a new avenue for bandgap engineering.

*Reference:* S. Wang, A. Kemper, M. Baldini, M. Shapiro, S. Riggs, Z. Zhao, Z. Liu, T. Devereaux, T. Geballe, I. Fisher, and W. Mao, Bandgap Closure and Reopening in CsAuI3 at High Pressure, *Phys. Rev. B: Condens. Matter*, **89**, 245109 (2014).

***c. Bulk Signatures of Pressure-Induced Topological Phase Transitions in Pb1−xSnxSe***

Topological insulators continue to be at the forefront of condensed matter physics in recent years. Featured by conducting surface states on insulating bulk, they promise applications in advanced electronic devices and quantum computing. One direction of the ongoing research is the study of topological phase transitions, which elucidate the mechanism for the topological phase and facilitate the discovery of new topological materials. An increasing amount of theoretical work has shown pressure-induced topological phase transitions in a variety of materials, most of which awaits experimental realization. The challenge is the lack of surface-sensitive probes compatible with high-pressure experiments.

A team lead by **Xiaoxiang Xi** from Brookhaven National Lab established multiple bulk signatures of pressure-induced topological phase transitions in the narrow-gap semiconductors Pb1-*x*Sn*x*Se (*x* = 0.00, 0.15, and 0.23), complementing surface-sensitive techniques for the study of topological insulators. A hallmark of a topological insulator is its inverted band gap as a consequence of the nontrivial topology of the bulk electronic wavefunctions. To transform an ordinary insulator into a topological insulator, the band gap inevitably closes and reopens to become inverted. Employing infrared micro-spectroscopy at high pressure and low temperature at Beamline U2A (supplementary high-pressure structural characterizations were performed at Beamline X17C), the team observed the band gap closing and reopening in Pb1-*x*Sn*x*Se (Figure 5b), which is obscured by the free carrier absorption at room temperature (Region I and II in Figure 5a). Such observation is further supported by first-principles calculations. Additional signatures of the pressure-induced topological phase transitions were uncovered, including a maximum in the pressure dependence of the free carrier spectral weight and Fermi velocity, as well as a steeper absorption edge in the topological phase.



*Figure 5. Pressure-dependent mid-infrared absorbance of PbSe measured at (a) 298 K and (b) 70 K. Data in the blank region between 200–300 meV are not shown because of unreliability caused by diamond phonon absorptions.*

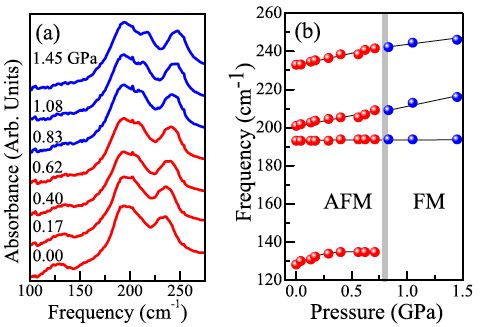
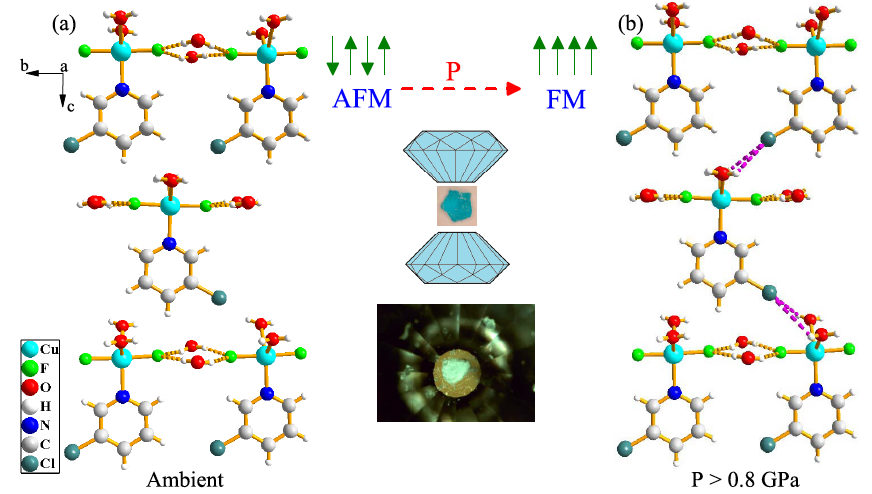
These results clarify a current controversy about what observable bulk features characterize topological phase transitions and provide a fresh perspective on their identification. This work highlights the bulk origin of the novel properties in topological insulators and opens up opportunities to create topological materials by pressure tuning.

*Reference:* X. Xi, X. He, F. Guan, Z. Liu, R. Zhong, J. Schneeloch, T. Liu, G. Gu, D. Xu, et al, Bulk Signatures of Pressure-Induced Band Inversion and Topological Phase Transitions in Pb1−xSnxSe, *Phys. Rev. Lett.,***113**, 096401 (2014).

***d. Pressure-Induced Magnetic Crossover Driven by Hydrogen Bonding in***

***CuF2(H2O)2(3-chloropyridine)***

The interplay between charge, structure, and magnetism leads to rich phase diagrams and highly tunable properties in multifunctional materials. This is because exotic properties tend to emerge when phases compete. Molecule-based materials are particularly revealing in this regard due to their low energy scales and sensitivity to various external stimuli like temperature, pressure, and magnetic field. Another characteristic of molecule-based materials is their tendency to develop hydrogen-bonding networks. Pressure and strain are especially attractive tuning parameters in this case because they act directly on bond lengths and angles as well as the hydrogen-bonding pattern. Moreover, hydrogen bonding plays a foundational role in the life, Earth, and chemical sciences, with its richness and strength depending on the situation. In molecular materials, these interactions determine assembly mechanisms, control superconductivity, and even permit magnetic exchange. In spite of its long-standing importance, exquisite control of hydrogen bonding in molecule-based magnets has only been realized in limited form and remains as one of the major challenges.



