Sound velocities and elastic constants of single crystal Pt under high pressure

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Abstract

Recently high pressure experimental techniques using a diamond anvil cell (DAC) have progressed and the phase relationships under the pressure conditions corresponding to the center of the Earth have been investigated (e.g. Tateno et al., 2010). The experimental pressures were generally decided based on an equation of state of a pressure scale (EOS). The EOSs were usually determined based on different pressure scale, such as Au, Pt, and NaCl. For instance, the pressure at the ICB condition of Holmes scale is approximately 10% higher than that of Fei scale (e.g. Fei et al., 2007; Holmes et al., 1989). Therefore, EOSs of a sample may give different pressures if the EOSs are established based on different EOSs of same pressure scale. It is important to determine the EOS independently from other scales. Measuring volumes or densities with sound velocities enables us to establish an independent EOS. Therefore, we have measured sound velocities of a single crystal of Pt under high pressure based on inelastic X-ray scattering and its volumes were simultaneously measured. The Pt single crystal was commercially purchased from MaTeck Co. A small piece of the single crystal of Pt was cut by FIB. The culet size used here was 400 μm. The small piece of single crystal of Pt was set in the sample chamber with ruby tips. Before loading Helium gas as a pressure medium inelastic X-ray scattering measurements were performed at room temperature and ambient pressure. The crystal parameter, $a0$, was also measured before the IXS measurements. The reference pressures were measured before and after each IXS measurement and crystal parameter, a, was measured before each IXS measurement. The sound velocities of single crystal of Pt were measured at 0, 1, 6, 10, 15, and 21 GPa. Cijs at ambient pressure were obtained to be C11=306(1), C12=193(1), and C44=56.4(2) GPa and C11=332(3), C12=228(3), and C44=62.8(3) GPa were obtained for 1 GPa. These values are slightly smaller than previous studies (Macfarlane et al., 1965; Menendez-Proupin and Singh, 2007). We will discuss the Cijs and EOS based on our results.

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