One-pot synthesis of high-aspect-ratio twin gold nanorods

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Large varieties of sizes in gold nanorods are developed. The long nanorods, especially those longer than 1 µm, are well-suited for use as electrodes, nanogap electrodes, nanorod arrays, and new photonic devices. It is well known that there are two kinds of crystal structures in gold nanorods, namely, single crystal and twin. Gold nanorods have different crystal planes at the sides and edges of the nanorods. Thus the twin gold nanorods are modified the surfaces in anisotropic way, whereby the side and edge are modified with different molecules. Moreover nanorods, especially those longer than 1 µm, are also easily manipulated. Therefore, for further application, high-aspect-ratio twin gold nanorods will be arranged or moving on a specially-patterned surface by means of the anisotropic interaction between the two surfaces. Here we present a new synthesis of high-aspect-ratio twin gold nanorods by using gelled surfactant solution.

Generally, twin gold nanorods are synthesized using a stepwise additive method [1]. In such method, citrate-stabilized seeds are added to the growth solution that contains the surfactant, Au ions, and the reducing agents. Some part of the mixture is then added to another growth solution, which is composed of the same constituents and the process is repeated. In these cases, the length of gold nanorods is limited to 500 nm and extra processes will be necessary to elongate nanorods longer than 1 µm [2,3]. In our method, however, the nanorods with the length of ca. 1.7 µm grow in a gelled surfactant solution with only one step and no extra processes are necessary (Fig1). The yield is relatively high: ca. 60 %.

In this study, we examined in detail the effects of NO$_3$ concentrations or number of seeds on the length of nanorods. As a result, NO$_3$ has an influence on the length of the gold nanorods and the longest ones were obtained at an optimal concentration of NO$_3$ even for growth in the gelled surfactant solution as well as the growth in aqueous surfactant solution. On the contrary, the number of seeds in the growth solution has no effect on the lengths of the nanorods[4].

![Figure1 SEM image of high-aspect-ratio twin gold nanorods (left). Diffraction pattern from the edge of a present gold nanorod (right). The indices with and without underlines mean two different series of spots.](image)

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