

COMPRES/GSECARS Gas Loading Facility at the APS

2014 COMPRES Annual Report

October 2013 – October 2014

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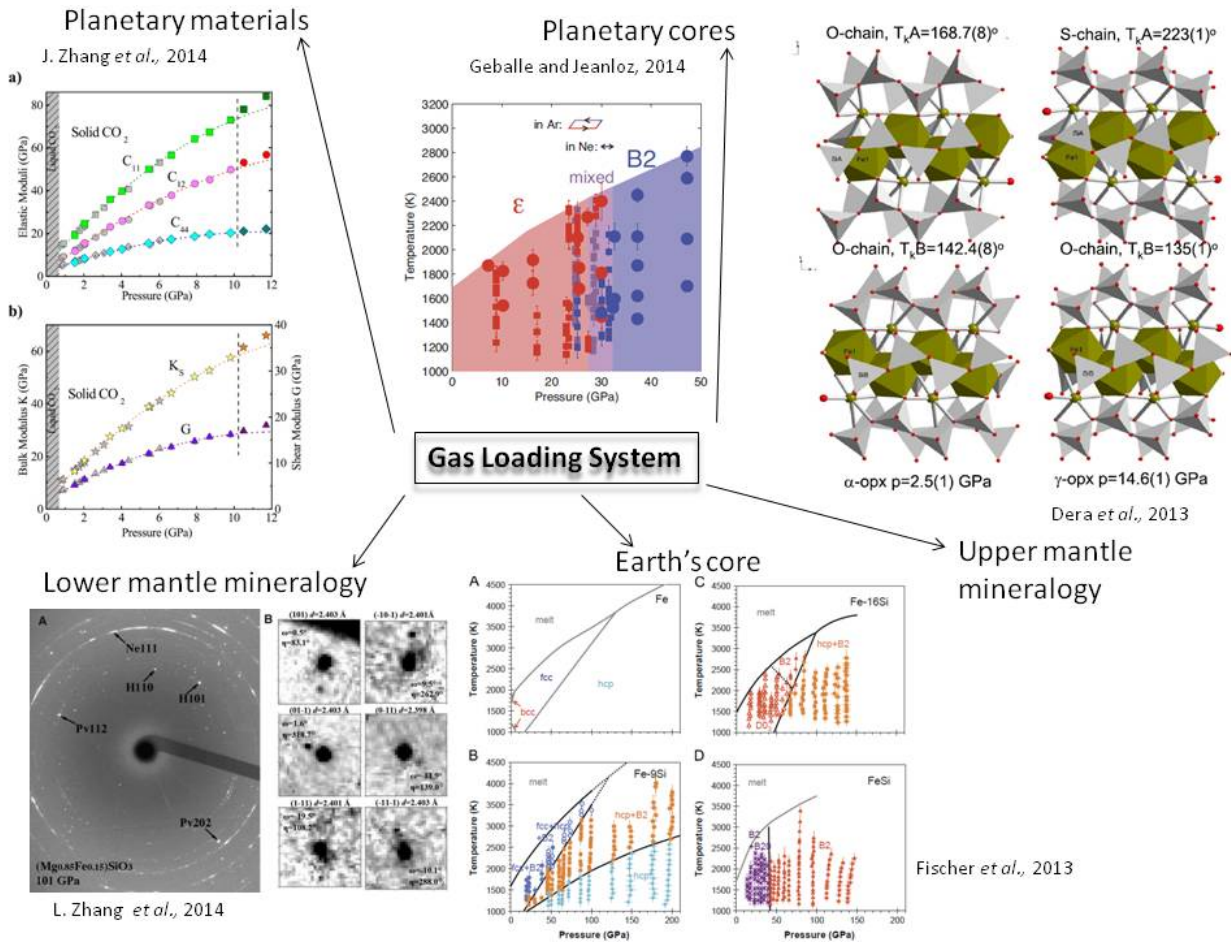
Overview

The COMPRES/GSECARS gas loading system at the APS has been a major advance for the U.S. diamond anvil cell community. Prior to the installation of this system in 2008 the use of noble-gas pressure media was restricted to a small number of scientists with access to systems at the Carnegie Institution or the Lawrence Livermore Laboratory. The COMPRES/GSECARS system has led to the improved hydrostatic conditions with Ne or He now being the norm for most synchrotron experiments in this country. This has greatly improved the quality of the measurements being made, and the system is available to the entire community.

