SUMMARY OF Ph.D. DISSERTATION

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Title

Design and Characterization of Novel Photocontrollable Nanoparticles

Abstract

Optically-switchable magnetic materials are becoming increasingly important in the field of high-density information storage media. I have been trying to prepare new types of magnets in which the magnetic properties can be controlled with photo-illumination. Although I have demonstrated several photo-controllable magnetic systems, the maximum successful efficiency demonstrated so far for the photo-switching of magnetization is ca. 10 %. If the electronic states of the constituent metal ions in magnetic compounds could be directly changed by redox reactions under photo-illumination, the magnetic properties could be perfectly photo-controlled like an on/off switch.

In order to create such on/off photo-switchable magnetic materials, we have designed a novel type of photo-controllable magnetic nanoparticles that combine photoconductive semiconductor CdS and magnetic material Prussian blue (PB) using reverse micelle as nanoreactor. The composite nanoparticle showed ferromagnetic behavior below ca. 4 K before illumination. The magnetization in the ferromagnetic region was substantially decreased after UV light illumination at 2 K, and could almost be restored to its original level by thermal treatment at room temperature. Furthermore, a hysteresis loop was observed before illumination at 2 K. Then, the hysteresis disappeared after UV light illumination at 2 K. The disappeared hysteresis loop restored after thermal treatment at room temperature. These results suggest the mechanism of photo-switchable magnetization that the photo-induced electron transfer between CdS and PB in the reverse micelle changed the magnetic properties of composite nanoparticles from ferromagnetic to paramagnetic. That is, the electronic state of PB changes from Fe^{II}-CN-Fe^{III} to Fe^{II}-CN-Fe^{II} by photo-induced electron transfer.