Aug 9th, 10:15 AM - 12:00 PM

Ionic alkalihalides as pressure media in DAC experiments

Julius Monello
Reed College

Repository Citation
Monello, Julius, "Ionic alkalihalides as pressure media in DAC experiments" (2011). Undergraduate Research Opportunities Program (UROP). 26.
https://digitalscholarship.unlv.edu/cs_urop/2011/aug9/26

This Event is brought to you for free and open access by the Undergraduate Research at Digital Scholarship@UNLV. It has been accepted for inclusion in Undergraduate Research Opportunities Program (UROP) by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact digitalscholarship@unlv.edu.
Ionic Alkalihalides as Pressure Media in DAC Experiments
Julius Monello (Reed College)
UNLV Physics REU Advisors: Oliver Tschauner and Valentin Iota
Dept. of Physics, University of Nevada Las Vegas, Las Vegas NV 89119

Abstract

In Diamond Anvil Cells (DACs), usually a pressure transmitting medium functions to transform the uniaxial pressure supplied by the opposing diamond anvils into uniform hydrostatic pressure acting on the sample. Conventionally, a 4:1 methanol-ethanol solution, or a 16:3:1 methanol-ethanol-water solution is used as pressure transmitting medium. However, these two solutions transform into a glass with high elastic shear strength at pressures around 12-14 GPa and no longer function as hydrostatic medium. Our goal was to determine if liquid ionic alkalihalide alkanoates complexes will provide more uniform pressure in the cell up to 20 GPa. Ruby (Cr-doped Al2O3) produces two Cr3+ fluorescence lines when exposed to sufficiently energetic radiation (457.9 nm in our case). These two fluorescence lines shift toward the IR with increasing pressure. We used the splitting of the two fluorescence lines as well as the width of the peaks in order to measure the shear strength of the alkalihalide-alkanolate as a function of pressure.

Introduction

Basic diagram of a DAC. The opposing diamond anvils provide uniaxial pressure onto the pressure medium, the sample, and the ruby. The pressure medium converts the uniaxial pressure from the anvils into uniform hydrostatic pressure. Since we were simply testing the pressure medium, no sample was inserted for our trials.

Data and Conclusions

The standard pressure medium in DACs, a 16:3:1 methanol-ethanol-water solution, begins to transition into a glass at approximately 9-14 GPa. In our case we saw a glass transition as pressure neared 10 GPa. The alkalihalide-alkanolate undergoes a glass transition at approximately 7 GPa. It is in the glass transition where the alkalihalide complex is superior to the methanol-ethanol-water solution. As pressure increases to above 15 GPa, the alkalihalide-alkanolate maintains a relatively constant R2 peak width, whereas the methanol-ethanol-water solution experiences a drastic increase in peak width (fig 3). Broader ruby fluorescence peaks imply a greater shear strain on the sample, in other words: non-hydrostatic conditions. Thus, at high pressures, the alkalihalide-alkanolate provides conditions closer to hydrostatic pressure.

Experimental Setup

Figure 3 shows our experimental setup. A 457.9 nm laser (labeled A in the above picture) is reflected such that it travels through a focusing lens and hits the DAC (B). The excited fluorescence from the DAC travels through a collecting lens, reflects off a translatable mirror. If the mirror is in position, then the sample can be viewed in the microscope (C). Otherwise, when the mirror is moved out of position, the light passes the microscope and travels through a condensing lens and into the spectrometer (D). We used the spectroscopy program WinSpec32 to image the peaks from the pressure media, and Origin 8 to subsequently analyze the peaks.

References

1 http://james.badro.free.fr/Java/RubyApprox.html
2 http://upload.wikimedia.org/wikipedia/commons/c/c9/DiaAnvCell1.jpg

Support from the REU program of the National Science Foundation under grant DMR-1005247 is gratefully acknowledged. I would also like to thank my research advisors: Dr. Oliver Tschauner and Dr. Valentin Iota for their help this summer.