Development of a high-efficiency PCR method utilizing the photothermal effect of nanoparticles

Y. Oyoshi[1], M. Suzuki[2], T. Mizuki[2], T. Maekawa[1,2] and H. Morimoto[1,2]

[1]Graduate School of Interdisciplinary New Science, Toyo University, Japan
[2]Bio-Nano Electronics Research Center, Toyo University, Japan

We develop a PCR method utilizing the photothermal effect of nanoparticles irradiated with near-infrared (NIR) light. We use carbon-coated iron (Fe@C) nanoparticles, the average diameter of which is 25 nm, as heat sources for PCR thermal cycling. To prevent the attachment of DNA polymerase to Fe@C nanoparticles, we immobilize bovine serum albumin (BSA) on the surface of the particles. We add Fe@C nanoparticles to a PCR reaction solution containing DNA polymerase, template DNA (pUC19), dNTPs, and primers in a test tube. The reaction solution is cooled by an ice-water cooled copper coil surrounding the test tube. The solution can be heated up by irradiating Fe@C nanoparticles dispersed in the solution with NIR light. We carry out PCR performing thermal cycling via the on/off operation of NIR irradiation using a computer-controlled mechanical shutter. The temperature of the reaction solution is monitored by an infrared thermography camera. We show that the total time of PCR is shortened compared to the conventional method thanks to rapid, efficient heating by Fe@C nanoparticles. We also show that the total amount of by-products is smaller than the conventional case, which may be attributed to the rapid thermal cycling.