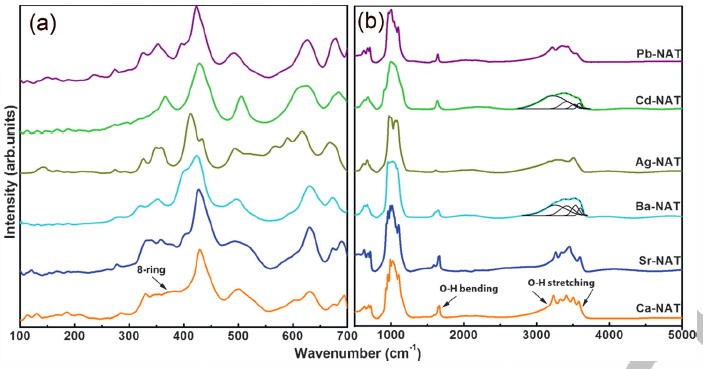
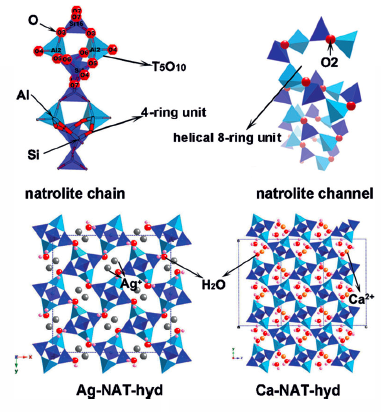
*Figure 6. Left: (a) Crystal structure of CuF2(H2O)2(3-chloropyridine) at 10 K showing the buckled two-dimensional hydrogen bonded layers. Parts of neighboring CuF2(H2O)2(3-chloropyridine) molecules have been omitted to emphasize the hydrogen bonding. (b) Schematic rendering of the structure above 0.8 GPa illustrating the three-dimensional network that is formed under compression. The connection in the third direction consists of intermolecular O-H•••Cl hydrogen bonds, as indicated by the purple dashed lines. Also included are drawings of the pressure-induced magnetic crossover and diamond anvil cell as well as a photo of CuF2(H2O)2(3-chloropyridine) on the diamond culet. Right: (a) Synchrotron infrared spectra of CuF2(H2O)2(3-chloropyridine) at 300 K and various pressures demonstrating the disappearance of the 125 cm-1 lattice mode through the 0.8 GPa transition. (b) Frequency versus pressure for the far-infrared active modes.*

New studies on CuF2(H2O)2(3-chloropyridine)led by **K. O’Neal** and **J. Musfeldt** (University of Tennessee) discovered that pressure can tune the dimensionality of hydrogen bonding networks in CuF2(H2O)2(3-chloropyridine) to induce magnetic switching. Specifically, the spectroscopic studies using synchrotron infrared and Raman scattering combined with diamond anvil cell techniques revealed how the development of O–H•••Cl exchange pathways under compression combined with an enhanced ab-plane hydrogen bonding network yields a three dimensional superexchange web between copper centers that triggers a reversible magnetic crossover. Similar pressure and strain-driven crossover mechanisms involving coordinated motion of hydrogen bond networks may play out in other quantum magnets.

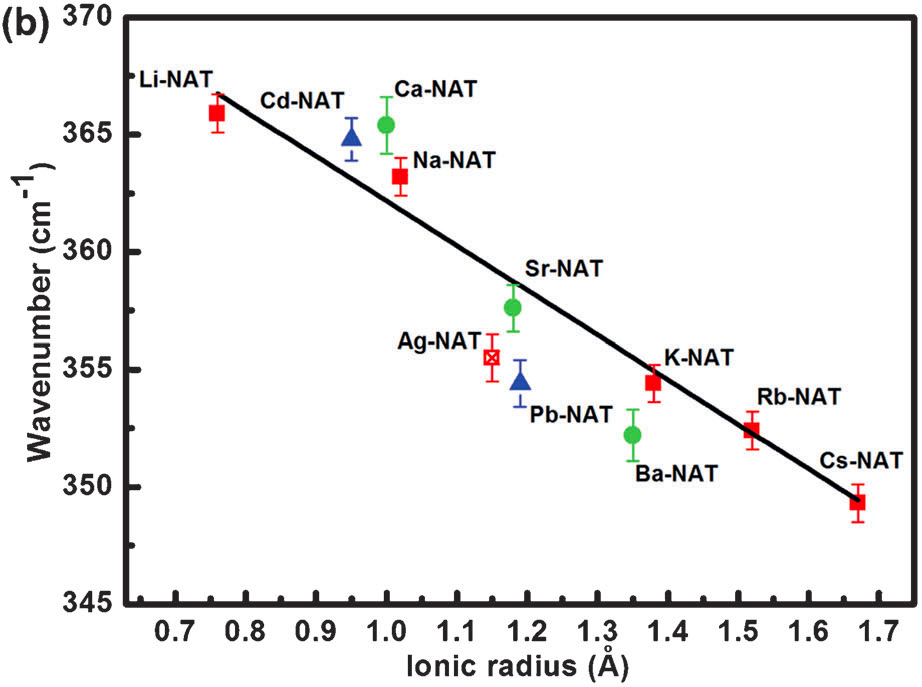
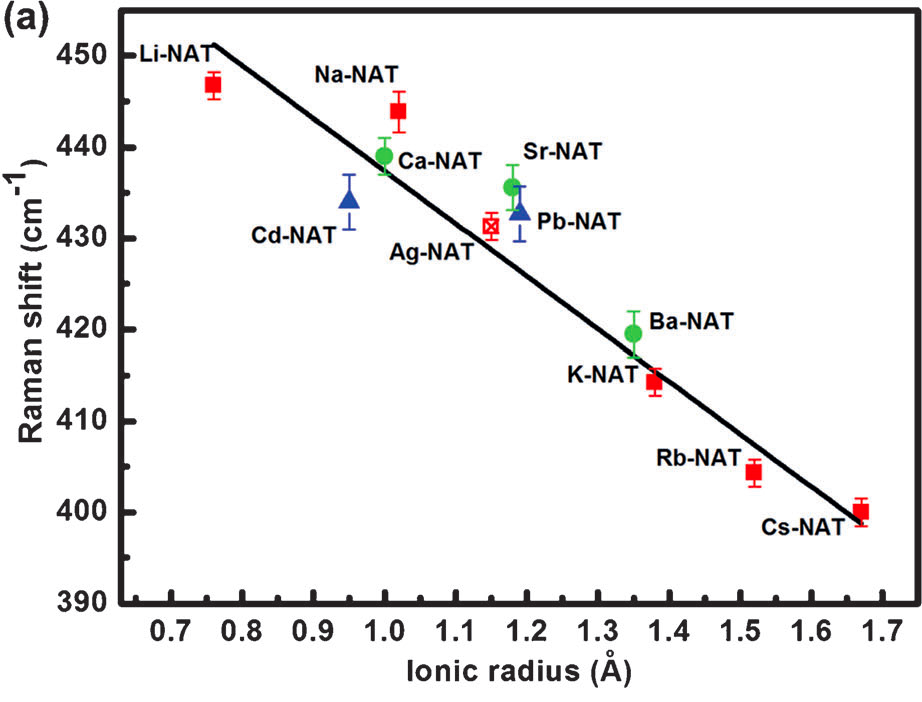
*Reference*: K. O’Neal, T. Brinzari, J. Wright, C. Ma, S. Giri, J. Schlueter, Q. Wang, P. Jena, Z. Liu, J. Musfeldt, Pressure-Induced Magnetic Crossover Driven by Hydrogen Bonding in CuF2(H2O)2(3-chloropyridine), *Nature Sci. Rep.*, **4**, 6054 (2014).

