Study of Nanoparticle/Polymer Composites: I) Microstructures and Nonlinear Optical Solutions Based on Single-Walled Carbon Nanotubes and Polymers and II) Optical Properties of Quantum Dot/Polymer Composites

Caroline Woelfle

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Chemical Engineering

Richey M. Davis (Chair)
Richard O. Claus (Co-Chair)
Garth L. Wilkes
Amadeu K. Sum

March 31st, 2006
Blacksburg, Virginia

Keywords: Single-Walled Carbon Nanotubes, Dendrimer, Quantum Dots

Study of Nanoparticle/Polymer Composites: I) Microstructures and Nonlinear Optical Solutions Based on Single-Walled Carbon Nanotubes and Polymers and II) Optical Properties of Quantum Dot/Polymer Composites

Caroline Woelfle

ABSTRACT

The overall research theme of this dissertation was the study of nanoparticle/polymer composites. Two types of nanoparticles were utilized: Single-Walled Carbon Nanotubes and quantum dots. Chapter 1 of this thesis comprises an extensive literature review on Carbon Nanotubes, which presents theoretical aspects relevant to the structure and properties of CNTs, methods of purifying and solubilizing CNTs in aqueous and organic solvents and selected applications. This literature review is followed by the study and comparison of the optical limiting performances of different Single-Walled Carbon Nanotubes/conjugated polymer dispersions (Chapter 2). The results obtained are discussed in terms of dispersion of the SWNTs in the polymer solutions and resulting SWNT bundle diameters. Chapter 3 presents the spontaneous assembly of dendrimer patterns induced by SWNTs. Finally, chapter 4 presents a new method for fabricating quantum dot/polymer composites, which uses the extraction of positively charged quantum dot into a hydrophobic liquid. The resulting solution is used as a compatible polymerization medium for poly(methylmethacrylate) networks enabling the formation of transparent and fluorescent composites.