

Experiment Brief

OneView IS Camera

Title

Recording atomic-scale crystal nucleation and growth dynamics.

Gatan Instrument Used

The OneView[®] IS camera is the fastest and highest performance fiber-coupled Gatan camera, displaying and saving 16 MP images to disk at up to 25 fps to **observe dynamic details during *in-situ* TEM experiments.**

Background

Nucleation and growth of crystals through self-organization of atoms or molecules are fundamental to a wide range of science and technology applications and have been studied for decades. Still, experimental observation of these processes at the atomic scale remains challenging. One promising approach for capturing the emergence of crystal nuclei is to contain the nucleating species within carbon nanotubes (CNT), thus constraining their position during nucleation and subsequent growth. *In-situ* transmission electron microscope (TEM) techniques can then be applied to capture dynamics in real-time with the highest possible spatial resolution.

Materials and Methods

An aggregate of aminated conical CNTs was soaked in aq. NaCl and dried in vacuo at room temperature. This sample was then observed in an image-corrected JEOL JEM-ARM200F operated at 80 kV with a dose rate of 4,000 e⁻/Å²/s. Data was continuously recorded using a OneView IS camera at 25 fps and 2048 x 2048 pixels.

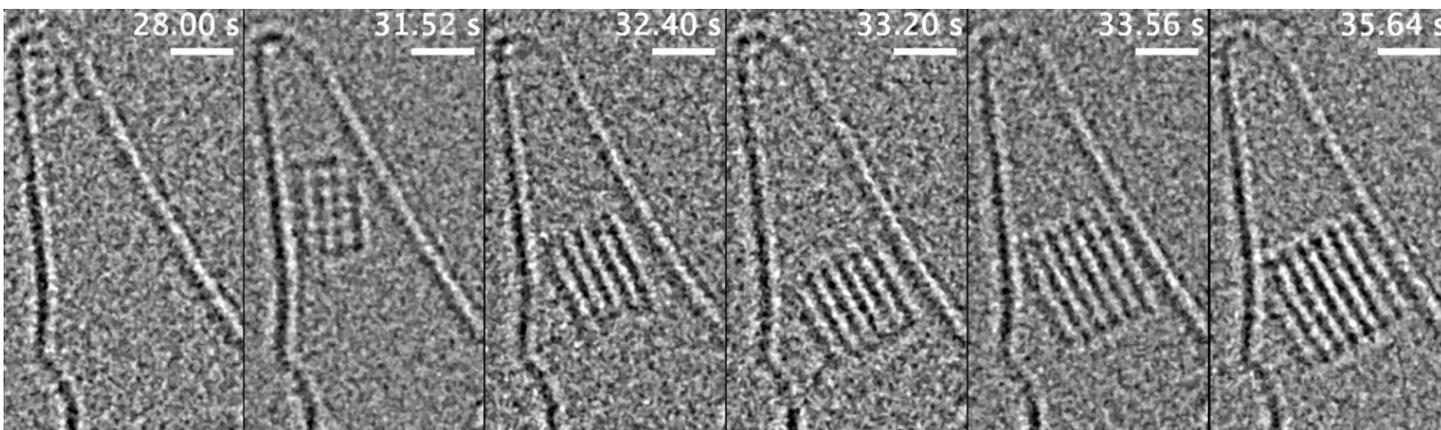


Figure 1. Six frames from a 132 s video, showing nucleation and growth of a single NaCl nanocrystal. The full video which covers the nucleation and growth of 9 crystals can be found on YouTube (<https://www.youtube.com/watch?v=SK6PCVPja8>).

Summary

Repeated nucleation and growth of NaCl nanocrystals were observed in a single conical CNT during one continuous *in-situ* video acquisition. This was published recently in JACS: Nakamuro, T. et al. J. Am. Chem. Soc. 2021 (<https://pubs.acs.org/doi/10.1021/jacs.0c12100>). Data from the third nanocrystal in the video is shown in Figure 1, where 6 of the 3300+ individual frames are shown. The full video records the formation of 9 nanocrystals over 132 s and can be found [here](#). The researchers measured the cross-sectional area of the NaCl crystallite from the *in-situ* video frames, finding stochastic variation in the measured size during nucleation, followed by largely quantized values during growth. Detailed measurements were made possible by the capture of high-quality image frames with the fast camera and constrained position of the nanocrystal within the CNT. Since the process repeated 9 times during a single video, both the average nucleation time as well as the variation in nucleation times could be determined.

Credit(s)

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Gatan, Inc. is the world's leading manufacturer of instrumentation and software used to enhance and extend electron microscopes—from specimen preparation and manipulation to imaging and analysis.

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