In-situ Analysis of Nucleation Processes of Sodium Chloride by Atomic-resolution Electron Microscopy

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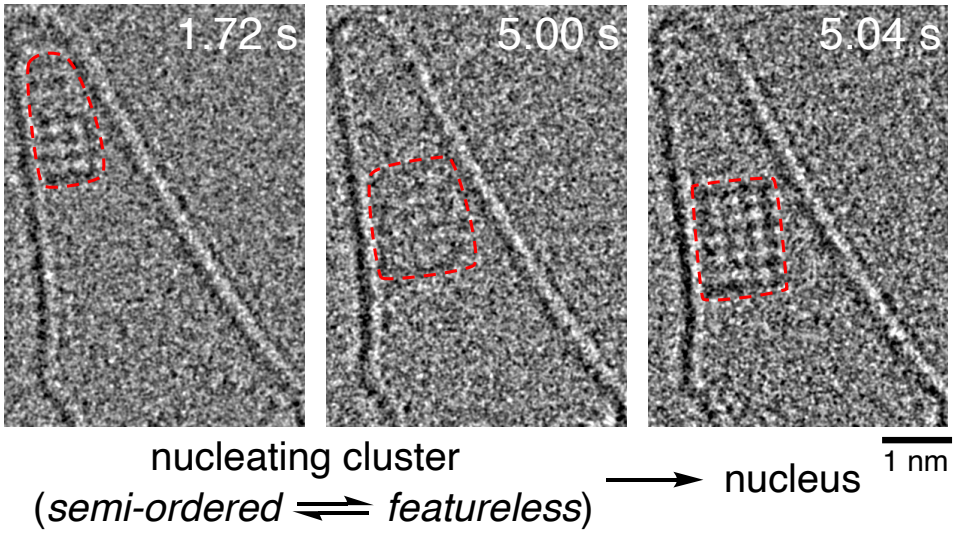
Nucleation, the early stage of crystallization, is important in a variety of fields[1] since it determines the properties of the crystals formed. Although a large number of researches have been conducted in this field, atomic-scale mechanism of nucleation has not been analyzed in detail because of the stochasticity of the process itself. Based on this situation, here we demonstrate in-situ observation of nucleation processes of sodium chloride (NaCl) in a nano-space of a conical-carbon nanotube (CNT) by single-molecule atomic-resolution real-time transmission electron microscopy (SMART-EM).[2]

Under SMART-EM observations, the emergence of NaCl crystal nuclei (at 5.04 s) from NaCl clusters formed at the tip of the CNT were recorded as shown in following images (NaCl clusters are highlighted with red lines). Moreover, it was revealed that the clusters prior to the phase transition were fluctuating between featureless (e.g. 5.00 s) and semi-ordered state with crystal-like periodicity (e.g. 1.72 s). This result strongly suggests that the structural dynamics of a nucleating cluster is crucial factor in crystal nucleation process as well as the size of the cluster discussed in classical nucleation theory.[3]



1) H. Li, C. Y. Sun, Y. Fang *et al. Nat. Commun*. **2020**, *11*, 5792. 2) E. Nakamura, *Acc. Chem. Res.* **2017**, *50*, 1281. 3) S. Karthika, T. K. Radhakrishnan, P. Kalachelvi, *Cryst. Growth Des.* **2016**, *16*, 6663.