UNIVERSITY of HOUSTON

TcSUH

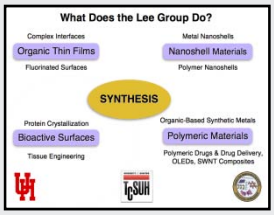
Nanoparticles, Polymeric Materials, and Nanoscale Organic Thin Films

Dr. T. Randall Lee

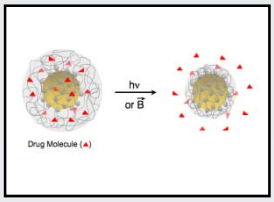
Cullen Distinguished Professor of Chemistry
Texas Center for Superconductivity and Departments of Chemistry and Chemical Engineering

Current Projects/Achievements:

NANOPARTICLES



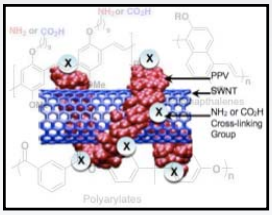
Magnetic and Light-Absorbing Nanoparticles: Due to their ultra-small dimensions, metal nanoparticles interact with magnetic fields and/or photons through unique mechanisms. Our group synthesizes a variety of these nanomaterials, with an emphasis on magnetic nanoparticles having controllable sizes, morphologies, and tunable magnetization, where the potential applications range from high density data storage to biomedical applications. Other projects target the synthesis and study of bimetallic nanoparticles having strong plasmon absorptions in the near IR region, which makes them attractive for use *in vivo* as diagnostic and therapeutic nanomaterials. Related projects explore the use of hydrogel-coated nanoparticles for use as discrete nanoscale drug-delivery agents.



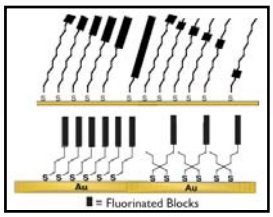
Hydrogel-coated metal nanoparticles for drug delivery ***in vivo***

POLYMERIC MATERIALS

High-Strength Nanotube Composites and Optoelectronics: Efforts to incorporate single-wall carbon nanotubes (SWNTs) into polymeric materials to achieve structural reinforcement remains an ongoing challenge. In particular, strategies that utilize covalent sidewall functionalization of the SWNTs are flawed because these processes introduce defects into the nanotubes that lead to diminished structural and electrical properties. Taking a different approach, our group utilizes highly conjugated polymers (e.g., PPVs) as non-covalent compatibilizers of SWNTs. Further, we modify the PPV-based compatibilizers so that they contain cross-linking groups (e.g., amines or carboxylic acids) designed to anchor the SWNT-PPV conjugates to various polymers commonly used as structural materials (e.g., nylons, polyesters, and polycarbonates). Other projects seek to develop novel conjugated polymers and various nanoparticle-doped conjugated polymers for use as long-lived emissive layers in organic light-emitting diode (OLED) devices.



PPV-wrapped single-walled carbon nanotubes for reinforced composites



Nano-Teflon coatings for corrosion prevention, lubrication, and adhesion-resistant bio-implants

NANOSCALE ORGANIC THIN FILMS

Nanoscale Teflon and Advanced Coatings: Our research utlizes organic synthesis and self-assembled monolayer (SAM) technology to prepare nanoscale fluorocarbon-based coatings (i.e., nanoscale Teflon®) for use as protectants and/or lubricants in nanoscale devices and as inert coatings for biomaterial applications. Related studies target the design and synthesis of chelating adsorbates for use in the generation of highly stable thin-film coatings. Our research further explores the development of new types of adsorbates for the purpose of generating structurally and compositionally well defined surfaces that expose a mixture of functional groups that can be designed to elicit specific molecular recognition (e.g., sensor devices) and/or catalysis (e.g., artificial enzymes). Studies of biologically active interfaces utilize SAMs to enhance the growth of protein crystals and to template cell adhesion and proliferation for applications in tissue engineering.

Personnel

Postdoctoral Fellows: Dr. Wei Wang and Dr. Kim Nam Hoon
Graduate Students: 15 Ph.D. (CHEM), 1 Ph.D. (CHEE), 1 Ph.D. (BCHM)
Undergraduates: 4 B.S. (CHEM), 1 B.S. (BIOL)

Resources

Ellipsometer for measuring the thickness of monolayer films.
Contact angle goniometer for measuring interfacial wettability.
Infrared reflection-absorption spectrometer for analyzing thin films.
Gel permeation chromatograph (GPC) for measuring polymer molecular weights.
Nitrogen dry box for handling of moisture and air-sensitive materials.
Various specialized equipment for organic and inorganic materials synthesis.