Crystallization, reentrant melting, and resolubilization of virus nanoparticles

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Crystallization is a fundamental and ubiquitous process that is well understood in the case of atoms or small molecules, but its outcome is still hard to predict in the case of nanoparticles or macromolecular complexes. Controlling the organization of virus nanoparticles into a variety of 3D supramolecular architectures is often done by multivalent ions and is of great interest for biomedical applications such as drug or gene delivery and biosensing, as well as for bionanomaterials and catalysis. In this presentation, we show that slow dialysis, over several hours, of wild-type Simian Virus 40 (wt SV40) nanoparticle solution against salt solutions containing $MgCl_2$, with or without added NaCl, results in wt SV40 nanoparticles arranged in a body cubic center crystal structure with Im3m space group, as a thermodynamic product, in coexistence with soluble wt SV40 nanoparticles. The nanoparticle crystals formed above a critical $MgCl_2$ concentrations. Reentrant melting and resolubilization of the virus nanoparticles took place when the $MgCl_2$ concentrations passed a second threshold. Using synchrotron solution X-ray scattering we determined the structures and the mass fraction of the soluble and crystal phases as a function of $MgCl_2$ and NaCl concentrations. A thermodynamic model, which balances the chemical potentials of the Mg^{2+} ions in each of the possible states, explains our observations. The model reveals the mechanism of both the crystallization and the reentrant melting and resolubilization and shows that counterion entropy is the main driving force for both processes [1].

Figure

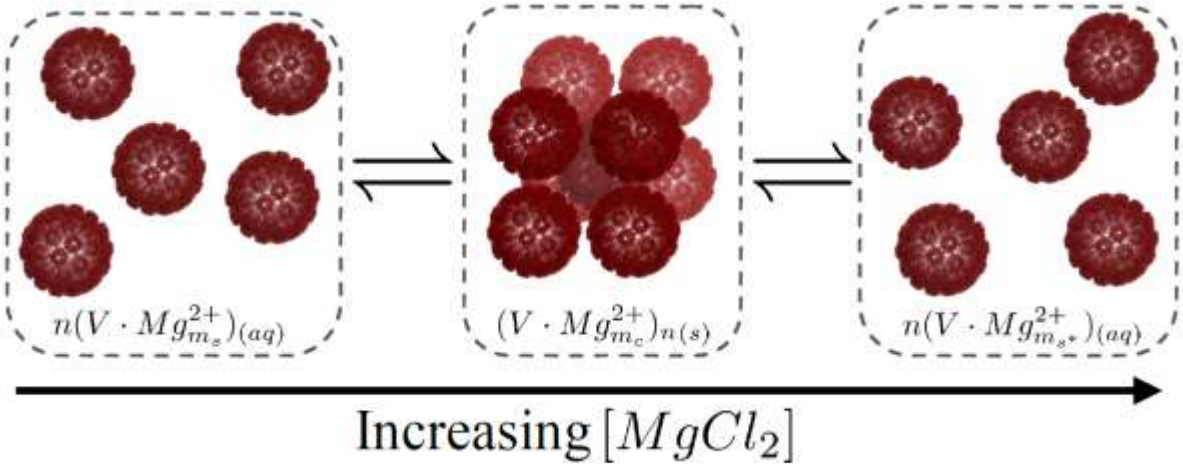

Figure 1. Effect of increasing $MgCl_2$ concentration on wtSV40 crystal formation and resolubilization

Reference

[1] R. Asor, O. Ben-nun Shaul, A. Oppenheim, and U. Raviv, ACS Nano, 11, 9814-9824, 2017.