Synchrotron X-ray Studies of Deformation of Hexagonal Metals

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Due to their inherent low crystallographic symmetry, polycrystalline hexagonal close packed metals such as beryllium, magnesium and zirconium, cannot experience arbitrary deformation on a single slip mode, e.g. basal slip. Moreover, by manipulating the crystallographic texture, one can control the active deformation mechanisms, slip or twin, in hexagonal metals in a way which cannot be done in cubic metals. Finally, because slip and twinning are controlled by very different kinetics, one may also control the activity of slip and twinning by varying the deformation rate and temperature.

Our group has coupled experimental research and polycrystalline plasticity modeling of hexagonal metals for over a decade in an attempt to understand the interplay of the various slip and twin systems, with the final goal being physics based computational codes which predict the evolution of mechanical properties and microstructure with high fidelity. With the advent of techniques which utilize the high brilliance of 3rd generation synchrotron x-ray sources, we have recently undertaken experimental studies which may be used to develop and validate models at length and time scales not previously possible. For example, we have monitored the evolution of the complete stress tensor of a parent grain and **its** twin during deformation of magnesium. This talk will focus on the integration of the new science which synchrotrons have recently made possible with our on-going modeling efforts, as well as speculate on future developments at the next generation source, that is the free electron laser.