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Electron energy-loss spectroscopy of silicate perovskite-magnesiowüstite high-pressure assemblages

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ABSTRACT

Silicate perovskite-magnesiowüstite assemblages synthesized from natural olivine in the multi-anvil press and diamond-anvil cell were studied by electron energy-loss spectroscopy (EELS). Spectra of crystalline silicate perovskite, and its post-amorphization phase, as well as magnesiowüstite were collected at the Fe and Si $L_{2,3}$ edge, and in the low loss (<50 eV) domain. The technique of line spectra ensuring very low beam doses allows good quality spectra to be collected from crystalline perovskite prior to amorphization and permits characterization of coexisting crystals of perovskite and magnesiowüstite. Spectra at the Si $L_{2,3}$ edge show that the beam-induced amorphization of silicate perovskite is accompanied by a change from sixfold to fourfold oxygen coordination of silicon atoms. Spectra at the Fe $L_{2,3}$ edge show that Fe^{2+} is the major form of Fe in olivine, ringwoodite, and magnesiowüstite, whereas Fe^{3+} is dominant in crystalline silicate perovskite and its amorphization products. In magnesiowüstite and silicate perovskite observed in contact in these samples, Fe^{3+} is strongly partitioned into the silicate phase.

Careful experimental substraction of zero-loss peak by off Bragg acquisition of electron energy-loss spectra allows good quality low loss spectra to be collected from crystalline silicate perovskite and magnesiowüstite. In magnesiowüstite, interband transitions are well characterized, leading to a measured gap of 7.8 eV, in agreement with previous theoretical calculations. Interband transitions at 10 eV and 12.5 eV are also well resolved in crystalline silicate perovskite, leading to a gap of about 9.5 eV.