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Acoustic dissipation associated with phase transitions in lawsonite, $CaAl_2Si_2O_7(OH)_2 \cdot H_2O$

Ruth E.A. McKnight,[1,*] Michael A. Carpenter,[1] Tim W. Darling,[2] Andy Buckley,[1] and Paul A. Taylor[1]

[1]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ, U.K.
[2]Department of Physics, University of Nevada, Reno, Nevada 89577, U.S.A.

Abstract

Resonant ultrasound spectra of a single crystal and a polycrystalline sample of lawsonite [$CaAl_2Si_2O_7(OH)_2 \cdot H_2O$] have been measured at room temperature and at low temperatures in the region 20–300 K. The influence of known phase transitions at 125 and 270 K is seen in the frequency variations of the resonance peaks, which are indicative of elastic stiffening, and in values for the quality factor Q_{QF}, which are indicative of dissipation. Two dissipation peaks, at ~250 and ~210 K, are interpreted as being due to the proton order-disorder processes associated with the two species of hydrogen atoms in the structure: one in hydroxyl OH groups and one in the H_2O molecules. These occur below the *Cmcm* ↔ *Pmcn* transition point but coincide with changes in the shear elastic constants and in features of IR spectra reported elsewhere. A third, much smaller, dissipation peak occurs immediately below the *Pmcn* ↔ $P2_1cn$ transition point. The combination of these anomalies in acoustic dissipation and in elastic constants is consistent with the view that the *Cmcm* ↔ *Pmcn* transition is driven both by displacive and proton ordering effects. For the *Pmcn* ↔ $P2_1cn$ transition, dissipation and the transition are more closely related, consistent with the view that the transition is driven essentially by proton ordering.

Keywords: Lawsonite, resonant ultrasound spectroscopy, dissipation, proton ordering