

Keynote lectures

KN-1 Colloids in the spotlight - watching crystal-crystal transitions in real time and real space

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Colloids have frequently been used as attractive model systems to study processes such as nucleation and crystal growth, melting, or crystal-crystal transitions. The nature of solid-solid phase transformations has indeed been a long-standing question in areas such as metallurgy and condensed matter physics. They are not only interesting from a fundamental science viewpoint, but have many applications in materials. However, despite their importance and the numerous investigations existing, we still lack a deep understanding of the micro-structural changes and the underlying kinetic mechanisms. Here I will show that we can use thermoresponsive colloids as an ideal model system to study such phase transitions using confocal laser scanning microscopy, and achieve exquisite control over the relevant thermodynamic variables. In particular the application of an external electric field allows us to carefully tune the resulting interparticle interactions such that we can cycle through the complex phase diagram of these systems. This allows us to probe crucial features of phase transitions: kinetics of phase change in both forward and reverse directions, reversibility and irreversibility, and the stability of arrested states. We see path-dependent crystal-to-crystal phase transition kinetics with both diffusive and martensitic transformations controllable via an external electric field, and we observe kinetic arrest, with the time to transit to the equilibrium phase controllable via temperature. We believe that these two path dependent transitions provide a first direct evidence of colloidal analogues of diffusive and martensitic transformation respectively in a single 3-dimensional system.

Keywords: colloid crystals, crystal-crystal transition, diffusive transformation, martensitic transformation

KN-2 Exploring crystalline molecular materials at high pressure

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Over the course of the past two decades, the number of high-pressure crystallographic studies on molecular materials reported in the literature has been increasing at an exponential rate. One of the reasons behind this surge is certainly the increasing ease with which these studies can be performed in the home laboratory and at large-scale facilities. Besides technology advances, the scientific community has realised that pressure is a powerful thermodynamic variable that allows modifying the structure, bonding and reactivity of all matter, *including molecular compounds*. High-pressure structural studies on such materials have managed to catch the attention and imagination of crystallographers and material scientists world-wide, opening up innumerable opportunities across several natural sciences disciplines. This is demonstrated by the observation that high-pressure crystallography is currently an integral part of several multidisciplinary research programs that aim at exploring and understanding the structure and property of molecular materials.

After a brief overview of recent and current trends in the field, I shall focus on a number of case studies, primarily involving molecular *organic* compounds. The aim here is to demonstrate the rich structural landscape that can be obtained when high-pressure crystallography and crystal growth techniques are combined with ambient-pressure studies. The examples will cover a range of topics, including a) "classical" high-pressure structural studies, *e.g.* studies of intermolecular interactions and of phase transitions but also of more exotic phenomena such as pressure-induced hydration, and b) practical applications of high-pressure techniques in the pharmaceutical industry.

Keywords: high pressure, polymorphism, molecular compounds, pharmaceuticals, crystallisation