***e. Spectroscopic and Computational Characterizations of Alkaline-Earth- and Heavy-Metal-Exchanged Natrolites***

Facile cation exchange and reversible hydration and dehydration are the two major chemical properties of zeolites, forming the basis of their industrial uses. An understanding of the host–guest interactions between the alumino-silicate framework and the adsorbed water molecules and extra-framework cations (EFCs) is, therefore, crucial for the estimation of their geochemical origin, stability, and reactivity, as well as for tailoring their physical and chemical properties for applications. A team led by **D. Liu** and **Y. Lee** (Yonsei University) employed synchrotron infrared and micro-Raman spectroscopy as well as *ab* initio calculations to study natrolites containing alkaline-earth ions (Ca2+, Sr2+, and Ba2+) and heavy metals (Cd2+, Pb2+, and Ag+) as extra-framework cations (EFCs) under ambient conditions. Complementing previous spectroscopic investigations of natrolites with monovalent alkali metal (Li+, Na+, K+, Rb+, and Cs+) EFCs, a correlation between the redshifts of the frequencies of the 4-ring and helical 8-ring units and the size of the EFCs in natrolite was established. Through *ab* initio calculations the team has derived structural models of Ca2+- and Ag+-exchanged natrolites with hydrogen atoms, and found that the frequency shifts in the H–O–H bending mode and the differences in the O–H stretching vibration modes can be correlated with the orientations of the water molecules along the natrolite channel. Assuming that the members of a solid solution series behave as an ideal mixture, one will be able to use spectroscopy to probe compositions. Deviation from ideal behavior might indicate the occurrence of phase separation on various length scales.



*Figure 7. Left: a) Polyhedral representations of the structural building units of the natrolite framework. The tetrahedral vertices of one T5O10 secondary building unit are labeled with the oxygen atoms. The 4-ring and helical/elliptical 8-ring units are emphasized. b) Calculated structural models of Ag+-NAT-hyd and Ca2+-NAT-hyd. Red/pink circles represent oxygen/hydrogen atoms of the adsorbed water molecules. Gray/yellow circles represent respective extra-framework Ag+/Ca2+ cations. Dotted lines outline the unit cell. Right: a) Synchrotron far-IR and b) mid-IR spectra of the alkaline-earth- and heavy-metal-exchanged natrolites under ambient conditions.*

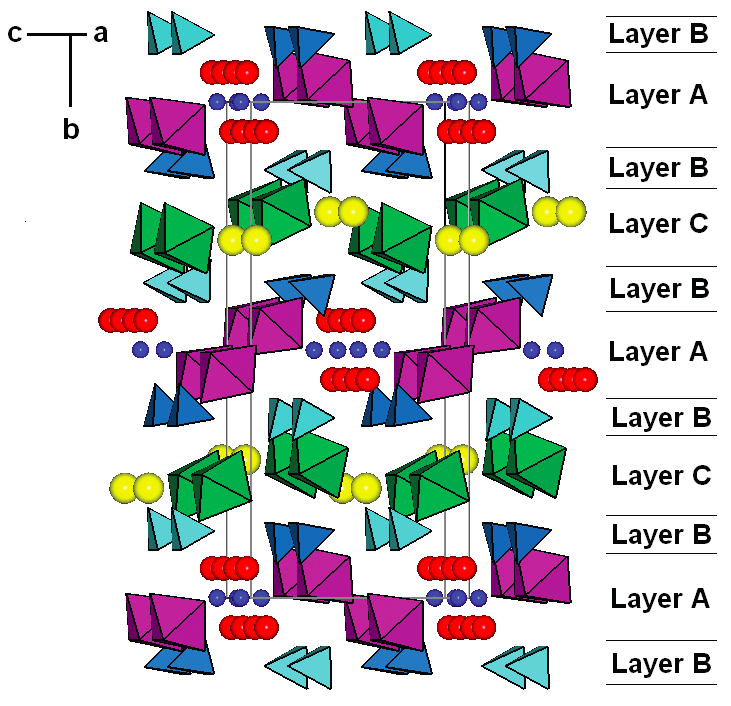
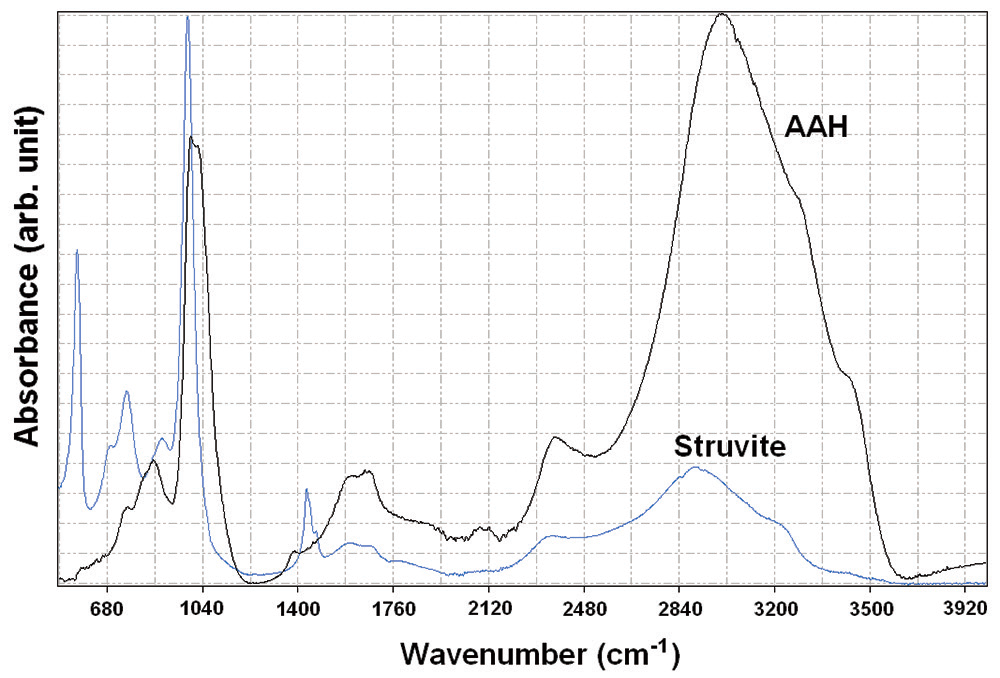
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*Figure 8. Dependency of the helical 8-ring vibrational modes in a) Raman and b) IR spectra on the extra-framework-cation radius. The solid black lines are linear fits to the data from the alkali-metal forms.*

*Reference*: D. Liu, X. Chen, Y. Ma, Z. Liu, T. Vogt, Y. Lee, Spectroscopic and Computational Characterizations of Alkaline-Earth- and Heavy-Metal-Exchanged Natrolites, *ChemPlusChem*, **79**(8), 1066 (2014) (cover page).

