

Division of Synthetic Chemistry –Advanced Inorganic Synthesis–

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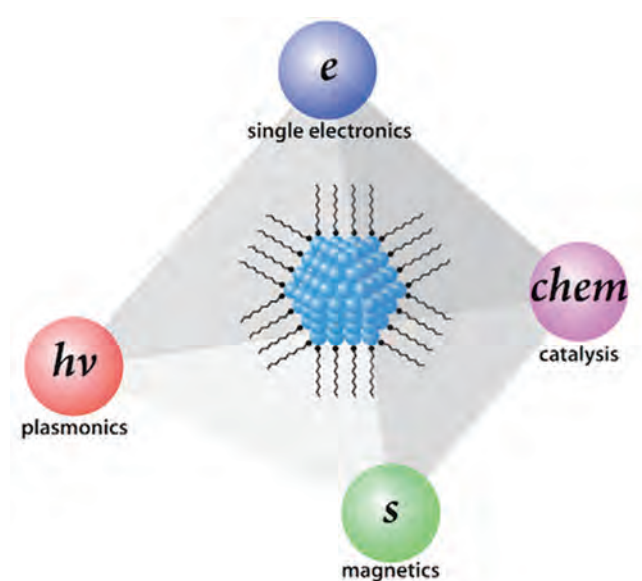
*Division of Synthetic Chemistry,
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Scope of Research

We are focusing on the precise synthesis of inorganic nanoparticles by controlling the primary (size, shape, composition, etc.) and secondary (spatial arrangement) structures to tune their properties, such as electron confinement, carrier oscillation, spin, and catalysis. These high quality inorganic nanoparticles are applied to both high-performance nanodevices (single electron transistor, plasmon waveguide, nanocomposite magnet) and photo-energy conversion materials (overall water splitting, solar cell).

KEYWORDS

Inorganic Nanoparticles
Single Electronics
Plasmonics
Nanocomposite Magnet
Photocatalysts



Selected Publications

- Teranishi, T.; Sakamoto, M., Charge Separation in Type-II Semiconductor Heterodimers, *J. Phys. Chem. Lett.*, **4**, 2867-2873 (2013).
Teranishi, T.; Inui, D.; Yoshinaga, T.; Saruyama, M.; Kanehara, M.; Sakamoto, M.; Furube, A., Crystal Structure-Selective Formation and Carrier Dynamics of Type-II CdS-Cu₃₁S₁₆ Heterodimers, *J. Mater. Chem. C*, **1**, 3391-3394 (2013).
Ikeda, T.; Xiong, A.; Yoshinaga, T.; Maeda, K.; Domen, K.; Teranishi, T., Polyol Synthesis of Size-controlled Rh Nanoparticles and Their Application to Photocatalytic Overall Water Splitting under Visible Light, *J. Phys. Chem. C*, **117**, 2467-2473 (2013).
Sakamoto, M.; Tanaka, D.; Teranishi, T., Rigid Bidentate Ligands Focus the Size of Gold Nanoparticles, *Chem. Sci.*, **4**, 824-828 (2013).
Eguchi, M.; Mitsui, D.; Wu, H.-L.; Sato, R.; Teranishi, T., Simple Reductant Concentration-Dependent Shape-Control of Polyhedral Gold Nanoparticles and Their Plasmonic Properties, *Langmuir*, **28**, 9021-9026 (2012).

Strongest π -Metal Orbital Coupling in a Porphyrin/Gold Cluster System

π -Metal coupling between the π orbital of a π -conjugated molecule and the metal orbital of a metal surface significantly modified the electronic structure of the molecule. The strength of the π -metal coupling was greatly affected by the molecular configuration on the metal surface and the distance between the molecule and the metal surface. A face-on and a close configuration of a π -conjugated molecule on the metal surface generated a strong interfacial interaction. An understanding of π -metal coupling at the interface between a π -conjugated molecule and a gold cluster is crucial for the development of various devices and materials such as single electron transistors and catalysts. SC_0P -coordinated gold clusters with the strongest known π -metal coupling were synthesized to investigate the interfacial interaction between the porphyrin and the gold cluster by UV-vis-NIR and transient absorption measurements. Spectroscopic investigations suggest that the strong π -metal coupling between the porphyrin and the gold cluster was in the ground state and an exciplex was formed upon photoexcitation.

