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Latency Dose Formation In DMC By Inelastic Electron Scattering

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Recent advancements of detection techniques in electron microscopy [1] enable approaching the ultimate detection limit while exploiting time resolution by operating with beam currents below 50 femto Amperes [2] or by using pulsed electron sources.[3] The TEAM I microscope is uniquely suited for such experiments because it features a Cc corrector, a Nelsonian illumination scheme, and direct electron detectors.[1] It is used here to address the long standing puzzle how it is possible to control beam-sample interactions well enough to reveal relevant catalytic processes in electron microscopy. A first step in this direction requires a better understanding of the decay of diffraction intensity with dose accumulation where contradicting reports exist. For example, radiation damage to soft matter is commonly modeled to be strictly exponential [4] while earlier investigations of this subject revealed the existence of a latency dose [5], which cannot be explained in this manner. The existence of a latency dose, however, is remarkable because it reveals that recording parameters exist that do not lead to a loss of diffraction intensity with dose accumulation, which is a typical feature of radiation hard materials.

The decay of Bragg intensities in gallium nitride (GaN) and high-density polyethylene (HDPE) are studied to provide benchmarks for the behavior of radiation soft and radiation hard matter in ultra-low dose conditions as shown in Figure 1. Further, a cobalt zinc double metal cyanide catalyst (DMC) was chosen for this study because platelets of the material can be grown with a well-defined single crystal structure and thickness that are inert to air exposure. As a result, repetitive measurements of different crystals exhibit a relatively low scatter of the experimental data, which enables studying the formation of a latency dose as shown in Figure 2. In this talk we describe how inelastic electron scattering triggers time-temperature-transformations that are traditionally approximated by Avrami equations.[6] If applied, excellent agreement can be achieved with the experiments of Figure 2, which explains the formation of a latency dose by energy consumption during phase transformations.[7]

References

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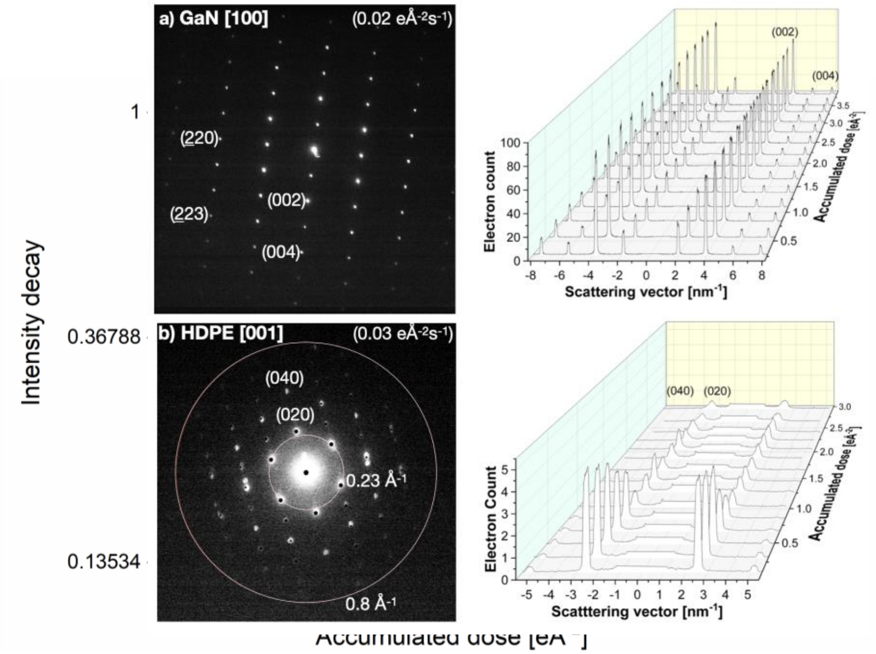

Figure 1: Decay of Bragg intensities from GaN and HDPE in ultra-low-dose conditions. Electron counts reach single digits.

Figure 2: Decay of Bragg intensities with dose accumulation in GaN, HDPE, and DMC. Avrami equations describe the data (solid lines). Data scatter from 10 measurements of DMC is indicated.