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Abstract

An Impedance-Based Label-Free Polymerase Chain Reaction Chip and Detection System †

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Abstract: In the conventional real-time polymerase chain reaction (RT-PCR) technique, DNA amplification is confirmed by quantitatively analyzing the increase in the fluorescence brightness using a fluorescent label. However, when using a fluorescence label-based technology, an optical structure enabling the accurate and expensive fluorescence detection is required, and the pretreatment of the sample is required to attach a visible fluorescence marker. In order to overcome this problem, many technologies have been studied for label-free detection using electrical sensors. Impedance has the characteristic of being highly correlated with the concentration of the sample solution and the fragment length of the DNA. If a change in the amount of DNA can be detected by a change in impedance during the PCR process, a detection device with a small and simple structure can be implemented without including an optical detection unit. In this paper, we propose a PCR chip and detection system based on impedance spectroscopy. Two types of chips were made using two types of flexible printed circuit boards (PCBs) with different electrode shapes, double-sided tape, and a plastic film. The system for driving the PCR process includes a microcontroller and is configured to control temperature and process measured values. The DNA sample solutions, diluted to various concentrations, were injected into the two types of chips, and the impedance values for each concentration were measured. The measured values were analyzed for each concentration and electrode type. As a result, it was found that although there is a difference in the size of the measured value depending on the type of chip, it is possible to distinguish between them by concentration.

Keywords: impedance spectroscopy; point of care testing (POCT); label-free detection; PCR chip

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