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從"科學至科學"演進"科學至社會"







2. 研究成果

奈米材料及其混成/複合型之組建





元件/感測器/系統含分層結構



3. Representative investigations within recent three years

Chemical and Bio-modulation Approaches for Gold Nanoparticles: Syntheses and Properties of Anisotropic to Plasmonic/luminescent **Particles**

Anisotropic gold nanostructures with "confeito-like shape" have been synthesized by a solution phase galvanic reaction or in a solution including fruit juice. The nanostructures are uniform in shape and size (~300 nm). These nanostructures possess smaller-sized protuberances (diameter ~30 nm, length ~40 nm) in large numbers, which are protruding from the body. An ultravioletvisible absorption spectrum shows surface plasmon bands at 320, 415, and 530 nm and a broad absorption band extending from 650 nm to near-infrared region. These nanostructures constitute an active substrate material for surface-enhanced Raman scattering, which was confirmed from representative experiments using rhodamine 6G as a probe molecule.





Surface Functionalization of Carbon Micro Coils, Their Selective **Immobilization on Substrates and Embedding in Polymer Matrix**

Carbon micro coil (CMC), one of carbon materials, is an amorphous material and exhibits properties of super-elasticity, electrical conductivity along the helical axis, and hydrogen adsorption. These distinctive characteristics of CMCs are thus valid as a highly attractive material and on applications as sensors and devices. We investigated the selective immobilization of CMCs on surface-modified and lithographically patterned silicon substrates. The selective and chemical anchoring of CMCs with high surface coverage was achieved on the amine-terminated surface and pattern. CMCs hybridized with poly(vinyl alcohol) (PVA) were homogeneously embedded in PVA matrix film. The presence of CMCs in the PVA film heightened the glass transition temperature of PVA. Moreover, overall mechanical and electrical properties of the PVA film were also enforced by embedding CMC.



Acid-treated CMC



Immobilized CMC



PVA esterification Acid-treated CMC Hybrid CMC hybrid CMC composite



β -cyclodextrin-modified TiO₂ and Ag-TiO₂ Core–shell Nanoparticles: Synthesis, Sensitizing of Pyrene Fluorescence and Photocatalytic Activity

TiO₂ nanoparticles were synthesized by hydrolysis of tetraisopropyl orthotitanate in an aqueous solution of β -cyclodextrin. Pyrene fluorescence was enhanced by increasing the concentration of β -cyclodextrin-modified TiO₂ nanoparticle and the sensitization effect was triply stronger than the case of β -cyclodextrin only due to the interaction of pyrene with an apolar cavity of β cyclodextrin and the charge transfer between pyrene and metal oxide nanoparticle, respectively. The β -cyclodextrin-modified Ag-TiO₂ core-shell nanoparticles were prepared by sodium borohydrate reduction of AgNO₃ and the subsequent hydrolysis of the tetraisopropyl orthotitanate in an aqueous medium. On the photodegradation of phenol by the ultraviolet light irradiation, the photocatalytic property of TiO₂ nanoparticles was enhanced, when the Ag nanoparticle was embedded in the core of TiO₂ nanoparticles. The mechanism is ascribed to the surface plasmon characteristics of Ag in the core of the TiO₂ nanoparticles under the acceleration by host-guest inclusion characteristics.



Visual Observation and Characterization of Fluorescent Poly(amido amine) Dendrimer in Film State: Visual Determination of Avidin-biotin Affinity

The visualization of fluorescent dendrimers is possible and indispensable for the utilization as an imaging agent. The selective electrostatic adsorption of fluorescent dendrimers was visually observed on the substrates with counter ionic pattern and hydrophobic pattern. An avidin molecule was labeled with 4.5th generation poly(amido amine) dendrimers through the amide chemical bond. It was confirmed by the observation of fluorescent dendrimers that avidins bound fluorescent dendrimers interact selectively with biotins immobilized on the patterned substrates. These results suggest that the photoluminescent dendritic polymers are valuable as biocompatible and chemically-stable fluorescent markers without quenching by oxygen.



Network of sodium hyaluronate with nano-knots junction of poly(amido amine) dendrimer

Amine-terminated poly(amido amine) (PAMAM) dendrimers have been attached to sodium hyaluronates (NaHAs) by a coupling reaction. The morphology of NaHAs was varied from the traditional network to the bead & string network, which gave rise to the decrease in viscosity of NaHAs. The bead & string network was more abundant for the covalent network complex than the noncovalent one. The beads, that is, the nano-knots of the network consist of the covalent-bonded NaHA/dendrimer composites, and the strings are NaHA chains. Beads shrank in size and strings decreased in number with decreasing a molecular weight of NaHA. The complexation of sodium poly-L-glutamates (NaPGAs) with PAMAM dendrimers was different in the manner from that of NaHAs with dendrimers. Flexible NaPGAs produced globular composites with dendrimers.



Macromolecular interaction in biology system

PAMAM dendron materials PAMAM dendron conjugated with two photon dye have been synthesized and investigate internalization behavior with cell. BG3, high generation PAMAM dendron, showed strong fluorescence on the cell membrane, indicating high affinity. Photo-damage on the cell membrane during live cell optical imaging, when HeLa cells were incubated with BG3, also indicated a high possibility of PAMAM dendron binding on the cell membrane during the uptake process.

Self-assembly of hexagonal lattice particles A hexagonal lattice in nano scale was constructed by an amphiphilic block copolymer and a porphyrin crystalline structure. The shape shows selective uptake efficacy for the HeLa and macrophage cells after 24 hour incubation. This discovery of selective uptake by macrophage can provide the foundation for designing a diagnosis and therapeutic nano agent application for cancer patients.



4. 歡迎參訪本研究室(T1-103) 或辦公室(TR1025,1024,1016)

