Rheology of hcp-iron up to 19 GPa and 600 K in the D-DIA

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Stress strain curves of polycrystalline hcp iron have been obtained at pressures up to 19 GPa, three different temperatures, and various strain rates using the deformation DIA coupled with monochromatic X rays. The experiment was carried out at the GSECARS bending magnet beamline 13 BM D at the Advanced Photon Source. We used two sintered diamond anvils on the down stream side in the DDIA, to serve as windows for diffracted X rays. The starting material was a bcc iron rod. The generated temperature was inferred from the input power using a power temperature relation which had been determined in a separate run. The cell assembly was pressurized isotropically up to a load of 50 tons. At this load, the sample was still bcc phase and the generated pressure was about 15 GPa. At this fixed load, the sample was heated up to 700 K, and the phase transition from bcc to hcp was observed. After the synthesis of hcp phase, five independent stress strain curves were obtained on axial shortening and the sample exhibited ductile behavior in all. Above 4 percent axial strain, sample stresses reach saturation and the sample exhibited steady state deformation. Stress exponents at temperatures of 400 and 600 K were determined to be 31 and 7, respectively. These results indicate that hcp iron deforms in plasticity regime below 400 K and that the dominant deformation mechanism at 600 K may be low temperature power law creep. The overall deformation behavior for hcp iron is consistent with that of zinc, suggesting that the deformation mechanism map of hcp iron resembles those of other hexagonal metals.