Centre de Nanosciences et de Nanotechnologies

Séminaire

Vendredi 20 octobre 2017

11h00 – C2N, Site Marcoussis (R. Planel)

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"Exploring the formation of nanomaterials in liquids through direct imaging"

Abstract

Nanostructures can be defined and formed through "bottom-up" processes such as assembly of nanoscale bodies or "top-down" processes such as nanoscale etching. Many of these processes, which are fundamental for materials engineering and fabrication of functional nanodevices, such as assembly of nanoparticles and chemical etching of nanoscale architectures are done in a liquid environment.

Using dynamic *in situ* TEM imaging [1-3] in liquids, I will describe how nanoparticles form in solution and how these nanoparticles interact with each other. First, I will discuss how phase separation of a solution containing Au ions into solute-rich and solute-poor phases leads to the formation of Au nanocrystal through a pathway that does not follow classical nucleation theory (CNT). Namely, I will show that multiple steps lead to the formation of nuclei from which nanocrystals grow [4]. These steps are: 1) phase separation of a liquid solution into solute-poor and solute-rich phases, from which 2) amorphous nanoparticles which serve as a precursor for nuclei emerges. This is followed by 3) crystallization of these amorphous nanoparticles into crystalline nuclei.

Next, I will highlight the role of intermolecular forces between nanoparticles in solution and describe their role in the assembly of nanostructures from individual nanoparticle building blocks (bottom-up approach) [5]. Specifically, I will show how the balance between repulsive hydration force and attractive van der Waals (vdW) force results in a metastable nanoparticle-pair which promotes their subsequent attachment to each other [5].

Finally, I will conclude by describing our recent work where we track the nanoscale dynamics of wet-etch (top-down approach) processes to shape semiconductor nanomaterials where, through direct imaging, we revealed the intermediate stages of Si wet-etch.

These findings highlight the role of solvent-mediated physical and chemical forces in material synthesis and self-assembly of nanoparticles. Our observations also emphasize the importance of direct nanoscale observation in uncovering previously unknown intermediate states that are pivotal for synthesis and self-assembly.

References:

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