# Measuring Pressure from Ruby and NaCl in "Liquid" Pressure Medium

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## Introduction

The ruby pressure scale has been widely used as a secondary calibration standard for diamond anvil cell (DAC) experiments. This pressure scale relies on the dependence of the spectral shift of ruby ($\alpha$-$Al_2O_3$: $Cr^{3+}$) fluorescence lines. The ruby R1 fluorescence line shift has been calibrated against pressures based on Decker's NaCl scale by Piermarini et al. [1] and Cu and Ag equation of state (EOS) by Mao et al. [2]. Piermarini et al.'s calibration is limited to 30 GPa because of the B1-B2 transition in NaCl, whereas Mao et al.'s calibration extends to 80 GPa. Therefore a large discrepancy (13% at 80 GPa) between these two calibrations can be expected. At 10 GPa, Piermarini et al.'s calibration yields a pressure 2% lower than Mao et al.'s calibration. Aiming to understand the ruby scales and NaCl scale, we conducted x-ray diffraction experiments of NaCl in a DAC at the insertion device (ID) beamline of sector 13.

## Materials and Methods

A finely powdered NaCl sample is loaded in a 120-μm-diameter chamber of a stainless steel gasket together with ruby chips. The DAC has a 300-μm truncation tip. A mixture of ethanol and methanol (4:1) is used as the pressure medium. The incident x-ray is along the DAC-loading axis. X-ray diffraction patterns are collected by using a charge-coupled device (CCD), and the energy of the monochromatic x-ray is 29.2 keV. The experiments are carried out at room temperature.

## Results and Discussion

Experiments are carried out up to 20 GPa. Calculated pressures from NaCl x-ray diffraction data and Decker's EOS are plotted against the line shift of ruby R1 fluorescence in Fig. 1. For comparison, Piermarini et al.'s scale [1] and Mao et al's scale (together with their Cu data) [2] are also plotted in the figure. A linear fit to all the NaCl data is very consistent with Piermarini et al.'s data. However, the compression data show a clear kink at 10 GPa (marked by an arrow), indicating an effect of solidification of the pressure medium. A linear fit to the compression data below the solidification point yields a result significantly different from the full data fitting. Pressures referring to this fitting can be as much as 10% lower than those based on Cu EOS. Stress in the sample probably gives rise to the pressure differences. A further analysis of sample stress is in process.

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## References

[1] G. J. Piermarini, S. Block, J. D. Barnett, and R. A. Forman, "Calibration of the pressure dependence of the R1 ruby fluorescence line to 195 kbar," J. Appl. Phys. **46**, 2774-2780 (1975).
[2] H. K. Mao, J. Xu, and P. M. Bell, "Calibration of the ruby pressure gauge to 800 kbar under quasi-hydrostatic conditions," J. Geophys. Res. **91**, 4673-4676 (1986).

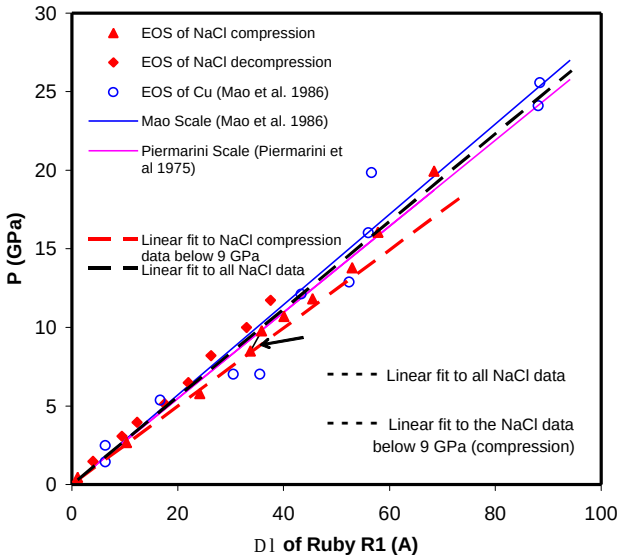


*FIG. 1. Calibration of ruby R1 fluorescence line shift.*