Inter-comparison of the Au, Pt and MgO Pressure Scales up to 140 GPa and 2500 K

Yu Ye*[1], Sang-Heon Shim[2], Yue Meng[3], and Vitali Prakapenka[4]

[1]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences (GPMR, CUG) – Lumo Road, Hongshan District, Wuhan, 430074, Hubei, China

[2]Arizona State University (ASU) – School of Earth and Space Exploration ASU Tempe AZ 85287-1404, United States

[3]Carnegie Institute of Washington (CIW) – United States

[4]GSECARS, University of Chicago (GSECARS) – United States

Abstract

Reliable and accurate pressure scales are essential in high pressure research. Because the equations of state (EOSs) of Au, Pt and MgO have been widely used for pressure determination, extensive efforts have been made to improve these pressure scales. However, significant discrepancies still exist among these pressure standards. We measured the unit-cell volume of Pt, Au, and MgO in the mixture of Pt+MgO and Au+MgO in laser-heated diamond-anvil cell up to 140 GPa at both room and high temperatures up to 2500 K. The samples were loaded in either an Ar or Ne pressure transmitting medium. We did not mix Au and Pt together, to avoid alloying at high temperature. The in-situ X-ray synchrotron experiments were carried out at beamlines 13-IDD (GSECARS) and 16-IDB (HPCAT), APS. For the unit-cell volume measured at 300 K after laser heating, we found agreement between the pressure standards within ±2.5 GPa up to 130 GPa. We further refined the EOSs of the three pressure standards at 300 K, making them consistent with each other within ±1 GPa up to 130 GPa ($K0$'= 5.23(3) & $K0$ = 277.3 GPa for Pt; $K0$' = 5.90(2) & $K0$ = 167 GPa for Au; $K0$' = 4.18(2) & $K0$ = 160.3 GPa for MgO). At high temperatures, these three standards agree with each other the best within ±1 GPa between 40 and 140 GPa, adopting the scales by *Dorogokupets and Dewaele* [2007]. However, a 2–3 GPa of discrepancy remains at 20–40 GPa and 1500–2000 K, with gold yielding the highest pressure regardless of pressure scales used. The pressure discrepancy is likely related to steep decreases in the Gŕuneisen parameter, the anharmonicity, and/or the electronic effects for the EOSs of the standards at low pressures (0–40GPa) and high temperature (2000–2500K). Because gold melts near 2000 K at the lower pressure range, severe anharmonic effects expected at pre-melting conditions make the quasi-harmonic EOSs of Au unsuitable for pressure determination at the conditions. Although the pressure scales by *Dorogokupets and Dewaele* [2007] do not completely resolve the discrepancies in the mantle phase boundary properties, they provide tighter constrains on the Clapeyron slopes of the post-spinel boundary to -2.0_˜-2.7 MPa/K and the post-perovskite boundary to 7_˜10 MPa/K. Our data and refined EOSs allow for reliable comparisons among experiments with different pressure standards for the entire P-T conditions expected for the Earth's lower mantle.

*Speaker