***f. A New Biogenic Ammonium-Analog of Hazenite, (NH4)NaMg2(PO4)2·14H2O***

Phosphate formation through microbial activities is one of the most common mechanisms for the biological transformation of inorganic phosphates. Among all biogenic phosphates, struvite, (NH4)MgPO4·6H2O, is the most widespread in various environ­ments, such as bat guano, decomposing foods, infection (e.g., urinary tract) stones in humans, water treatment facilities, and in a range of bacterial cultures. The specific roles that microorganisms play in struvite formation, however, are not well understood. It has been speculated that bacterial cell surfaces may serve as nucleation sites and biological activities provide a steady supply of phosphate and ammonia as the crystals grow. New work from a team led by **H. Yang** (University of Arizona) discovered a new biogenic, struvite-related phosphate, the ammonium analog of hazenite (AAH), ideally (NH4)NaMg2(PO4)2·14H2O in cultures containing the bacterial strain *Virgibacillus* sp.NOT1 (GenBank Accession Number: JX417495.1) isolated from an XVII Century document made of parch­ment. The chemical composition of AAH, determined from the combination of electron microprobe and X‑ray structural analyses, is [(NH4)0.78K0.22]NaMg2(PO4)2·14H2O. Single-crystal X‑ray diffraction shows that AAH is orthorhombic with space group *Pmnb* and unit-cell parameters *a* = 6.9661(6), *b* = 25.236(3), *c* = 11.292(1) Å, and *V* = 1985.0(3) Å3. Compared with hazenite, the substitution of NH4+ for K+ results in a noticeable increase of the average *A*-O (*A* = NH4++K+) bond length and the unit-cell volume for AAH, as also observed for struvite vs. struvite-K. Both infrared and Raman spectroscopic studies performed at NSLS-U2A revealed that the spectra of AAH resemble those of hazenite, as well as struvite. The study indicates that AAH forms only in cul­tures with Na-bearing solutions and pH below 10.0. No AAH or hazenite was found in experiments with the K-bearing solutions, suggesting the necessity of a Na-bearing solution for AAH formation.

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*Figure 9. Left: Crystal structure of the ammonium-analog of hazenite. Tetrahedra = PO43– groups and octahedra = Mg(H2O)6. The largest, medium, and smallest spheres represent A (= NH4+K), Ow9 (the H2O molecule bonded to Na only), and Na, respectively. Layer A consists of Mg1(H2O)6 octahedra and NaO6 trigonal prisms, layer B of P1O4 and P2O4 tetrahedra, and layer C of Mg2(H2O)6 octahedra and AO6 polyhedra.*  *Right: Infrared spectrum of the ammonium-analog of hazenite, along with that of struvite taken from the RRUFF project (http://rruff. info/R050511) for comparison.*

*Reference:* H. Yang, L. Martinelllli, F. Tasso, R. Sprocati, F. Pinzari, Z. Liu, R. Downs, H. Sun, A New Biogenic, Struvite-Related Phosphate, the Ammonium-Analog of Hazenite, (NH4)NaMg2(PO4)2·14H2O, *Am. Mineral.,***99**, 1761–1766 (2014).

**Beamline Personnel**

The management team from the Carnegie Institution of Washington is headed by PIs Russell J. Hemley (Senior Staff Member, Geophysical Laboratory) and Zhenxian Liu (Research Scientist, Geophysical Laboratory). Carnegie also serves as the funding host for the project.

***Beamline Scientist***

Zhenxian Liu was appointed as Research Scientist/Beamline Scientist at Carnegie in 2000. He provides scientific and technical support to the high-pressure program at the U2A beamline. He has a strong background in spectroscopy, solid-state physics, and multiple synchrotron techniques. He actively develops novel experimental techniques (e.g., vacuum far-IR spectroscopy down to 30 cm-1 at high pressure and cryogenic techniques with DACs down to 5 K and 360 GPa, off-line CO2 laser heating for DACs) and assists users in carrying out research projects in geoscience, planetary science, materials science, condensed matter physics, and chemistry. In addition, he uses synchrotron infrared spectroscopy, Raman scattering, photoluminescence as well as synchrotron x-ray diffraction techniques to explore physical and chemical properties and phase transitions of hydrous minerals, simple molecular systems, and nanoscale materials at high pressures and variable temperatures.

**Beamline Operations**

The U2A beamline is a NSLS Facility Beamline with a Contributing User Agreement with COMPRES. The NSLS is responsible for the operation of the beamline (optics inside of the VUV ring, safety systems, etc.) while COMPRES is responsible for operation of the experimental endstations. Under the NSLS Contributing User Agreement ending Sep. 30, 2014, 50% of the beam time (approximately 100 days) is allocated to U2A for General Users (GU time). The COMPRES community is the dominant user group in this category. All proposals are first submitted through the proposal system at NSLS to compete for GU time. The remaining 50% of Contributing User (CU) beam time is allocated by COMPRES and Carnegie, and includes the following categories.

The first portion of the CU beam time is allocated by COMPRES and is dedicated to support research by members of the COMPRES community through proposals vetted by the NSLS General User program. The NSLS User Administration provides the CU group proposed here with the ratings of all proposals for a beam time cycle, so that these ratings may be used in making decisions on requests for beam time.

The second portion of the CU beam time is utilized by the beamline scientist and postdoc for beamline improvements/upgrades to maintain the beamline at the state of the art, as well for carrying out their research projects. The remaining CU beam time goes to the Carnegie and its collaborators (many of whom are in the COMPRES community) for development projects and users supported by its grants. Consistent with the portfolio of experiments done at all COMPRES beamlines, a fraction of the experiments at U2A concern general high-pressure research. As shown repeatedly over the years, these experiments help to advance high-pressure geoscience with the development, testing and extension of new techniques.

The U2A beamline operation at NSLS was ending on a very high note when the NSLS ceased operations on September 30, 2014. U2A had approximately 53 person-visits representing 23 separate universities and institutes. All funding for the NSLS-U2A effort in 2013~2014 is provided by COMPRES and CDAC. Details of the publication list, proposals, beam time allocated and total usages are listed in Appendices 1, 2 and 3.

**Planned Activities**

The National Synchrotron Light Source (NSLS) has the unique capability to provide synchrotron radiation over a broad range from hard x-ray down to the very far infrared. The infrared radiation at the VUV ring of the NSLS has world-class performance with up to ~104 times the brightness of a conventional thermal (lamp) source. As one of the six infrared beamlines at the NSLS, U2A is the first dedicated high-*P* synchrotron infrared facility in the world, with many unique capabilities compared to high-pressurex-ray beamlines. The beamline was built and managed by Geophysical Laboratory, Carnegie Institution of Washington since 1998 and became available for general users in 2000. The high-pressure infrared program at the NSLS has been very successful in terms of beamline development, outreach of user community, and scientific productivity. A number of important scientific and technical challenges are being addressed at the facility, making it a highly attractive complement to x-ray sources for high-pressure studies. However, after more than 30 years of service, the NSLS ceased its operation on Septeber 30, 2014. Fortunately, it will be replaced by the NSLS-II, a new state-of-the-art synchrotron facility, which is designed to produce not only x-rays more than 10,000 times brighter than the current NSLS but also more brilliant and stable infrared radiation. This will provide new opportunities for new science under extreme conditions.

