Chemical Routes to the Production and Modification of Photonic Band Gap and Related Materials

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Abstract

Although the basic chemistry required for the production of simple colloidal spheres of say SiO_2 or polymer has been known for many years, if such spheres are to be assembled into photonic band gap materials then the chemical processes governing their formation and in particular their surface functionalisation must be considered very carefully. This talk will present results for the production of novel photonic band gap materials based on silica and polymer- based colloidal epitaxy, i.e. the process by which the photonic crystal is formed, and will include results for dye-loaded systems, systems containing metallic and semiconducting nanoparticles, controlled evaporation methods for self-assembly and systems where Langmuir-Blodgett (LB) self-assembly methods for the fabrication of homo and heterostructure photonic crystals prepared using size-matched sets of different particles. It is demonstrated that the LB approach, while producing high-quality photonic crystals in a highly controlled layer-by-layer fashion, does not actually produce true opal structures since the films formed do not possess the full fcc structure.

Additionally, once formed these materials may then be modified by chemically altering their refractive index contrast. We have achieved considerable success in this area and as such the use of novel CVD and ALD methods will be described, focussing on the production of materials infilled with InP, GaP, Ge and GaAs. From these systems, some high quality semiconducting inverse opal structures have been formed. Finally, time permitting, some very novel uses of opaline systems in related aspects of materials science will be described.