

Supplementary Table 1 Measured acoustic V_P and V_S velocities of the single-crystal periclase (MgO) as a function of the crystallographic orientation within the (100) plane at ambient conditions. The azimuthal angle is expressed as the rotated angle with respect to an arbitrary reference direction within the plane.

Azimuthal angle (degree)	V_P (km/s)	V_S (km/s)
0	9.868 (± 0.004)	5.535 (± 0.003)
5	9.958 (± 0.004)	5.417 (± 0.002)
10	9.951 (± 0.004)	5.339 (± 0.003)
15	9.955 (± 0.004)	5.346 (± 0.003)
20	9.910 (± 0.004)	5.414 (± 0.003)
25	9.835 (± 0.004)	5.550 (± 0.004)
30	9.731 (± 0.003)	5.722 (± 0.003)
35	9.599 (± 0.004)	5.915 (± 0.004)
40	9.457 (± 0.004)	6.143 (± 0.005)
45	9.327 (± 0.003)	6.355 (± 0.005)
50	9.210 (± 0.004)	6.506 (± 0.004)
55	9.143 (± 0.004)	6.589 (± 0.004)
60	9.147 (± 0.003)	6.594 (± 0.002)
65	9.215 (± 0.004)	6.505 (± 0.004)
70	9.313 (± 0.003)	6.340 (± 0.004)
75	9.457 (± 0.003)	6.135 (± 0.004)
80	9.599 (± 0.004)	5.909 (± 0.004)
85	9.713 (± 0.005)	5.707 (± 0.004)
90	9.813 (± 0.005)	5.516 (± 0.003)
95	9.895 (± 0.004)	5.403 (± 0.002)
100	9.930 (± 0.004)	5.335 (± 0.002)
105	9.927 (± 0.004)	5.334 (± 0.003)
110	9.882 (± 0.004)	5.389 (± 0.003)
115	9.819 (± 0.004)	5.508 (± 0.003)
120	9.712 (± 0.004)	5.683 (± 0.004)
125	9.568 (± 0.004)	5.874 (± 0.004)
130	9.427 (± 0.003)	6.097 (± 0.004)
135	9.286 (± 0.003)	6.309 (± 0.004)
140	9.187 (± 0.003)	6.472 (± 0.004)
145	9.101 (± 0.004)	6.561 (± 0.005)
150	9.108 (± 0.003)	6.557 (± 0.004)
155	9.169 (± 0.004)	6.475 (± 0.004)
160	9.281 (± 0.005)	6.308 (± 0.003)
165	9.403 (± 0.005)	6.104 (± 0.004)
170	9.559 (± 0.004)	5.881 (± 0.003)
175	9.680 (± 0.005)	5.666 (± 0.003)
180	9.768 (± 0.004)	5.482 (± 0.002)

Numbers in parentheses are standard deviations ($\pm 1\sigma$).

Supplementary Table 2 Measured acoustic V_P and V_S velocities of the single-crystal periclase (MgO) as a function of the crystallographic orientation within the (110) plane at ambient conditions. The azimuthal angle is expressed as the rotated angle with respect to an arbitrary reference direction within the plane.

