ICAM2009

11th International Conference on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Organic-Inorganic Hybrid Liquid Crystals: Innovation towards "Suprahybrid Material" by Utilization of Size- and Shape-Controlled Inorganic Nanoparticles

Kiyoshi Kanie*

Institute of Multidisciplinary Research for Advanced Materials, Tohoku University
2-1-1, Katahira, Aoba-ku, Sendai, Japan, e-mail: kanie@tagen.tohoku.ac.jp

Abstract – In the present study, we have succeeded in introduction of thremotropic liquid crystallinity into size- and shape-controlled inorganic nanoparticles by hybridization of organic liquid crystals (LCs). For example, rod-like monodispersed TiO_2 nanoparticles show a thremotropic nematic liquid-crystalline phase by the hybridization with an amino-substituted organic LC. We have investigated the effects of size and shape of the inorganic nanoparticles on the formation of LC phases.

Organic-inorganic hybrid material is a functional material based on the nano- or molecular-level interactions between organic and inorganic matters for the induction of novel functions. One of the most important research topics in this area is the generation of synergistic functions between organic and inorganic matters. Recently, extensive efforts have been carried out for the synergistically adaption of the cross functions such as flexibility of organic materials and high hardness of inorganic materials into the resulting hybrids. Furthermore, on-demand appearance of the desired cross functions between organic and inorganic matters as required is an also important research topic in the material development.

Recently, utilization of nanoparticles have attracted great deals of attention because nanoparticles show interesting properties such as magnetic, electric, fluorescence, and catalytic properties and surface Plasmon resonance behavior, and it can be applicable for the development novel organic-inorganic hybrid materials. In the present study, we focused on the anisotropic shapes of the TiO_2 particles, which were readily obtained by the Gel-Sol method,[1-2] for the induction of thermotropic liquid crystallinity into the particles by the organic-inorganic hybridization. For example, hybridization of organic liquid crystals (LCs) with an amino group with monodispersed needle-like TiO_2 nanoparticles by the mixing together brought the induction of thermotropic liquid-crystallinity into the TiO_2 nanoparticles.[3] Basis on this idea, we also succeeded in thermotropic liquid crystallization of monodispersed α-Fe_2O_3 fine particles with spindle- and cubic-shapes.[4] For the induction of thermotropic liquid crystallinity into inorganic nanoparticles, the aspect ratio of the inorganic particles and their uniformity in morphology are decisive factors. Furthermore, adsorption of functional groups-substituted organic LCs on the surfaces of inorganic particles also plays an essential role for the formation of thermotropic LC phases.

We expanded these concepts for the hybridization of CO_2H-substituted monodispersed spherical gold nanoparticles with amino-substituted cubic liquid-crystalline dendrons (Figure 1). The hybridization was readily achieved by the amidation, and the resulting hybrids showed fluidity at room temperature. Characterization of the hybrids revealed that the generation of the dendrons played an important rule for the induction of thermotropic liquid-crystallinity into the gold nanoparticles. We have also applied *in-situ* preparation of surface-modified inorganic nanoparticles for the development of LC-substituted suprahybrid materials. The nano-level hybridization of inorganic nanoparticles with unique properties and LCs with good electric response would led to novel horizon in materials sciences.

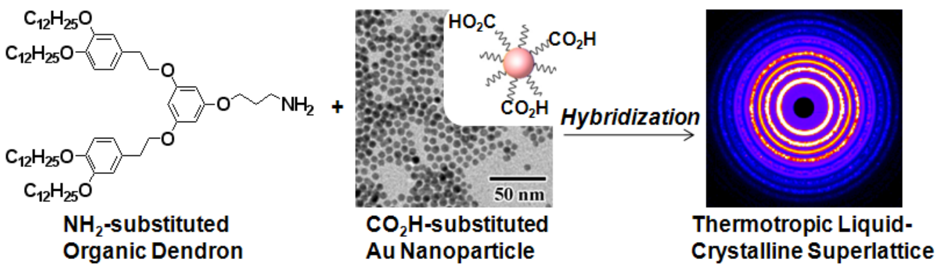

Figure 1: A schematic illustration of hybridization of an organic dendron with a CO_2H-substituted Au nanoparticle to obtain liquid-crystalline superlattice.

References

[1] T. Sugimoto, *"Monodispersed Particles,"* Elsevier, Amsterdam, 2001.
[2] K. Kanie, T. Sugimoto, *Chem. Commun*., **2004**, 1584.
[3] K. Kanie, T. Sugimoto, *J. Am. Chem. Soc.*, **125**, 10518 (2003).
[4] K. Kanie, A. Muramatsu, *J. Am. Chem. Soc.*, **127**, 11578 (2005).