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Heat transfer in plagioclase feldspars

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Abstract

Laser-flash analyses (LFA) of oriented sections of six natural plagioclase crystals provide thermal diffusivity (D) as function of temperature (to ~1300–1500 K) and composition (An_{5-95}). Plagioclase has low-thermal diffusivity; our measurements indicate that plagioclase is more insulating than other major igneous rock-forming minerals. Over much of the solid solution, room-temperature D ranges from 0.751 to 0.979 mm^2/s along **c**, 0.722 to 0.919 mm^2/s along **b**, and 0.632 to 0.868 mm^2/s perpendicular to **b** and **c**. The directionally averaged D is 30–45% lower than D of Amelia albite. Thermal conductivities calculated using measured D values are almost the same for all samples with $18 \leq An \leq 65$, ranging from 1.5 to 1.9 W/m/K and changing little with temperature. Increasing Al-Si disorder causes D to decrease with increased An content, although sample structure causes more ordered samples to have higher D than more disordered samples. Anorthite is a special case. Although ordered, the larger unit cell provides many lattice modes, leading to low diffusivity. Structure dictates whether D along the b-axis is greater or less than that along the c-axis, possibly because ordering in An-like domains increases D more along **c** relative to **b**. Inflections in $1/D(T)$ are connected with lattice distortion during heating, and occur near temperatures expected for phase transitions; for example, the lattice stretch occurring at the temperature of the transition to $C\overline{1}$ structure lowers diffusivity. Likewise, lattice distortion during heating decreases D in albite along **c** but has little impact on D in the other directions. The anharmonic lattice effects that dictate both thermal expansivity and D are masked by effects of disorder; the latter plays a major role in heat transport in plagioclase.

Keywords: Plagioclase, heat transfer, thermal diffusivity, thermal conductivity, laser-flash analysis, high-temperature studies