In order to continue to accommodate the growing user demand and further expand the high-pressure infrared research at the NSLS-II, we proposed the establishment of **F**rontier Synchrotron **I**nfrared **S**pectroscopy Beamline under Extreme Conditions (**FIS**), an integrated infrared facility dedicated to the study of materials under extreme pressure and temperature (*P-T*) conditions. The design capabilities of NSLS-II with its small source size, high brightness, and broad spectral range ideally match the materials research under extreme *P-T* conditions. The continued development of synchrotron IR spectroscopy at NSLS-IIwill provide superior capabilities for *in situ* studies under extreme conditions in order to address a broad range of problems in Earth and planetary sciences, physics, biology, chemistry, materials science, and high-technology. The proposal has been approved by NSLS-II and FIS together with MET is now considering as one of the eight NxtGen project beamlines.

We are very excited about the opportunities to explore new sciences with a brighter infrared source at NSLS-II. On the other hand, we have to deal with the uncertainties due to the transitions from NSLS to NSLS-II starting on October 1, 2014. Currently, the location/floor space and beamline hutch design/specs including hutch layouts, electrical/utility systems, laser enclosures, etc. for FIS/MET has been completed. However, the planned procurement for the beamline hutches has been delayed about one year due to the funding issues for the NxtGen project. The NSLS-II management is considering all the existing IR beamlines/programs at NSLS as a whole and will allocate several laboratory rooms in another building nearby NSLS-II. Our plans are to move all necessary equipment to that lab space, set up, and begin normal operation with internal IR sources for our COMPRES user community. Due to the prolonged dark period for IR programs at NSLS-II, we are discussing with beamline scientists at ALS about the possibility to develop an Approved Program (AP) proposal and will submit the proposal before the deadline on Jan. 15, 2015. If succeed, it will receive an assured percentage of beam time to carry out an extended program of research for a period of up to three years, fully covered the dark period.

**Budget**

Actual and anticipated spending for beamline operations (June 2014– May 2015):

**1. Budget for Beamline Operations: June 2014-May 2015**

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| Personal:  Beamline scientist | Salary plus fringe benefits | $13,6095 | These include a normal raise and cost of living adjustment for the beamline scientist. |
| Materials/supplies  a.  b.  c. | Liquid helium  ($610/60L, 8 tanks in total)  Stockroom& NSLS fees  Misc. expenses | $4,880  $6,500  $17,160 | Usage of the FIR system where it is necessary to cool the Si bolometer and high-*P* and low-*T* experiments with the compact cryostat for the COMPRES users.  Routine beamline expenses including office spaces, phone charges, and materials.  Miscellaneous expenses for the beamline transition from NSLS to NSLS-II and expenses for experiments at other facilities. |
| Travel | Travel for beamline scientists and spokesperson | $6,000 | Travel between BNL and Washington as well as for the beamline scientist to attend COMPRES and other scientific meetings. |
|  | Total direct cost | **$170,635** |  |
| **Total cost for operation** |  | **$215,000** | This total includes indirect costs at a rate of 26%. ($170,635×1.26\*) |

**2. Budget for Beamline Operations: June 2015-May 2016**

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| --- | --- | --- | --- |
| Personal:  Beamline scientist | Salary plus fringe benefits | $14,0868 | These include a normal raise and cost of living adjustment for the beamline scientist. |
| Materials/supplies  a.  b.  c.  d. | Liquid helium  ($610/60L, 4 tanks in total)  Repair expense  Diamond anvils  Operation | $2,440  $22,402.6  $6,000  $19,115 | Usage of the FIR system where it is necessary for high-*P* and low-*T* experiments with the compact cryostat for the COMPRES users.  This is a one-time expense to fix the Bruker Vertex 80v FTIR spectrometer electrical boards and He-Ne laser.  CVD synthetic type IIa anvils are required for dedicated use at the facility.  Miscellaneous expenses for the beamline operation and travel expenses (~$8000) for experiments at ALS. |
| Travel | Travel for beamline scientists and spokesperson | $6,000 | Travel between BNL and Washington as well as for the beamline scientist to attend COMPRES and other scientific meetings. |
|  | Total direct cost | **$196,825.6** |  |
| **Total cost for operation** |  | **$248,000** | This total includes indirect costs at a rate of 26%. ($196,825.6×1.26\*) |

\* Indirect Costs  
Carnegie has a rate agreement with its cognizant agency, NSF, which has issued a maximum provisional indirect cost rate of 75.0% for FY2011; however, for administrative purposes the Carnegie Institution is voluntary limiting its indirect cost recovery to 26.0% of Total Modified Direct Costs (TMDC). Total Modified Direct Costs are calculated as Total Direct Costs minus Equipment, Participant Support Costs, and Subcontract costs in excess of $25,000 for each subcontract.

**Appendices**

***1. Publication list for 2013 and 2014.***

Bishop, M., R. Chellappa, Z. Liu, D. Preston, M. Sandstrom, D. Dattelbaum, Y. Vohra, N. Velisavljevic, High Pressure-Temperature Polymorphism of 1,1-diamino-2,2-dinitroethylene, *J Phys.: Conf. Ser.*, **500**, 052005 (2014).

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Panero, W., J. Pigott, D. Reaman, J. Kabbes, Z. Liu, Dry (Mg,Fe)SiO3 perovskite in the Earth’s lower mantle, *J. Geophysical Research - Solid Earth*, Submitted.

Schmandt, B., S. Jacobsen, T. Becker, Z. Liu, K. Dueker, Dehydration Melting at the Top of the Lower Mantle, *Science*, **344**(6189), 1265-1268 (2014).

Wang, S., A. Kemper, M. Baldini, M. Shapiro, S. Riggs, Z. Zhao, Z. Liu, T. Devereaux, T. Geballe, et al., Bandgap Closure and Reopening in CsAuI3 at High Pressure, *Phys. Rev. B: Condens. Matter*, **89**, 245109 (2014).

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Graphene Oxide Surface and Its Applications for the Detection of Hydrogen Peroxide, *Electroanalysis*, 26, 2513-2519 (2014).

