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Elastic wave velocities of $Mg_3Al_2Si_3O_{12}$-pyrope garnet to 10 GPa

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Abstract

Elastic wave velocities of $Mg_3Al_2Si_3O_{12}$ pyrope garnet were measured to 10 GPa at ambient temperature, using ultrasonic interferometry in a 1000 ton split-cylinder, multi-anvil apparatus (USCA-1000). The sample used in the ultrasonic measurements was a polycrystalline specimen hot-pressed at 5 GPa and 1350 °C in a 2000 ton uniaxial split-sphere apparatus (USSA-2000) from a homogeneous glass of pyrope composition. Special *P-T* paths used during synthesis minimized effects of decompressing and thermal cracking; the bulk density of the sample was indistinguishable from the X-ray density. The elastic wave velocities measured at the ambient condition agree with the Hashin-Shtrikman averages of the single crystal values within the mutual uncertainties. The high-pressure experiments yielded the elastic moduli and their pressure derivatives (finite strain fit) for the shear modulus $G_0 = 92 \pm 1$ GPa, $G_0' = (\partial G/\partial P)_T = 1.6 \pm 0.2$ and for the longitudinal modulus $L_0 = 294 \pm 1$ GPa, $L_0' = (\partial L/\partial P)_T = 7.4 \pm 0.5$, ($L = K_S + 4/3G$), from which the bulk modulus $K_0 = 171 \pm 2$ GPa, $K_0' = (\partial K_S/\partial P)_T = 5.3 \pm 0.4$ was calculated. The pressure derivative for the shear modulus of pyrope did not differ from those of natural pyrope-almandine-grossular garnets. For the bulk modulus, the pressure derivative for pyrope agreed with that for pyrope-almandine but was substantially higher (25%) than that for the Ca-bearing garnet. In the pyrope-majorite series, K_0' remained constant, whereas G_0' increased by 25 for 38% majorite content.