DNA-Functionalized Nanoparticles for Biosensing

DNA固定化ナノ粒子を用いるバイオセンシング

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DNA-modified nanoparticles disperse in an aqueous medium due to electrostatic repulsion between anionic phosphate groups in the DNA backbone. Interestingly, when complementary single-stranded DNA, whose base number is identical to that of the DNA on the surface, is added to the dispersion of DNA nanoparticles to form the fully matched double helix on the surface, the DNA nanoparticles become unstable and spontaneously form aggregates in a non-crosslinking manner [1].

Furthermore, we have found that the double-stranded DNA-carrying nanoparticles acquire high colloidal stability to disperse in an aqueous medium when a terminal single-base mismatch exists at the interface between the DNA corona and the disperse medium. Exploiting the unique colloidal behavior of the DNA nanoparticles, we have devised a facile single-nucleotide polymorphism genotyping method [2-4].

We applied the SPR imaging technique on our original, power-free microfluidic devices to the detection of the nanoparticles aggregation [5, 6]. Through a combination of non-crosslinking aggregation of DNA nanoparticles and molecular recognition by aptamers or aptazymes, we have also developed analytical systems for detecting cGMP, ATP, FMN, theophyllin [7, 8], and Hg(II) [9]. These analytical functions are designed based on unique properties of soft interface made from relatively-dense assembly of DNA strands.

[1] K. Sato, K. Hosokawa, M. Maeda, J. Am. Chem. Soc., 125, 8102-8103 (2003).
[2] K. Sato, K. Hosokawa, M. Maeda, Nucleic Acids Research, 33, e4 (2005).
[3] K. Sato, M. Onoguchi, Y. Sato, K. Hosokawa, M. Maeda, Anal. Biochem., 350, 162-164, (2006).
[4] K. Hosokawa, K. Sato, N. Ichikawa, M. Maeda, Lab Chip, 4, 181-185 (2004).
[5] Y. Sato, K. Sato, K. Hosokawa, M. Maeda; Anal. Biochem., 355, 125-131 (2006).
[6] Y. Sato, K. Hosokawa, M. Maeda, Colloids Surf., B, 62, 71-76 (2008).
[7] A. Ogawa, M. Maeda, Bioorg. Med. Chem. Lett., 18, 6517-6520 (2008).
[8] A. Ogawa, M. Maeda, Chem. Commun., 4666-4668 (2009)
[9] N. Kanayama, T. Takarada, M. Maeda, Chem. Commun., 47, 2077–2079 (2011).