Detection of Pathogenic Bacteria Using Nanocomposite as an Optical Nanoantenna

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1. Introduction

Pathogenic bacteria which cause infections and food poisoning are a major public health problem. Methods for the rapid detection and their identifications are required to prevent and diagnose these diseases. The high signal enhancement capability of biological sensors has spurred considerable efforts in developing antenna systems based on metal nanoparticles. Gold nanoparticles (Au NPs), which exhibit excellent elastic light-scattering properties, are expected to be utilized as an optical nanoantenna for bacterial detection.

2. General Instructions

We have developed uniformly structured nanocomposite material consisting of polyaniline and Au NPs.[1] The composite was prepared by the following process. An aqueous 20 mM aniline solution (25 mL) was added to an aqueous 36 μM tetrachloroauric acid solution (500 mL) and the mixture was stirred at 353 K for 20 min. According to TEM observation, Au NPs with a mean diameter of 5 nm were dispersed in polyaniline matrix and constructed 100 nm composites. According to observation using dark-field microscopy, the composite scattered light significantly, comparing to those of Au NPs. This result is due to the structure of the composite, which consists of many non-contacting Au NPs divided by polyaniline.

In order to introduce a selectivity to the composite, we immobilized an anti-*E. coli* O157 antibody using glutaraldehyde as a cross-linker. We applied the antibody-introduced composite to the identification of *E. coli* O157.[2] The composite dispersion was respectively added to suspension including *E. coli* O157 or other kind of *E. coli* which have different O-antigen structure (O26, O111). Dark-field images of each kind of *E. coli* after labeling with the composite were shown in Figure 1. Significant light scattering was observed at the surface of O157 due to selective binding of the composite by antigen-antibody interaction. On the other hand, weak light scattering was observed at the surface of O26 and O111, as well as that of non-labeled O157. Light-scattering spectra of an each kind of bacteria were observed with the spectrometer attached to the dark-field microscope by an optical fiber. Light scattering intensity of the composite-labeled O157 was three times greater than that of O26 and O111 (Figure 1). Therefore, it is expected that the use of the composite as an optical nanoantenna leads us to rapidly detect and identify pathogenic bacteria.

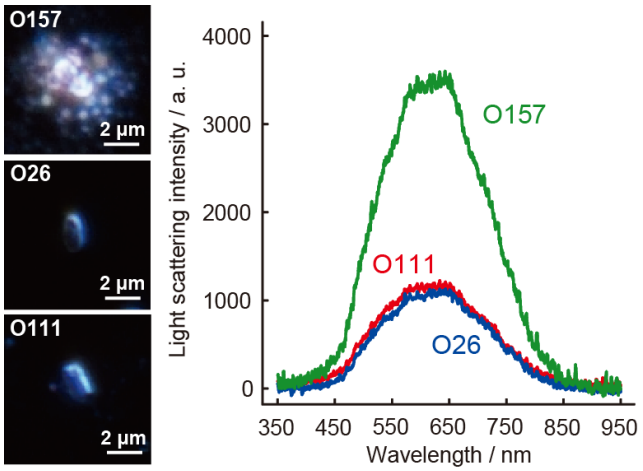

Figure 1. Dark-field images and light scattering spectra of an *E.coli* O157, O26 and O111 after labeling with the nanocomposites. Acquisition time was 100 ms.

3. Conclusions

We developed a method for the simple and rapid detection of pathogenic bacteria utilizing nanocomposite as a nanoantenna. We successfully formed nanoantennas through the antigen-antibody interaction between the composite and *E. coli* O157. This detection system promises to provide a new technique that will benefit efforts to improve safety by better detection of pathogenic bacteria.

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References

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Appendix

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