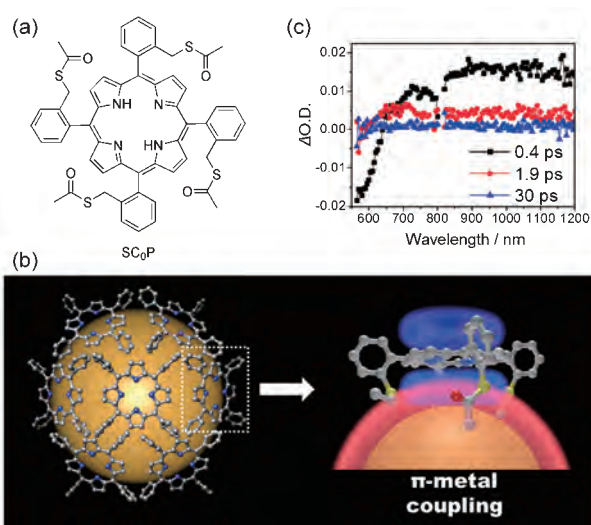


Figure 1. (a) Chemical structure of SC_0P . (b) Schematic illustration of SC_0P -coordinated gold cluster and π -metal coupling between the π orbital of a porphyrin and the metal orbital of a gold cluster. (c) Transient absorption spectra of SC_0P -coordinated gold clusters in DMF.

Structure Independent Photo-Induced Charge Separation in CdS/CdTe Heterostructured Nanopencils

Geometrical structure is a key to determining the properties of the semiconductor nanocrystals (NCs) because band structure and carrier dynamics of NCs are significantly affected by their size and shapes. Selective synthesis of NCs composed of two or more intrinsic chemical species tremendously expands the available geometrical structures and functions of NCs. Among them, the heterostructured NCs (HNCs) are promising nano-functional materials to the photo-electro conversion systems, sensors, and catalysts, etc. owing to the integration of independent functional units and/or efficient carrier transfer between the phases. Here, we synthesized novel anisotropically phase-segregated CdS/CdTe heterostructured nanopencils (HNPs) with precisely controlled anisotropic structure and CdS/CdTe volume, and investigated the relation between geometrical factors and the photo-induced carrier dynamics. The novel CdS/CdTe HNPs with type-II band alignment, in which the CdTe phases serve as light-absorbing layers, are successfully formed through an anion exchange of CdS nanopencils. Furthermore, the transient absorption measurement using fs-laser flash photolysis revealed that the geometry factors do not impact the charge separation rate in the present CdS/CdTe HNPs. This result provides us with an important insight necessary to design novel heterostructured nanocrystals having both efficient charge separation and integrated structure.

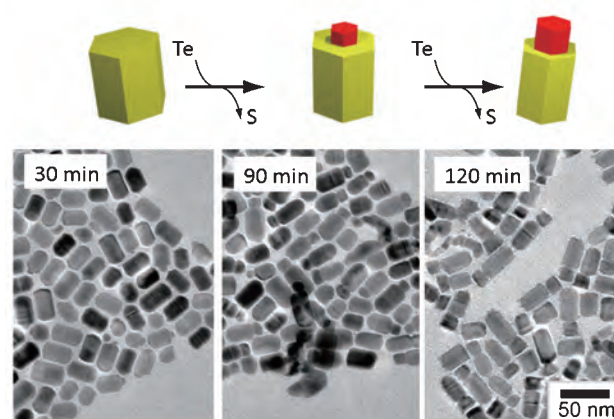


Figure 2. TEM images of the CdS/CdTe HNPs obtained by the anion exchange reaction of CdS nanopencils for 30–120 min.