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Structural phase transition in wadsleyite - a MID/FAR-Infrared Study

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The Earth‘s Upper Mantle mainly consists of $(Mg,Fe)_2SiO_4$-polymorphs. The discontinuity in seismic velocity at app. 410 km depth is caused by the transformation of olivine to wadsleyite ($\alpha-$ to $\beta-(Mg,Fe)_2SiO_4$). Both phases can incorporate a certain amount of water as hydroxyl groups and it is known that water incorporation strongly affects physical properties such as density and bulk modulus (Mao et al. 2008).
We synthesised hydrous and anhydrous wadsleyite (Mg_2SiO_4) in a multi-anvil-press and measured IR-spectra on polycrystalline thin films in a diamond anvil cell.
The relatively easily accessible measurements in the MID-IR-region show the pressure-depending behaviour of the quite incompressible SiO_4-tetrahedra. However these bands only display slight changes with increasing pressure. Therefore we developed a THz/FIR microscope adapted to a Bruker IFS 66/v spectrometer at the BESSY Synchrotron IR-beamline IRIS (Berlin, Adlershof). It was built to conduct in situ pressure depending measurements in diamond anvil cells in the FAR-IR-region, where the metal-cation-involved vibrations take place.
On the basis of the compressional behaviour of these bands we observed changes, indicating a phase transition. These changes occur at slightly different pressures comparing hydrous (8 – 9 GPa) and anhydrous (around 10 GPa) samples.
Chopelas (1991) measured Raman spectra on wadsleyite and found a structural phase transition at 9.2 GPa. Cynn and Hofmeister (1994) detected changes in the slope of FAR-IR-bands around 10 GPa in hydrous $\beta-(Mg,Fe)_2SiO_4$.

References:
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