The system began operation in February 2008 and has been running with minimal downtime since then. The system works extremely well, with the only significant problems being some failures of the commercial compressor. We have in-house technical support (Guy Macha) to repair such problems, and the mean time to repair has typically been 1 day. We have recently purchased a spare compressor, so that we can rapidly swap it if there is a major problem.

The COMPRES/GSECARS system at the APS is available for use by any member of the COMPRES community, regardless of whether they are performing experiments at GSECARS, at another APS sector, at another synchrotron, or in their home laboratory. The support from COMPRES allows the system to be available for users who cannot afford the time or money to travel to APS, by providing a “mail-in” service. It also allows the system to be available to users who are conducting experiments at APS sectors other than GSECARS. These include users from sectors 3 (inelastic), 4 (magnetism), 16 (HP-CAT), and 32 (imaging), 34 (microdiffraction), and others.

Scientific Highlights



The diagram above illustrates a small number of featured studies highlighting recent successes from the project for this year. The publication list in the appendix lists over 100 papers that have been published in 2013 and 2014 using the gas loading system.

Personnel

This COMPRES project partially funds staff scientist to reside at the APS. Dr. Sergey Tkachev began in this position in the second week of June, 2010. Sergey is responsible for loading cells that are sent to the APS by users who do not travel here. He is also responsible for training and assisting all of the on-site users with loading their cells. The other part of Sergey's salary and responsibilities is covered by GSECARS.

Guy Macha is a GSECARS funded technician who provides mechanical support for the system.



Figure 1. Dr. Sergey Tkachev with the COMPRES/GSECARS gas loading system

Operations, Performance Metrics

The following table summarizes the mail-in service in the past year, since October 1st, 2013.

University	Name	Number of DACs loaded
Washington State University	Zbigniew Dreger	3
University of Chicago	Andrew Campbell + Rebecca Fischer	9
UNLV	Oliver Tschauner + Barbara Lavina + Jinlong Zhu + Daniel Mast	5
Texas Tech University	Qinglin Wang	4
Stanford University	Zhao Zhao	4
Yale University	Kanani Lee + Tingting Gu	9
Stony Brook University	Xinguo Hong	8
University of Western Ontario	Sean Shieh	2
Northwestern University	Josh Townsend + Xiaobing Liu	3
University of Hawaii at Manoa	Przemek Dera	4
Los Alamos National Laboratory	Nenad Velisavljevic + Matt Jacobsen	6
Jilin University	Cheng Ji + Fangfei Li	6
University of Alabama at Birmingham	Spence Smith	1
TOTAL		64

In addition to this mail-in service, there have been 618 diamond anvil cells loaded in this year. 188 of these cells were prepared for experiments at GSECARS, while the remaining 430 were prepared for experiments at other APS sectors, home laboratories and other synchrotrons. The gas loading of 574 of these cells were directly assisted by Sergey. Thus on average he is assisting in gas loading of more than 2 cells every working day. Sergey spends more than 60% of his time assisting such users and providing the mail-in service. Because of the constantly growing usage of the GSECARS/COMPRES gas loading system during the normal APS user operation periods, significant time is required for repairs and preventative maintenance for the valves and commercially built compressor. Sergey and Guy perform these tasks, during the downtime between the APS beamtime cycles.