Azimuthal angle (degree)	V_P (km/s)	V_S (km/s)
0	9.417 (± 0.007)	6.286 (± 0.004)
5	9.564 (± 0.007)	6.114 (± 0.005)
10	9.736 (± 0.006)	5.952 (± 0.005)
15	9.867 (± 0.005)	5.807 (± 0.004)
20	9.989 (± 0.009)	5.716 (± 0.004)
25	10.100 (± 0.007)	5.668 (± 0.004)
30	10.152 (± 0.007)	5.663 (± 0.004)
35	10.200 (± 0.006)	5.721 (± 0.004)
40	10.218 (± 0.007)	5.807 (± 0.005)
45	10.207 (± 0.007)	5.945 (± 0.004)
50	10.201 (± 0.007)	6.091 (± 0.004)
55	10.137 (± 0.005)	6.248 (± 0.003)
60	10.075 (± 0.007)	6.410 (± 0.004)
65	10.037 (± 0.005)	6.516 (± 0.006)
70	10.000 (± 0.004)	6.598 (± 0.005)
75	9.986 (± 0.005)	6.630 (± 0.005)
80	9.981 (± 0.004)	6.613 (± 0.004)
85	10.018 (± 0.006)	6.530 (± 0.005)
90	10.073 (± 0.004)	6.405 (± 0.003)
95	10.124 (± 0.004)	6.252 (± 0.005)
100	10.124 (± 0.008)	6.123 (± 0.005)
105	10.200 (± 0.008)	5.940 (± 0.004)
110	10.221 (± 0.004)	5.806 (± 0.004)
115	10.186 (± 0.008)	5.710 (± 0.004)
120	10.169 (± 0.007)	5.651 (± 0.004)
125	10.093 (± 0.007)	5.667 (± 0.004)
130	10.014 (± 0.004)	5.726 (± 0.003)
135	9.869 (± 0.004)	5.814 (± 0.003)
140	9.734 (± 0.005)	5.958 (± 0.004)
145	9.574 (± 0.006)	6.112 (± 0.004)
150	9.418 (± 0.005)	6.280 (± 0.005)
155	9.290 (± 0.004)	6.443 (± 0.004)
160	9.185 (± 0.004)	6.552 (± 0.005)
165	9.138 (± 0.004)	6.604 (± 0.005)
170	9.160 (± 0.004)	6.575 (± 0.004)
175	9.263 (± 0.005)	6.472 (± 0.005)
180	9.373 (± 0.004)	6.334 (± 0.004)

Numbers in parentheses are standard deviations ($\pm 1\sigma$).

Supplementary Table 3 Measured acoustic V_P and V_S velocities of the single-crystal periclase (MgO) as a function of the crystallographic orientation within the (111) plane at ambient conditions. The azimuthal angle is expressed as the rotated angle with respect to an arbitrary reference direction within the plane.

Azimuthal angle (degree)	V_P (km/s)	V_{S1} (km/s)	V_{S2} (km/s)
0	9.925 (± 0.007)	5.629 (± 0.010)	6.173 (± 0.004)
5	9.926 (± 0.009)	5.546 (± 0.007)	6.225 (± 0.004)
10	9.909 (± 0.009)	5.462 (± 0.008)	6.322 (± 0.005)
15	9.889 (± 0.006)	5.394 (± 0.005)	6.425 (± 0.004)
20	9.892 (± 0.011)	5.310 (± 0.005)	6.498 (± 0.006)
25	9.871 (± 0.006)	5.284 (± 0.004)	6.545 (± 0.006)
30	9.849 (± 0.008)	5.274 (± 0.003)	6.549 (± 0.005)
35	9.859 (± 0.007)	5.307 (± 0.004)	6.530 (± 0.006)
40	9.854 (± 0.010)	5.371 (± 0.006)	6.452 (± 0.005)
45	9.878 (± 0.007)	5.465 (± 0.006)	6.366 (± 0.003)
50	9.872 (± 0.013)	5.543 (± 0.011)	6.255 (± 0.005)
55	9.861 (± 0.006)	5.584 (± 0.006)	6.162 (± 0.003)
60	9.825 (± 0.006)	5.605 (± 0.012)	6.160 (± 0.005)
65	9.830 (± 0.006)	5.577 (± 0.011)	6.234 (± 0.005)
70	9.816 (± 0.006)	5.442 (± 0.006)	6.311 (± 0.005)
75	9.847 (± 0.006)	5.373 (± 0.005)	6.413 (± 0.007)
80	9.831 (± 0.005)	5.308 (± 0.005)	6.491 (± 0.007)
85	9.824 (± 0.005)	5.259 (± 0.004)	6.535 (± 0.007)
90	9.820 (± 0.005)	5.249 (± 0.004)	6.527 (± 0.006)
95	9.828 (± 0.006)	5.299 (± 0.005)	6.480 (± 0.004)
100	9.833 (± 0.008)	5.356 (± 0.006)	6.405 (± 0.004)
105	9.832 (± 0.005)	5.463 (± 0.010)	6.300 (± 0.004)
110	9.860 (± 0.006)	5.530 (± 0.013)	6.204 (± 0.005)
115	9.853 (± 0.007)	5.613 (± 0.007)	6.157 (± 0.005)
120	9.869 (± 0.006)	5.588 (± 0.012)	6.164 (± 0.004)
125	9.810 (± 0.008)	5.498 (± 0.011)	6.237 (± 0.006)
130	9.795 (± 0.006)	5.397 (± 0.008)	6.313 (± 0.006)
135	9.836 (± 0.006)	5.328 (± 0.005)	6.443 (± 0.007)
140	9.817 (± 0.007)	5.290 (± 0.004)	6.497 (± 0.007)
145	9.818 (± 0.006)	5.244 (± 0.005)	6.520 (± 0.008)
150	9.824 (± 0.007)	5.282 (± 0.005)	6.534 (± 0.007)
155	9.842 (± 0.006)	5.315 (± 0.004)	6.484 (± 0.005)
160	9.843 (± 0.005)	5.393 (± 0.006)	6.410 (± 0.005)
165	9.859 (± 0.005)	5.494 (± 0.009)	6.310 (± 0.005)
170	9.874 (± 0.007)	5.591 (± 0.018)	6.202 (± 0.005)
175	9.873 (± 0.005)	5.647 (± 0.012)	6.180 (± 0.002)
180	9.895 (± 0.006)	5.635 (± 0.013)	6.208 (± 0.005)