***2. List of proposals and usage (PI, Affiliation, Title, Funding, Days requested / Days allocated / Days used) for the period***

***Sep. 1, 2013—Sep. 30, 2014.***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BL** | **Year** | **Cycle** | **FORM ID** | **Max. Days** | **Min. Days** | **Days Allocated** | **Last Name** | **First Name** | **Title** |
| U2A | 2013 | September - December | 22075 | 6 | 5 | 0 | Zhou | Qiang | Dielectric properties study of MgNb2O6 by high pressure infrared scattering experiments |
| U2A | 2013 | September - December | 23211 | 3 | 2 | 2 | Lang | Maik | Response of Minerals to Extreme Conditions of Ion Irradiation and High Pressure: A Novel Approach in Geosciences |
| U2A | 2013 | September - December | 20106 | 3 | 2 | 0 | Ciezak-Jenkins | Jennifer | High pressure Infrared Characterization of Extended Solids: Carbon Monoxide |
| U2A | 2013 | September - December | 25186 | 3 | 2 | 2 | Goncharov | Alexander | Infrared synchrotron spectroscopy in hydrogen bearing molecular solids to Mbar pressures |
| U2A | 2013 | September - December | 25218 | 7 | 5 | 0 | Liu | Gang | High Pressure XRD and IR Study of Polytypically Disordered Nano-ZnS |
| U2A | 2013 | September - December | 25239 | 3 | 2 | 0 | Aihaiti | Muhetaer | Infrared reflectivity measurements of H2 under high pressure |
| U2A | 2013 | September - December | 18939 | 6 | 4 | 4 | Chellappa | Raja | High Pressure Chemistry of Simple Molecules: Hydrazine and its methylated derivatives |
| U2A | 2013 | September - December | 20500 | 4 | 3 | 3 | Chellappa | Raja | Role of Mode Anharmonicity in Initiation of High Explosives |
| U2A | 2013 | September - December | 25106 | 2 | 1 | 2 | Yang | Yan | In situ FTIR investigations of hydrogen defects in pyroxene at high pressures and temperatures |
| U2A | 2013 | September - December | 22834 | 6 | 5 | 5 | Xi | Xiaoxiang | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy |
| U2A | 2013 | September - December | 21301 | 5 | 5 | 5 | Musfeldt | Janice | Pressure-induced in the magnetoelastic coupling of Co(dca)2 by synchrotron infrared spectroscopy |
| U2A | 2013 | September - December | 21977 | 3 | 2 | 2 | Feng | Huan | Chemical Study of Metal Chelation on Functionalized Graphene Surface for Development of Metal Catalysts and Sensors |
| U2A | 2013 | September - December | 24184 | 5 | 4 | 4 | Townsend | Joshua | Water in post-perovskite: A hydrogen trap at the core-mantle boundary? |
| U2A | 2013 | September - December | 24933 | 4 | 2 | 0 | Zhu | Jinlong | Anomalous antiferromagnetic metallic evolution of CaCrO3 single crystal under high pressure: an IR spectroscopy study |
| U2A | 2013 | September - December | 25060 | 4 | 3 | 3 | Reaman | Daniel | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials |
| U2A | 2013 | September - December | 25256 | 3 | 2 | 0 | Aihaiti | Muhetaer | Infrared reflectivity measurements of D2O under high pressure |
| U2A | 2014 | January - April | 26353 | 3 | 2 | 2 | Velisavljevic | Nenad | Structural stability and decomposition of FOX-7 energetic material |
| U2A | 2014 | January - April | 22996 | 5 | 2 | 3 | Plonka | Anna | Pressure induced polymerization of dyines in assembled cocrystals |
| U2A | 2014 | January - April | 26127 | 4 | 2 | 2 | Chidester | Bethany | Spectroscopic properties of pyrite (FeS2) at high pressure |
| U2A | 2014 | January - April | 26211 | 4 | 3 | 0 | Li | Haining | In Situ Synchrotron X-Ray Diffraction and Infrared Spectroscopic Study of Ionic Liquid under High Pressure |
| U2A | 2014 | January - April | 26242 | 8 | 3 | 0 | Hu | Yue | High pressure studies of Metal-Organic Frameworks by IR spectroscopy |
| U2A | 2014 | January - April | 26249 | 7 | 3 | 0 | Zhu | Xiang | Structure of Ni-doped ZnO under high pressure |
| U2A | 2014 | January - April | 22834 | 5 | 4 | 4 | Xi | Xiaoxiang | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy |
| U2A | 2014 | January - April | 21972 | 7 | 5 | 3 | Ma | Chunli | High pressure infrared spectroscopy studies of cyclopentane |
| U2A | 2014 | January - April | 21977 | 3 | 2 | 2 | Feng | Huan | Chemical Study of Metal Chelation on Functionalized Graphene Surface for Development of Metal Catalysts and Sensors |
| U2A | 2014 | January - April | 26262 | 6 | 6 | 4 | Sangwan | Manuvesh | Kinetic Study of methanol synthesis from carbon dioxide and hydrogen at elevated temperature and pressures. |
| U2A | 2014 | January - April | 26262 | 6 | 4 | 0 | Sangwan | Manuvesh | Kinetic Study of methanol synthesis from carbon dioxide and hydrogen at elevated temperature and pressures. |
| U2A | 2014 | January - April | 26276 | 3 | 3 | 3 | Tse | John | Pressure induced single molecular conductor |
| U2A | 2014 | January - April | 26394 | 4 | 2 | 3 | Fischer | Rebecca | High pressure optical absorption across an electronic spin transition in (Mg,Mn)O |
| U2A | 2014 | January - April | 25060 | 3 | 2 | 3 | Reaman | Daniel | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials |
| U2A | 2014 | January - April | 24184 | 3 | 2 | 2 | Townsend | Joshua | Water in post-perovskite: A hydrogen trap at the core-mantle boundary? |
| U2A | 2014 | January - April | 26492 | 7 | 3 | 3 | Chen | Bin | Copy of High Pressure IR and XRD Study of Mix-stacking Nano-ZnS |
| U2A | 2014 | May - September | 27332 | 6 | 3 | 5 | Chellappa | Raja | Melt line of energetic materials. |
| U2A | 2014 | May - September | 25218 | 7 | 5 | 5 | Liu | Gang | High Pressure XRD and IR Study of Polytypically Disordered Nano-ZnS |
| U2A | 2014 | May - September | 26127 | 2 | 2 | 2 | Chidester | Bethany | Spectroscopic properties of pyrite (FeS2) at high pressure |
| U2A | 2014 | May - September | 27542 | 3 | 3 | 3 | Tse | John | Reflectivity of metal doped Mg2Si |
| U2A | 2014 | May - September | 27535 | 3 | 3 | 3 | Holyoke | Caleb | High-Resolution FTIR Study of Water Contents of Caledonide and Himalayan Mylonites |
| U2A | 2014 | May - September | 26242 | 8 | 3 | 3 | Hu | Yue | High pressure studies of Metal-Organic Frameworks by IR spectroscopy |
| U2A | 2014 | May - September | 27522 | 9 | 7 | 7 | Zhao | Zhao | High pressure infrared study on topological insulators Ag2Se and Ag2Te |
| U2A | 2014 | May - September | 26394 | 3 | 2 | 3 | Fischer | Rebecca | High pressure optical absorption across an electronic spin transition in (Mg,Mn)O |
| U2A | 2014 | May - September | 22834 | 5 | 4 | 5 | Xi | Xiaoxiang | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy |
| U2A | 2014 | May - September | 27325 | 6 | 4 | 4 | Chellappa | Raja | CAN N-H…N FRAMEWORK IN HYDRAZINE (N2H4) STABILIZE HOST MOLECULES (H2, Xe) AND FORM NOVEL CLATHRATES? |
| U2A | 2014 | May - September | 21977 | 3 | 2 | 3 | Feng | Huan | Chemical Study of Metal Chelation on Functionalized Graphene Surface for Development of Metal Catalysts and Sensors |
| U2A | 2014 | May - September | 27256 | 6 | 6 | 0 | Sangwan | Manuvesh | Experimental investigation of effect of pressure and catalyst surface on CH4 production from Fisher – Tropsch synthesis and CO2 hydrogenation |
| U2A | 2014 | May - September | 27139 | 5 | 3 | 0 | Zhu | Xiang | In Situ Synchrotron X-Ray Diffraction and Infrared Spectroscopic Study of Ionic Liquid under High Pressure |
| U2A | 2014 | May - September | 18939 | 3 | 3 | 3 | Chellappa | Raja | High Pressure Chemistry of Simple Molecules: Hydrazine and its methylated derivatives |
| U2A | 2014 | May - September | 27118 | 10 | 5 | 5 | Musfeldt | Janice | Do local lattice distortions trigger magnetic crossovers in molecule-based magnets? |
| U2A | 2014 | May - September | 25060 | 3 | 2 | 3 | Reaman | Daniel | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials |
| U2A | 2014 | May - September | 26597 | 3 | 3 | 3 | Zheng | Haiyan | The Reaction Mechanism and Dynamics of Acetonitrile under High Pressure |
| U2A | 2014 | May - September | 26492 | 5 | 4 | 4 | Chen | Bin | Copy of High Pressure IR and XRD Study of Mix-stacking Nano-ZnS |
| U2A | 2014 | May - September | 27378 | 5 | 3 | 3 | Bishop | Matthew | Isobaric heating of 1,1-diamino-2,2-dinitroethylene (FOX-7): Evolution of Hydrogen Bonding at Extreme Conditions |

