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Dehydration and Collapse of Protein Crystals. I.K. Robinson, S. Boutet, Dept. of Physics, Univ. of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL, 61801.

When a coherent x-ray beam illuminates an object, the diffraction pattern observed corresponds to the Fourier transform of the entire object. The new technique of Coherent X-ray Diffraction (CXD) makes use of that fact to image in 3 dimensions crystals that are smaller than what is visible with an optical microscope. With this technique, one can track the changes in external shape of small crystals, as well as, in theory, all internal defects. This technique is then suitable for the study of individual radiation damage events.

During a study of the crystallization kinetics of the protein ferritin, we observed single small crystals becoming destroyed by the x-ray beam over time. For each crystal, there is a latent period before any significant change is detected, followed by a sudden change. We were able to track the changes over time. The intensity from a Bragg peak is seen to spread to larger momentum transfer (q) in a way that resembles an explosion. What is surprising about these catastrophic events is the fact that the intensity moving to larger momentum transfer means that the crystal is physically collapsing inwards on itself over time.

We explain this observation with a dehydration model in which the water in the center of the small crystal is heated and eventually dehydrates the crystal. The protein molecules making up the crystal then collapse onto each other, reducing the lattice spacing of the crystal over time, until the whole crystal breaks up CXD methods can be applied to study the shape of the resulting crystal fragments. We will present the data showing this effect as well as the model describing it.