T6.2-O5 Simple Systems and Experiments at extreme conditions

The crystal structure of ruby up to 170 GPa

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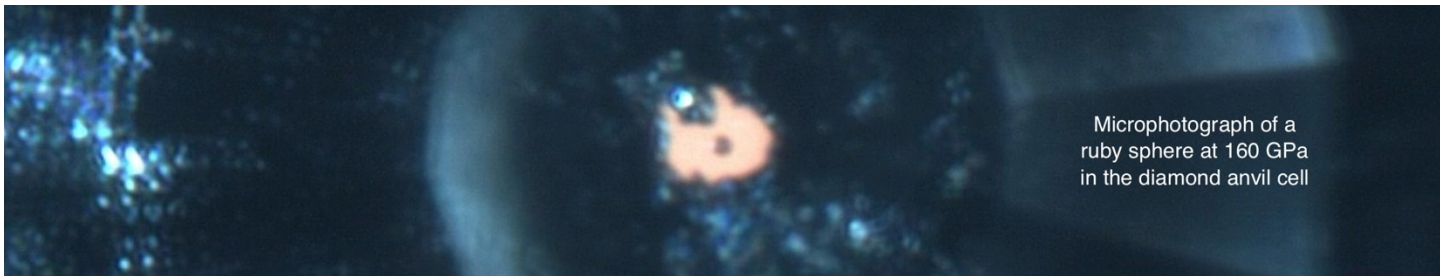
Abstract ()

Ruby, chromium-doped corundum, might very well be the second most critical material in high-pressure experimental science after diamond. The pressure and temperature dependence of its fluorescence is indeed the most widely used pressure gauge [1,2], it is also used as window material in shock compression, as medium and insulator in micro fabricated sample chambers and so on. Corundum is a prototypical structure - common to many sesquioxides and 2:3 compounds; AlO_6 octahedra are common building blocks of minerals. It is therefore important to determine precisely the deformation mechanisms of Al_2O_3. Indeed, a great deal of work has been performed in determining experimentally and computationally its properties under pressure with the greatest accuracy possible (see [3] and references therein).



We obtained an accurate assessment of the behavior of the material at ambient temperature in its metastable pressure range, above 80 GPa. A small ruby sphere was compressed in helium in a diamond anvil cell, and its long-range ordering was probed using synchrotron single-crystal micro-diffraction. We improved greatly from previous analogous measurements [4] with higher resolution and better sampling of the reciprocal space.

We will compare bulk and axial compressibility data with the literature. Robust single-crystal structural refinements were obtained at about 80 and 127 GPa, settling any lingering controversy on the bonding response of ruby under pressure.
These results represent a reference experimental structural observations to understand and model ruby's behavior under very high pressures.

[1] Mao et al. (1978) J Appl. Physics 49 (6) [2] Shen et al. (2020) High Press. Research 40, 3, 299-314 [3] Syassen (2008) High Press. Research, 28, 2, 75-126 [4] Dewaele and Torrent (2013) Phys Rev B, 88, 164107.