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A Robust Worm-like micellar Template Based Method for the Synthesis of Anisotropic Nanoparticles

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Abstract

Wormlike micelles (WLMs) are a special class of surfactants, which due to their peculiar morphology (semi-flexible polymer like), provide an exciting template for synthesis of nanoparticles. In this work, a robust method for synthesis of nanorods, assisted by the templating effect of the WLMs, as well as specific magnetic or electrical dipolar interaction between the particles, is provided. Thereby, nanorods of a variety of materials such as semiconductors, metal halides, magnetic and photovoltaics are synthesized using this method. The generality of this method is established by the use of both cationic and anionic surfactant systems. The method shows a good yield of nanorods when the viscosity of the worm-like micellar phase is reduced. It appears that spherical nanoparticles, assisted by the templating effect of the WLMs, self-assemble into chains, which fuse together by interparticle interaction to yield well formed nanorods. This establishes the method as a fairly reproducible and straight-forward method of synthesizing nanorods, albeit in certain classes of materials.

Keywords: Nanorods, Worm-like micelles, Dipole moment, Surfactant.

1. Introduction

Hierarchical nanostructures, formed by the self assembly of small nanoparticles, continue to attract attention because of their novel properties and applications [1]. Self assembly involves the arrangement of nanoparticles or building blocks in ordered structures because of specific direct interactions or indirectly, through the environment [2]. Typically, templates such as surfactant micelles [3–5], proteins [6, 7], polymers [8], etc. have been used for self assembling the nanoparticles into specific nanostructures.

One of the most commonly used templates for nanoparticle synthesis are self-assembled surfactant molecules that yields structures of different sizes and shapes [9]. Amongst these structures, worm-like micelles have been the focus of recent attention since their behavior is similar to polymers and these exhibit signatures of Maxwellian rheology [10]. Worm-like micelles are long cylindrical chains formed by a mixture of surfactants with organic or inorganic salts. Our previous works demonstrated that worm-like micelles can be used as a template for the synthesis of anisotropic nanoparticles with silver halide nanorods as a model system [11]. More recently we also demonstrated formation of

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