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Meteorite impacts produce a suite of deformation features and high-pressure phases that can be used to suggest the pressure and temperature conditions reached during the impact [1, 2]. Olivine is common in meteorites, and it is an important component of numerous planetary bodies. In olivine, with increasing shock pressures and temperatures, initially optical extinction is observed, followed by mosaicism, several types of deformation features, and mineral transformations to higher pressure phases. We use a new technique, rapid compression, to assist with identifying the specific deformation processes that result in shock deformation. We compare our results to previous terrestrial deformation maps in order to identify compression rate effects on deformation.

Using a membrane diamond anvil cell, we compressed two samples, synthetic olivine $(Mg_{0.5},Fe_{0.5})_2SiO_4$ and San Carlos olivine $(Mg_{0.9},Fe_{0.1})_2SiO_4$ at compression rates of 0.04(6) -1.79(1) GPa/s to peak pressures of approximately 50 GPa. *In-situ* X-ray diffraction images were taken every 1 second. All experiments were non-hydrostatic and were conducted at room temperature. The diffraction patterns were analyzed using multiple techniques. LeBail fitting was performed to determine unit cell and peak shapes parameters. Peak width measurements were made in order to create Williamson-Hall plots. These plots allow determination and separation of the contributions of size and micro-strain to peak broadening. Recovered samples were investigated by SEM.

The study produced several novel findings: 1) From the LeBail fitting, samples compressed at faster rates were more brittle. 2) In faster compression rate experiments, lattice parameter ***a*** ceased to change above 10 GPa. 3) Both peak strain and differential stress build-up at higher pressures with increasing rate. 4) Based on our measurements of differential stress vs. strain rate, samples compressed at slower compression rates reached a cataclastic regime. Samples compressed at faster rates, remain in either discrete obstacle resistance or Peierl's mechanism dominated plastic regimes. 5) Despite compression at different rates, our recovered samples appeared to have extremely similar grain sizes and morphologies. Cataclastic (superplastic) flow has no strain rate dependence and produces similar flattened morphologies. Therefore, we suggest the deformation observed during our experiments was a form of low temperature plasticity followed by cataclastic flow at higher pressures. Our experiments produced micro-strain values that are commensurate with those of an experimental shock study that uses the same technique to calculate micro-strain [3]. Given the micro-strain measurements and the lack of significant mechanism change between the 0.42(8) and 1.79(0) GPa/s compression rates, similar deformation mechanisms and regimes may be occurring during meteorite impacts.

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[2] D.K. Stöffler, Geochim. Cosmochim. Acta 1991, **55**(12), 3845-3867.
[3] A. Uchizono, et al., Mineral. J. 1999, **21**(1), 15-23.