Effect of surfactant gelation on growth process of gold nanorods

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It is well known that the ionic surfactant solution (alkyltrimethylammonium bromide) is used for the synthesis of a gold nanorod, which is a one-dimensional crystal with diameter of ~ 20 nm and length of ~ 200 nm [1]. A gold nanorod is among the objects of most interest for new nanotechnological and medical-technological materials due to the plasmon band. Because the wave length of the plasmon depends on the aspect ratio of gold nanorods, it is important to synthesize nanorods with preferable aspect ratio and size. For this purpose, the mechanism of the nanorod growth were studied in some previous reports, however the mechanism has not been well understood.

Recently, we have reported that high-aspect-ratio gold nanorods can grow in high yield followed by the gelation of surfactant solution [2]. This gelation is caused by the structural transition of surfactant self-assembly at the Krafft point. Hence, it seems to be helpful for better understanding of the growth of gold nanorods to clarify the relation between the gelation of surfactant solution and the elongation of gold nanorods.

In this study, we observed the time series of the growth process of gold nanorods in the gelled surfactant solution (Fig. 1) by stopping the growth reactions completely and compared the growth process with that in the solution without gelation. We also measured the time change in the transmittance of the surfactant solution, and as a result, it was suggested that the formation of a self-assembly of surfactant molecules represented by a decrease in transmittance would especially affect the resulting morphology of short-axis length of nanorods. Small angle X-ray scattering (SAXS) and small angle neutron scattering (SANS) revealed that the self-assembly is an interdigitated lamellar structure (Fig .2). From the results obtained experimentally, we will present a model for the growth of the short-axis length through either a decrease in the spontaneous curvature of the outer surfactant layer and/or an increase in the bending modulus of the surfactant membrane neighboring the gold surface.

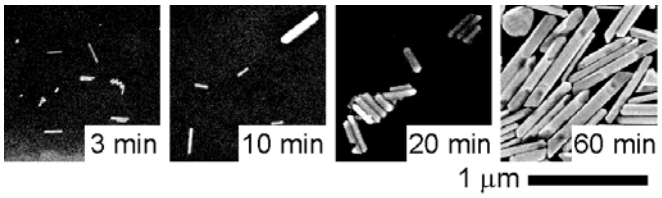

Fig. 1: Growth process of gold nanorods.

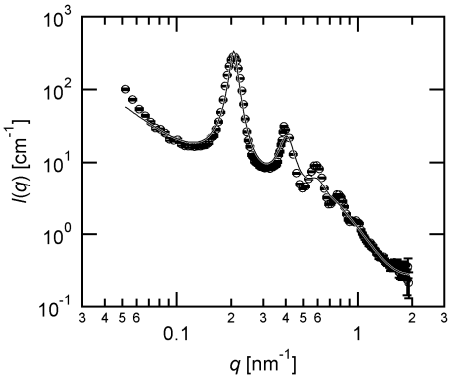

Fig. 2: SANS profile of gelled surfactant solution.

[1] Xia, Y.; Xiong, Y.; Lim, B.; Skrabalak, S. E., Angew. Chem., Int. Ed. 2009, 48, 60-103.
[2] Takenaka, Y.; Kitahata, H., Chem. Phys. Lett. 2009, 467, 327-330.