Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C3-015

Engineering gyroid-structured functional materials via templates discovered in nature and in the lab

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In search of optimal structure for functional materials fabrication, the gyroid (G) structure has emerged as a promising subject of widespread research due to its distinct symmetry, 3D interconnected networks and inherent chiral helixes. In the past two decades, researchers have made great progress in fabricating G-structured functional materials (GSFMs) based on G templates discovered both in nature and in the lab. The GSFMs demonstrate extraordinary resonance when interacting with light and matter. The superior properties of GSFMs can be divided into two categories based on the dominant structural properties of G structure, namely dramatic optical performances dominated by the short-range symmetry and well-defined texture, and effective matter transport subjected to the long-range 3D interconnection and high integrity. Since most of the G systems are made up of organic components with limited applications, research interests focus on combining knowledge about these organic G systems with the functionality of solid-state materials to generate novel hierarchical and multifunctional hybrid materials. The choosing of proper G templates is a key step determining the successful fabrication of GSFMs. Therefore, in this review, we will firstly give a detailed classification of G templates available for fabrication of functional materials. And then we will put an emphasis on the state-of-the-art achievements of optical applications of GSFMs originated from efficient light-matter interaction, including photonic band gap materials, chiral materials and plasmonic materials in State Key Lab of Metal Matrix Composites, Shanghai Jiao Tong University in the past five years. Finally, some major challenges that may hinder the final applications of GSFMS and possible solutions will be thoroughly discussed.

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