**3. The beamtime schedule for the last year’s cycles (*Oct 1, 2013—Sep. 30, 2014*).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| J. Townsend  Z. Liu | Northwestern University Geophysical Laboratory | Water in post-perovskite: A hydrogen trap at the core-mantle boundary? (proposal #24184) | Oct. 8-11, 2013 | 4 |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Oct. 12-15, 2013 | CU beam time |
| J. Musfeldt  K. O'Neal | University of Tennessee | Pressure-induced in the Magnetoelastic Coupling of Co(dca)2 by Synchrotron Infrared Spectroscopy (proposal #21301) | Oct. 19-23, Oct. 24-25, 2013 | 5  CU beam time |
| B. Chen  L. Kong  G. Liu | HPSTAR | High Pressure IR and XRD Study of Mix-stacking Nano-ZnS (proposal #26492) | Oct. 26-28, 2013 | CU beam time |
| J. Townsend  Z. Liu | Northwestern University Geophysical Laboratory | Water in post-perovskite: A hydrogen trap at the core-mantle boundary? (proposal #24184) | Oct. 29-31, 2013 | CU beam time |
| B. Chen  L. Kong  G. Liu | HPSTAR | High Pressure IR and XRD Study of Mix-stacking Nano-ZnS (proposal #26492) | Nov. 2-3, 2013 | CU beam time |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Jan. 24-Feb. 9, 2014 | CU beam time |
| H. Feng | Montclair State University | Chemical Study of Mental Chelation on Functionalized Graphene Surface for Development of Metal Catalysis and Sensors (proposal #21977) | Feb. 10-11, 2014 | 2 |
| D. Reaman | Army Research Laboratory | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials (proposal #25060) | Feb. 12-14,  2014 | 3 |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Feb. 15-18, 2014 | 4 |
| H. Zheng  K. Li | Geophysical Lab | The Reaction Mechanism and Dynamics of Acetonitrile under High Pressure (proposal #26597) | Feb. 18-21, 2014 | CU beam time |
| J. Zhu  S. Zhang | LANL  Institute of Physics  Chinese Academy of Sciences | Anomalous antiferromagnetic metallic evolution of CaCrO3 single crystal under high pressure: an IR spectroscopy study (proposal #24933) | Feb. 22-Mar. 1, 2014 | CU beam time |
| J. Thomas  A. Kronenberg | Rensselaer Polytechnic Institute  Texas A&M University | High-Resolution FTIR Study of Water Contents of Caledonide and Himalayan Mylonites (proposal #27535) | Mar. 2-5, 2014 | CU beam time |
| J. Tse  J. Zhao | University of Saskatchewan | Pressure induced magetic and insulator to nano-organometallic radical complexes (proposal #19433) | Mar. 6-8, 2014  Mar. 9, 2014 | 3  CU beam time |
| D. Reaman | Army Research Laboratory | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials (proposal #25060) | Mar. 10-13,  2014 | 3 |
| J. Townsend  Z. Liu | Northwestern University Geophysical Laboratory | Water in post-perovskite: A hydrogen trap at the core-mantle boundary? (proposal #24184) | Mar. 14-16, 2014 | 3 |
| A. Plonka | SUNY @ Stony Brook | Pressure induced polymerization of dyines in assembled cocrystals (proposal #22996) | Mar. 19-21, 2014 | 3 |
| Z. Liu  X. Xi | Geophysical Laboratory  BNL | Infrared spectroscopy of H2O up to 100 GPa | Mar. 22-25, 2014 | CU beam time |
| M. Sangwan | Geophysical Laboratory | Kinetic Study of methanol synthesis from carbon dioxide and hydrogen at elevated temperature and pressures (proposal #26262) | Mar. 26-27, 2014 | 2 |
| L. Kong  G. Liu | HPSTAR | High Pressure IR and XRD Study of Mix-stacking Nano-ZnS (proposal #26492) | Mar. 28-30,  Mar. 31-Apr.1, 2014 | 3  CU beam time |
| Z. Liu  Y. Ma  Y. Lee | Geophysical Laboratory  Yonsei University | Pressure-induced Trapping of Large Cations and Molecules in Small-pore Zeolites (proposal #21211) | Apr. 1-2, 2014 | CU beam time |
| C. Ma  B. Yang  J. Chen  H. Zhu  Q. Cui | HPSTAR  Jilin University | High pressure infrared spectroscopy studies of cyclopentane (proposal #21972) | Apr. 3-5, 2014  Apr. 6, 2014 | 3  CU beam time |
| A. Campbell  B. Chidester  E. Tompson  R. Fisher | University of Chicago | High pressure optical absorption across an electronic spin transition in  (Mg,Mn)O (proposal #26394) | Apr. 7-9, 2014 | 3 |
| A. Campbell  B. Chidester  E. Tompson  R. Fisher | University of Chicago | Spectroscopic properties of pyrite (FeS2) at high pressure (proposal #26127) | Apr. 10-11, 2014 | 2 |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Apr. 12-15, 2014 | CU beam time |
| R. Liu  Q. Li | Jilin University | Pressure induced metal-insulator transition in VO2 bulks and nanomaterials (proposal # 21238) | Apr. 16-18, 2013 | CU beam time |
| Z. Liu  X. Xi | Geophysical Laboratory  BNL | Infrared spectroscopy of H2O up to 100 GPa | Apr. 19-22, 2014 | CU beam time |
| M. Sangwan | Geophysical Laboratory | Kinetic Study of methanol synthesis from carbon dioxide and hydrogen at elevated temperature and pressures (proposal #26262) | Apr. 24-25, 2014 | 2 |
| R. Chellappa  M. Bishop  Velisavljevic | Los Alamos National Laboratory | High Pressure-Temperature Phase Stability and Decomposition Boundary Investigation of FOX 7(proposal # 24073) | Apr. 28-29, Apr. 30, 2014 | 2  CU beam time |