Community/Broader Impacts

The success of the COMPRES/GSECARS system design has led other groups to copy many aspects of it for systems of their own, including HPSync at the APS. In addition three other identical units have been built by the University of Chicago Engineering Center. One of these was delivered to Jennifer Jackson at Caltech. The other was delivered to the Advanced Light Source at the Lawrence Berkeley National Laboratory where it is available to users of the COMPRES supported high-pressure beamline, 12.2.2. Sergey has provided valuable expertise and hands-on support during construction for these new gas loading systems. A new system is about to be delivered to Sandia National Laboratory. An order has recently been received from Brazil, and there are negotiations for systems in Korea and China.

Planned Activities

All activities listed in the previous sections will continue during the next COMPRES funding cycle (June 2015 – May 2016).

Budget Request for 2015-2016

We are asking here for funding for 50% of Sergey Tkachev's salary. This is an increase from 40% in past years, but based on the fact the 2/3 of the cells that Sergey has loaded are for non-GSECARS experiments we feel this is justified.

Budget			
		Total	COMPRES
Salary		\$66,000	\$33,000
Fringe	26.6%	\$17,556	\$8,778
Total subject to indirect		\$83,556	\$41,778
Indirect	26.0%	\$21,725	\$10,862
			\$0
TOTAL		\$105,281	\$52,640

Appendices

Publications

We have no way to track the publications which have resulted from all of the 682 diamond anvil cells that were loaded in the past year. Instead we have listed all of the diamond anvil cell publications that used GSECARS in 2013 and 2014. These citations are taken directly from the APS Publication Database. They include papers that used the gas-loading system but for which x-ray measurements were done on other beamlines. Most of these publications (but not all) were done with cells loaded with the COMPRES/GSECARS gas loading system. We currently lack a mechanism to track exactly which publications used the gas loading system.

Diamond Anvil Publications that acknowledge GSECARS in the APS Publication Database (2013, 2014)

Matthew M. Armentrout, Emma S.G. Rainey, Abby Kavner, ["High-pressure and high-temperature equation of state of cobalt oxide: Implications for redox relations in Earth's mantle,"](#) Am. Mineral. **98** (5-6), 993-999 (2013). DOI: 10.2138/am.2013.4339

Tiziana Boffa Ballaran, Alexander Kurnosov, Dmytro Trots, ["Single-crystal X-ray diffraction at extreme conditions: a review,"](#) High Pressure Res. **33** (3), 453-465 (2013). DOI: 10.1080/08957959.2013.834052

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Nirup Bandaru, Ravhi S. Kumar, Daniel Sneed, Oliver Tschauner, Jason Baker, Daniel Antonio, Sheng-Nian Luo, Thomas Hartmann, Yusheng Zhao, Rama Venkat, ["Effect of Pressure and Temperature on Structural Stability of MoS₂,"](#) J. Phys. Chem. C **118** (6), 3230-3235 (2014). DOI: 10.1021/jp410167k

K. Burgess, V. Prakapenka, E. Hellebrand, P.V. Zinin, ["Elastic characterization of platinum/rhodium alloy at high temperature by combined laser heating and laser ultrasonic techniques,"](#) Ultrasonics **54** (4), 963-966 (2014). DOI: 10.1016/j.ultras.2014.01.011

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Zhen-Hua Chi, Xiao-Miao Zhao, Haidong Zhang, Alexander F. Goncharov, Sergey S. Lobanov, Tomoko Kagayama, Masafumi Sakata, Xiao-Jia Chen, ["Pressure-Induced Metallization of Molybdenum Disulfide."](#) Phys. Rev. Lett. **113** (3), 036802-1-036802-5 (2014). DOI: 10.1103/PhysRevLett.113.036802

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Przemyslaw Dera, Jawad Nisar, Rajeev Ahuja, Sergey Tkachev, Vitali B. Prakapenka, ["New type of possible high-pressure polymorphism in NiAs minerals in planetary cores."](#) Phys. Chem. Miner. **40** (2), 183-193 (2013). DOI: 10.1007/s00269-012-0560-6

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