Numbers in parentheses are standard deviations ($\pm 1\sigma$).

Supplementary Table 4 Measured acoustic V_P and V_S velocities of the single-crystal spinel (MgAl_2O_4) as a function of the crystallographic orientation within the (100) plane at ambient conditions. The azimuthal angle is expressed as the rotated angle with respect to an arbitrary reference direction within the plane.

Azimuthal angle (degree)	V_P (km/s)	V_S (km/s)
0	10.216 (± 0.013)	4.215 (± 0.007)
5	10.187 (± 0.012)	4.305 (± 0.004)
10	10.100 (± 0.008)	4.499 (± 0.006)
15	9.981 (± 0.013)	4.783 (± 0.011)
20	9.828 (± 0.014)	5.154 (± 0.012)
25	9.651 (± 0.008)	5.562 (± 0.011)
30	9.437 (± 0.007)	5.953 (± 0.011)
35	9.222 (± 0.010)	6.260 (± 0.009)
40	9.061 (± 0.007)	6.527 (± 0.007)
45	8.978 (± 0.007)	6.600 (± 0.006)
50	9.043 (± 0.007)	6.549 (± 0.006)
55	9.208 (± 0.008)	6.315 (± 0.010)
60	9.449 (± 0.009)	5.993 (± 0.011)
65	9.658 (± 0.012)	5.597 (± 0.015)
70	9.886 (± 0.011)	5.227 (± 0.012)
75	10.075 (± 0.008)	4.859 (± 0.012)
80	10.195 (± 0.010)	4.583 (± 0.008)
85	10.274 (± 0.008)	4.342 (± 0.009)
90	10.351 (± 0.011)	4.274 (± 0.005)
95	10.289 (± 0.009)	4.304 (± 0.005)
100	10.231 (± 0.005)	4.462 (± 0.006)
105	10.108 (± 0.007)	4.724 (± 0.009)
110	9.936 (± 0.011)	5.042 (± 0.014)
115	9.722 (± 0.008)	5.415 (± 0.008)
120	9.469 (± 0.010)	5.799 (± 0.012)
125	9.233 (± 0.008)	6.165 (± 0.011)
130	9.023 (± 0.009)	6.420 (± 0.007)
135	8.949 (± 0.009)	6.536 (± 0.007)
140	8.945 (± 0.009)	6.520 (± 0.006)
145	9.048 (± 0.014)	6.330 (± 0.008)
150	9.297 (± 0.014)	6.028 (± 0.014)
155	9.541 (± 0.008)	5.599 (± 0.009)
160	9.711 (± 0.009)	5.220 (± 0.012)
165	9.891 (± 0.007)	4.832 (± 0.010)
170	10.058 (± 0.005)	4.554 (± 0.008)
175	10.117 (± 0.006)	4.293 (± 0.005)
180	10.154 (± 0.011)	4.206 (± 0.005)

Numbers in parentheses are standard deviations ($\pm 1\sigma$).