

Using drops to structure materials

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Drops are well-suited templates to produce nanoparticles of a defined size, shape, and composition. For example, they are often used to produce powders in the food and pharmaceutical industries through spray drying. In this case, the size of drop is adjusted to tune the size of the spray-dried particles. In addition, drops can be used to control the structure of these particles by tuning the evaporation rate of the solvent. If drops are made sufficiently small, such that they have a high surface-to-volume ratio and therefore dry very quickly, they can even produce amorphous particles from materials that have a high propensity to crystallize. In this talk, I will present a microfluidic spray drier that produces 300 nm diameter drops, which are surrounded by air that flows at supersonic speeds. These drops dry so quickly that crystallization of solutes, contained in the drops, is kinetically suppressed. Hence, the resulting spray-dried particles are amorphous even in the absence of any crystallization inhibiting additives. This is particularly beneficial for the formulation of hydrophobic substances, such as many newly developed drugs or certain food additives, whose bioavailability is limited by their slow dissolution rates and low solubility. In addition, drops dry so quickly that they allow rapid quenching of chemical reactions. This rapid quenching enables studying early stages of the formation of materials with a high simultaneous spatial and temporal resolution, and offers the possibility to generate materials with unusual properties.