Approaches to self-assembly of colloidal monolayers: A guide for nanotechnologists

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Approaches to self-assembly of colloidal monolayers: a guide for nanotechnologists

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Abstract

Self-assembly of quasi-spherical colloidal particles in two-dimensional (2D) arrangements is essential for a wide range of applications from optoelectronics to surface engineering, from chemical and biological sensing to light harvesting and environmental remediation. Several self-assembly approaches have flourished throughout the years, with specific features in terms of complexity of the implementation, sensitivity to process parameters, characteristics of the final colloidal assembly. Selecting the proper method for a given application amidst the vast literature in this field can be a challenging task. In this review, we present an extensive classification and comparison of the different techniques adopted for 2D self-assembly in order to provide useful guidelines for scientists approaching this field. After an overview of the main applications of 2D colloidal assemblies, we describe the main mechanisms underlying their formation and introduce the mathematical tools commonly used to analyse their final morphology. Subsequently, we examine in detail each class of self-assembly techniques, with an explanation of the physical processes intervening in crystallization and a thorough investigation of the technical peculiarities of the different practical implementations. We point out the specific characteristics of the set-ups and apparatuses developed for self-assembly in terms of complexity, requirements, reproducibility, robustness, sensitivity to process parameters and morphology of the final colloidal pattern. Such an analysis will help the reader to individuate more easily the approach more suitable for a given application and will draw the attention towards the importance of the details of each implementation for the final results.

Keywords

Colloidal self-assembly; colloidal monolayer; binary colloids; self-assembly set-ups; self-assembly apparatuses