| Z. Liu  X. Xi | Geophysical Laboratory  BNL | Infrared spectroscopy of H2O up to 100 GPa | May 1-3, 2014 | CU beam time |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | May 5-9,  May 10-11, 2014 | 5  CU beam time |
| H. Feng | Montclair State University | Chemical Study of Mental Chelation on Functionalized Graphene Surface for Development of Metal Catalysis and Sensors (proposal #21977) | May 21-23, 2013 | 3 |
| J. Zhu  S. Zhang | UNLV  Institute of Physics  Chinese Academy of Sciences | Anomalous antiferromagnetic metallic evolution of CaCrO3 single crystal under high pressure: an IR spectroscopy study (proposal #24933) | May 24-Jun. 1, 2014 | CU beam time |
| J. Bohn  R. Chellappa  Velisavljevic  M. Bishop | Los Alamos National Laboratory  U. Alabama at Birmingham | Can N-H…N Framework in hydrazine (N2H4) stabilize host moleculars (H2, Xe) and form novel clathrates? (proposal # 24325) | Jun. 2-9, 2014 | 8 |
| D. Reaman | Army Research Laboratory | High pressure IR analysis of compressed gas mixtures with application to high-energy and super-hard materials (proposal #25060) | Jun. 10-12,  2014 | 3 |
| J. Zhu  S. Zhang | UNLV  Institute of Physics  Chinese Academy of Sciences | Anomalous antiferromagnetic metallic evolution of CaCrO3 single crystal under high pressure: an IR spectroscopy study (proposal #24933) | Jun. 13-15,  Jun. 18-26, 2014 | CU beam time |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Jun. 27-30,  Jul. 1, 2014 | CU beam time |
| A. Kronenberg  C. Holyoke  H. Hasnan | Texas A&M University | High-Resolution FTIR Study of Water Contents of Caledonide and Himalayan Mylonites (proposal #27535) | Jul. 2-4,  Jul. 5-6, 2014 | 3  CU beam time |
| L. Kong  G. Liu | HPSTAR | High Pressure XRD and IR Study of Polytypically Disordered Nano-ZnS (proposal #25218) | Jul. 7-11,  Jul. 12-13, 2014 | 5  CU beam time |
| H. Zheng  K. Li | Geophysical Lab HPSTAR | The Reaction Mechanism and Dynamics of Acetonitrile under High Pressure (proposal #26597) | Jul. 16-18, 2014 | 3 |
| J. Musfeldt  K. O'Neal  J. Cherian | University of Tennessee | Do local lattice distortions trigger magnetic crossovers in molecule-based magnets? (proposal #27118) | Jul. 19-23,  Jul. 24-26, 2014 | 5  CU beam time |
| F. Hong  B. Zheng | HPSTAR | High Pressure IR and XRD Study of Mix-stacking Nano-ZnS (proposal #26492) | Jul. 27-30,  Jul. 31-Aug. 1, 2014 | 4  CU beam time |
| S. Karato  Y. Wu | Yale University | Water (hydrogen) partitioning between olivine and orthopyroxene studied by high spatial resolution synchrotron FTIR scpectroscopy | Aug. 1, 2014 | CU beam time |
| Y. Lin  Z. Zhao | Stanford University | High pressure infrared study on topological insulators Ag2Se and Ag2Te (proposal #27522) | Aug. 2-8, 2014 | 7 |
| X. Xi | Brookhaven National Lab | Evolution of superconductivity with pressure in iron-based superconductors studied by infrared spectroscopy (proposal #22834) | Aug. 9-12, 2014 | CU beam time |
| R. Chellappa  M. Bishop  M. Margevicius  D. Dattelbaum | Los Alamos National Laboratory | Melt line of energetic materials (proposal # 18939) | Aug. 13-17, 2014 | 5 |
| Y. Hu  Y. Song | U. West Ontario | High pressure studies of Metal-Organic Frameworks by IR spectroscopy (proposal # 26242) | Aug. 18-20, 2014 | 3 |
| M. Bishop  Velisavljevic | Los Alamos National Laboratory | Isobaric heating of 1,1-diamino-2,2-dinitroethylene (FOX-7): Evolution of Hydrogen Bonding at Extreme Conditions (proposal # 27378) | Aug. 21-23,  Aug. 24-25, 2014 | 3  CU beam time |
| A. Campbell  E. Tompson  R. Fisher | University of Chicago | High pressure optical absorption across an electronic spin transition in  (Mg,Mn)O (proposal #26127) | Aug. 28-30, 2014 | 3 |
| A. Campbell  E. Tompson  R. Fisher | University of Chicago | Spectroscopic properties of pyrite (FeS2) at high pressure (proposal #26394) | Aug. 31-Sep. 1, 2014 | 2 |
| E. Vinitsky  Z. Liu | Geophysical Lab | Synchrotron IR studies of BaReH9 up to 100 GPa | Sep. 3-8, 2014 | CU beam time |
| H. Zhu  Q. Cui | Jilin University | Pressure-driven variations of hydrogen bonding energy in ammonium azide (NH4N3): IR absorption and Raman scattering studies | Sep. 9-13,  2014 | CU beam time |
| Z. Liu | Geophysical Lab | Infrared spectroscopy of dense solid hydrogen up to 250 GPa at room temperature | Sep. 14-18, 2014 | CU beam time |
| Z. Liu  D. Shim | Geophysical Lab  Arizona State University | Synchrotron IR measurements on hydrous minerals quench from lower mantle conditions | Sep. 19-22, 2014 | CU beam time |
| J. Townsend  Z. Liu | Northwestern University Geophysical Lab | Synchrotron infrared studies of diamond inclusions | Sep. 23-24, 2014 | CU beam time |
| C. Ma  B. Yang | HPSTAR | Low-T synchrotron infrared spectroscopic studies of boron doped diamonds | Sep. 25-26, 2014 | CU beam time |
| J. Tse  J. Zhao  B. Billinghurst | University of Saskatchewan  Canadian Light Source | Reflectivity of metal doped Mg2Si (proposal #27542) | Sep. 27-29, 2014 | 3 |
| Z. Liu | Geophysical Lab | Infrared spectroscopy of D2O up to 100 GPa | Sep. 30, 2014 | CU beam time |