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In situ determination of the compressibility of synthetic pure zircon ($ZrSiO_4$) and the onset of the zircon-reidite phase transition

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Abstract

We have determined the room-temperature compressibility of pure, synthetic zircon ($ZrSiO_4$). Unit-cell volumes of a powdered sample were determined in situ as a function of pressure up to 27 GPa in a diamond anvil cell (DAC), by using angle-dispersive synchrotron X-ray diffraction (XRD) techniques. Unit-cell volumes were fitted to a Birch-Murnaghan equation of state, resulting in a room-temperature bulk modulus for the zircon structure, $K_{T0} = 199 \pm 1$ GPa, and ambient pressure unit-cell volume $V_0 = 260.89 \pm 0.03$ Å^3, when $(\partial K_{T0}/\partial P)_T = K'_{T0}$ is fixed at 4. This bulk modulus is over 12% lower than that suggested by earlier measurements using impure, natural zircon sample. In addition, we observed the start of the transformation of zircon to reidite (scheelite-structured $ZrSiO_4$) at a pressure of 19.7 GPa, over 3 GPa lower than previously determined for natural (impure) zircon. Together with compressibility measurements of a trace-element-doped zircon, these observations suggest that impurities affect the phase transition kinetics and compressibility of zircon, and by analogy, perhaps of other silicate minerals.