Development of a CsCl pressure standard and its use in testing a series of multi-anvil cells (the COMPRES assemblies)

Kurt Leinenweber, Emmanuel Soignard, Yanbin Wang
Purpose

• We needed to calibrate multi-anvil cells for the COMPRES cell project
• (pictures of the cells to follow)
• But the cells are VERY absorbing, and we didn’t want to alter them.
Example: COMPRES 10/5 assembly
Example: COMPRES 14/8 box heater assembly
Pressure standard

- We tried MgO and W, but soon settled on CsCl, and used the Decker (1971) equation of state for CsCl.
Advantages of CsCl

• Good scatterer.
• Simple cubic symmetry, so no extinctions.
• Highly compressible \((K_0 = 16)\).
• High melting point compared to NaCl.
• No phase transitions at high pressure.
Effect of temperature on pressure of 10/5 assembly
(CsCl pressure standard)

![Graph showing the effect of temperature on pressure for different loadings.
363 tonnes
454 tonnes
635 tonnes]
Assembly behavior with temperature (CsCl standard)

Pressure (normalized)

Temperature

10/5 assembly
14/8 G2 assembly
"14/8 "Bay-tech"
8/3 assembly
Poly. (10/5 assembly)
• Summary – CsCl is very useful for precise calibrations in many situations.
• However, how does Decker EOS for CsCl compare to better-known standards?
• The next part of this study is a comparison of CsCl to MgO, Au, and W.
(Sample arrangement for equation of state comparison)
Octahedral multi-anvil cell with x-ray access.
Miniature rhenium furnaces for high-pressure experiments, with x-ray access. Design #6D
In-situ assemblies

- Forsterite (Mg$_2$SiO$_4$) sleeve replacing zirconia – below 14 GPa.
- LaCrO$_3$ and Re with windows – from 14 GPa to 22 GPa, up to 2000 degrees C.
Technique of analysis

Analysis was by homewritten program “Crystal Cracker.”
The program can move the lines with P and T (fluorescences do not move).

The pattern can be automatically fitted and P calculated from the equation of state of any standard.

Red: CsCl
Green: W
Blue: BN
Yellow: Fluorescence
MgO + Au

Red: MgO
Blue: Au
Yellow: Fluorescence
Results – comparison of CsCl to MgO and Au.
Results – comparison of CsCl to MgO and Au (cont.)

900 tons, 10/5

P(CsCl) P(MgO) P(Au)
Summary

• CsCl is a good, sensitive pressure standard for high-resolution pressure measurements.

• The old Decker equation for CsCl is systematically lower than new MgO and Au equations of state by 1 GPa at moderate temperatures, ~0.5 GPa at higher temperatures (in the 10 – 20 GPa range).