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# Time-domain Brillouin scattering: Application to elasticity measurement in cubic solids compressed in a diamond anvil cell

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Time-domain Brillouin scattering (TDBS) is based on the technique of picosecond laser ultrasonics, which permits measurement of sound velocities in transparent samples compressed a diamond anvil cell (DAC) with a very high temporal/spatial resolution. We present here our recent works on two minerals, both crystallizing in the cubic B1-structure, using the TDBS+DAC technique. Knowledge of their elastic behaviour at high pressures permits a better understanding of the seismic observations in the Earth's interior and thus to conclude about its dynamics. Here, elastic anisotropy of MgO, the end-member of the second most abundant mineral of the lower mantle, namely ferropericlase ( $\text{Mg}_{1-x}\text{Fe}_x\text{O}$ ), is of particular importance. Using the TDBS+DAC technique, we measured pressure dependences of the longitudinal sound velocities ( $V_L$ ) in single crystals of MgO along two different directions  $\langle 100 \rangle$  and  $\langle 111 \rangle$ . All three independent members of the elastic tensor  $C_{ij}$ , as well as its elastic anisotropy at high pressures were derived applying reliable experimental equation of state. Our measurements revealed a continuous enhancement of the elastic anisotropy of MgO at pressures of the upper part of the lower mantle [1], in contrast to the only earlier experimental data. However, our results agree with all theoretical predictions and the measurements on ferropericlase with a moderate Fe-content. Also, we demonstrated that the TDBS technique permits access to the  $C_{ij}(P)$  dependences of cubic solids via a very different approach: Thanks to a very high spatial resolution (typically two or three hundreds of nm) of the technique, we measured the  $V_L$  distributions in polycrystalline NaCl samples and derived the extreme  $V_L$  values, which are  $V_{L100}$  and  $V_{L111}$  in any cubic crystal, using the envelope method [2,3,4]. This advantage of the TDBS technique permitted us the measurement of  $C_{ij}(P)$  of the high-pressure B2-phase of NaCl having cubic CsCl-type structure which is not accessible as single crystals. The latter result, together with the earlier reports on the  $C_{ij}(P)$  of CaO, permitted us to propose a mechanism of the B1-B2 phase transition [5]. Furthermore, we applied this finding to predict pressure of the B1-B2 phase transition of MgO. The above presented results demonstrated the potential of the TDBS technique in examination of the elastic behaviour and phase transition of cubic minerals compressed in a DAC to high pressures, also in excess of 100 GPa.

## References:

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