Bright insights into the nanoworld

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Structures of the scales from a nanometre to several microns are playing an increasingly important role in modern research. They are at the heart of nanomaterials and soft matter. Synchrotron radiation is able to provide crucial insights into the nanoscale structures, which can be gained in-situ and time-resolved.

One of the unmissable pillars of nanomaterials is quantum dots, i.e. semiconductor nanoparticles that are so tiny that their size strongly affects their properties. The discovery of synthesis routes to produce monodisperse quantum dots in the 80s and 90s was recently crowned by the 2023 Nobel Prize in chemistry. These pioneering works led to the development of a broad and active research field. By now, a broad spectrum of nanoparticles of different composition, size and shape can be produced and studied. I will illustrate some insights into the nanoparticle synthesis, which can be provided by synchrotron radiation.

The central concept in nanomaterials and soft matter is self-assembly, i.e. spontaneous organisation of nanometric building blocks into certain structures. This process and the resulting structure depend on the amount of space available for the Brownian motion, the shape of the building blocks, the presence of weak attractive or repulsive interactions between them, as well as external stimuli or fields. By playing with these parameters, one can create many new materials, most of which do not exist in nature and have unprecedented electric, magnetic, optical, and/or mechanical properties and, therefore, are interesting for many applications. The self-assembly of nanometric units is also often seen as a model of similar processes occurring in atomic systems. Several examples of synchrotron studies of the self-assembly process and the resulting structures will be discussed.

Finally, a brief discussion of the effect of the EBS upgrade of the ESRF for nanomaterials and soft matter research will given.