Design and Simulation of MEMS Micro Heater for DNA Amplification

D. Sharma[1], A. Siddiqua[1]

[1]Nitte Meenakshi Institute of Technology, Bengaluru, Karnataka, India

Abstract

PCR (Polymerase Chain Reaction) is a recent well researched technique which can be employed to obtain an amplified DNA (Deoxyribonucleic Acid). A continuous flow polymerase chain reaction with integrated MEMS based design micro heater for DNA amplification is implemented. Deoxyribonucleic Acid is a molecule that is present in each and every living organism which encodes the genetic information which is used in the development and functioning of all living organisms. Polymerase Chain Reaction is currently the best technique that can be used in order to amplify an amount of DNA. Temperature zone is obtained by natural heat conduction rather than making use of typical silicon thermal cycler. In this process, the DNA sample with reagents has to be heated and cooled in a controlled manner. By doing this, the two strands of the DNA are split and each strand becomes a template by itself which can be copied and replicated and thus the amplification of the DNA sample takes place. When the DNA samples are made to flow through the micro channel, the samples experiences three distinct temperature zones as shown in figure 2. Denaturation at a temperature variation of 90-98 degree C for duration of 1-2 minutes, Renaturating (annealing) at a temperature cooled down to 45-60 degree C for duration of 45 seconds, Extension over a temperature variation of 72 degree C for duration of 2 minutes. Interconnect that are based on polydimethylsioxane (PDMS) material is used for system integration. Material used for micro channel is poly-silicon and simulation is carried out using COMSOL Multiphysics. Simulation result obtained using saliva and blood DNA sample is shown below in figure 1(i) and 1(ii) respectively.

Reference

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2. Shifeng Li and Shaochen Chen, ‘Design, Simulation, and Microfabrication of a Heat-Conduction DNA Chip with Integrated Microheaters’ 2004.
3. A.Ohlander, T. Hammerle, G. Klink, C. Zilio ‘Dna melting curve analysis on semi-transparent Thin film microheater on flexible lab’ October 28 - November 1, 2012, Okinawa, Japan.

Figures used in the abstract

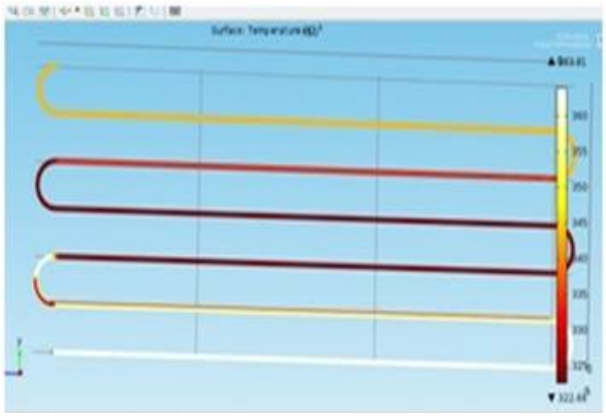

Figure 1: Simulation result obtained by using saliva sample.

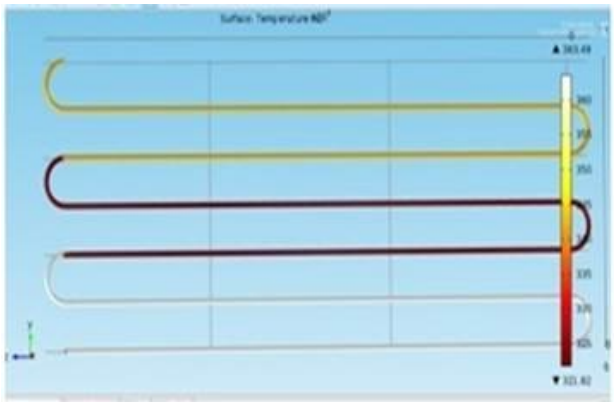

Figure 2: Structure of micro heater.

Figure 3: Simulation result obtained by using blood sample.

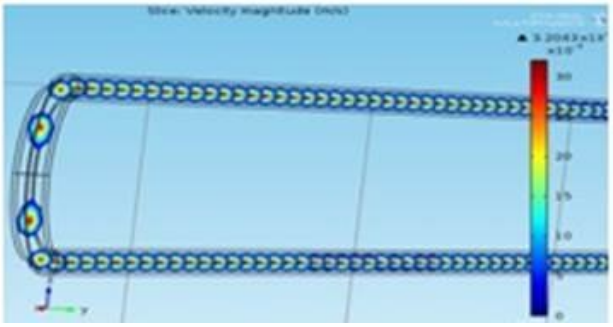

Figure 4: Velocity gradient in micro channel.