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TEM observation of dissolution process of sodium chlorate nanocrystals

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Recent years, we are focusing on nanometer scale live imaging of nucleation and dissolution of crystals in a solution using transmission electron microscope (TEM) to know the fundamental processes. Since, basically, high-vacuum environment has to be maintained in the TEM during the observation, sample is limited. To overcome the difficulties to introduce a solution into a TEM, very ingenious graphene cell or specially designed amorphous silicon nitride membrane has been established and achieved in situ observation of nucleation [e.g., 1-4]. As the results, several new perspectives such as, non-classical nucleation pathway, coalescence and oriented attachment, in the nucleation process have been reported. Against the use of liquid cell, we used ionic liquid as a solvent instead of water to avoid evaporation of a solvent in the high-vacuum of a TEM [5]. Ionic liquids have a great properties for TEM observation, such as negligible vapor pressure and high electrical conductivity. As the result, following new consequences were found after experiments of sodium chlorate nanocrystals.

1. Solubility-independent formation of polymorph.
2. Crystals do not dissolve smoothly but in a fluctuating manner.
3. New crystals form even in a totally dissolving system.
4. Ripening occurs but different from Ostwald ripening.

In case of Ostwald ripening, initially presenting larger particles grow as a result of dissolution of smaller particles. However, our observation shows that ripening occurs with accompanying formation of new crystals, i.e., most of the initial crystals is replaced by new crystals. In the presentation, we will show the difference of the dissolution process between in ionic liquid and water solutions, which can be observed by a special holder having a liquid cell for TEM observation.

References

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