

Ultrafast Dynamics of Materials studied by Coherent X-ray Diffraction

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The structure of materials is accessible through X-ray diffraction techniques. In 1936 Lawrence Bragg developed the idea of imaging materials through an X-ray microscope. Today this has become possible with the development of synchrotron radiation sources of X-rays and will move into the ultrafast time domain in the near future with the development of free-electron laser sources.

I will describe my group's latest Bragg Coherent Diffraction Imaging (BCDI) experiments, which are capable of imaging nanometer-sized crystals in three dimensions [1]. The method is different from many other imaging methods in that it uses data measured around individual Bragg peaks of the crystal studied. For this reason, it is highly sensitive to strain fields present in the crystal under investigation, which are therefore mapped in three dimensions [2]. The latest development is to measure several Bragg peaks from the *same nanocrystal* to reveal multiple components of the displacement field and the resulting strain tensor. The strain induced by ion-beam milling of nanocrystals has been imaged in 3D in this way [3]. I will show recent progress in understanding some of these systems in the first few picoseconds after excitation with a laser [4].

[1] "Three-dimensional Mapping of a Deformation Field inside a Nanocrystal", Mark A. Pfeifer, Garth J. Williams, Ivan A. Vartanyants, Ross Harder and Ian K. Robinson, *Nature* 442 63-66 (2006).

[2] "Coherent Diffraction Imaging of Strains on the Nanoscale", Ian Robinson and Ross Harder, *Nature Materials* 8 291-298 (2009)

[3] "3D lattice distortions and defect structures in ion-implanted nano-crystals", Felix Hofmann, Edmund Tarleton, Ross Harder, Nicholas Phillips, Pui-Wai Ma, Jesse Clark, Ian Robinson, Brian Abbey, Wenjun Liu, and Christian Beck, *Nature Scientific Reports* 7 45993 (2017)

[4] Melt-front Dynamics in Polycrystalline Gold Thin Films, Tadesse A. Assefa, Yue Cao, Soham Banerjee, Sungwon Kim, Dongjin Kim, Sunam Kim, Jae Hyuk Lee, Sang-Youn Park, Intae Eom, Jaeku Park, Daewoog Nam, Sangsoo Kim, Sae Hwan Chun, Hyojung Hyun, Kyung Sook Kim, Pavol Juhas, Emil S. Bozin, Ming Lu, Changyong Song, Hyunjung Kim, Simon J. L. Billinge and Ian K. Robinson (2019)