ハロイサイトナノチューブの利用による機能性高分子複合材料の設計

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Design of Functional Polymer Hybrid Materials Based on Halloysite Nanotube

Recently, tubule halloysite clay has garnered a great interest in material science due to its versatile features of large surface area, high porosity, and tunable surface chemistry which enabled this nanomaterial to be utilized for entrapment of active agents, and as a nanofiller for polymers. Halloysite nanotubes (HNTs) comprise naturally occurring aluminosilicate nanotubes with a 1:1 Al:Si ratio and a stoichiometry of Al$_2$Si$_2$O$_5$(OH)$_4$•nH$_2$O. Generally, HNTs have a 15 nm lumen with 30-50 nm external diameter and length of around 1 μm. HNTs consist of gibbsite octahedral sheet (Al-OH) groups on the internal surface and siloxane groups (Si-O-Si) on the external surface, which have been successfully bifunctionalized for the sustained drug and flame retardent release.

The purpose of study is to prepare functional polymer hybrid materials based on naturally occurring HNTs and investigate their applications for hybrid electrospun fibers, water purification and drug loading/release. This thesis deals with three main topics: (1) inorganic nanotube induced chain orientation in poly(glycolic acid)/halloysite nanotube hybrid electrospun fibers, (2) adsorption behavior of dyes from aqueous solution on halloysite nanotubes/polyelectrolyte hybrids, (3) design of inorganic drug nanocarriers based on selectively modified halloysite nanotubes.

General introduction is given in Chapter 1.

Chapter 2 concerns with the preparation and characterization of hybrid electrospun fibers, mainly focusing on the chain orientation behavior of PGA/HNT hybrid aligned fibers. Polarized FT-IR and 2D-WAXD measurements are carried out to characterize hybrid fibers in an attempt to correlate the chain orientation behavior of PGA and HNT loading.

In Chapter 3, HNTs/cationic polyelectrolyte hybrids are prepared for overcoming the drawbacks of HNTs for water purification, and the effects of adsorbent dose, initial concentration and temperature for dye adsorption are examined and the adsorption mechanisms are studied in details.

In Chapter 4, HNTs surface is modified by polysulfobetaine brushes via surface initiated atom transfer radical polymerization (SI-ATRP) and the lumen is modified by hydrophobic monolayer to generate a selectively modified drug carrier. The modified HNTs are characterized by XPS, FT-IR, TGA and the drug loading/release mechanism is proposed as well.

Finally, concluding remarks are given in Chapter 5.