Mineral Physics and Chemistry of the Deep Mantle and Core

HEMLEY, R.J. and MAO H.K. Geophysical Laboratory and Center for High Pressure Research, Carnegie Institution of Washington, Washington, D.C. 20015 U.S.A.

Recent experimental and theoretical studies provide great many new insights on the physics and chemistry of deep mantle and core materials. Laser-heating diamond-cell experiments indicate that the partitioning of Fe and Mg between coexisting (Mg,Fe)SiO_3-perovskite and (Mg,Fe)O-magnesiowüstite strongly depends on pressure, temperature, bulk Fe/Mg ratio, and ferric content, and the perovskite stability field expands relative to magnesiowüstite + SiO_2 on increasing pressure and temperature. The soft-mode transition in SiO_2 to the $CaCl_2$-type structure, first predicted by accurate theoretical methods, has been documented by both Raman scattering and single-crystal diffraction, and the transition to higher pressure forms has been examined. The phase diagram of FeO, including the rhombohedral and higher pressure NiAs transition, has been determined, and the former has been studied in magnesiowüstites. Moreover, high-spin/low-spin transitions in FeO, as well as Fe_2O_3 and FeS, have been examined by high-resolution x-ray emission spectroscopy to 150 GPa. For the core, laser-heating studies to above 150 GPa and 2500 K show that (hcp) ε-Fe exhibits a large *P-T* field of stability field. Radial x-ray diffraction measurements carried out at room temperature to above 200 GPa have been used to constrain the elasticity, rheology, and sound velocities of ε-Fe at core pressures. Comparison with seismic data indicates large temperature effects on the shear velocities, additional low velocity phases, and/or complicated textures for the inner core.