Using in-situ Diffraction and Elastic Plastic Self-consistent Models to Interpret the Low Strain Behavior of Olivine Polycrystals in the D-DIA Apparatus

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The textbook stress strain curve has an elastic response followed by a yield point and then plastic flow. Typically in rock deformation experiments the observed 'elastic' behavior deviates from the Young's modulus because the mechanical response of the loading frame and friction in the sample assembly and between moving parts of the loading frame cannot be easily corrected for. Stress strain curves generated in a D-DIA apparatus used in conjunction with synchrotron x-rays should not have these problems because the sample length is measured directly by radiography and the stress in the sample is measured from the sample itself by x-ray diffraction. However, the sample's 'elastic behavior', in many instances, still deviates from what is expected. For example, in constant strain rate experiments on both polycrystalline San Carlos olivine and fayalite olivine conducted at a variety of temperatures (25° – 1200° C) and pressures (4 and 7 GPa) although we are able to use elastic plastic self-consistent (EPSC) models to describe the plastic behavior of the olivine we are not able to fit the initial elastic behavior for all but the lowest temperature experiments. To a first approximation it appears that samples are generally more compliant than their elastic properties would predict and that the degree of softening is temperature dependent. For D-DIA experiments which have been conducted at strain rates of ~10^{-5} /sec, there are not enough data points to really clarify what is happening in the elastic portion of the experiment. Therefore, we conducted a suite of low strain experiments using the D-DIA at ~5 x 10^{-6} /sec at temperatures ranging from 400° to 1200° C, at beamline 6BM-B at the Advanced Photon Source, Argonne National Lab. For each experiment we fit the diffraction data using EPSC models. We present the results from our diffraction analysis. The relative degree of relaxation observed for each grain population in the diffraction data as well as to the predictions of the EPSC model combined with the microstructural data, will be used create a more comprehensive picture of how individual grains and various grain populations contribute to the low strain mechanical behavior of the polycrystal.