World Academy of Science, Engineering and Technology
International Journal of Biotechnology and Bioengineering
Vol:12, No:04, 2018

Magnetophotonics 3D MEMS/NEMS System for Quantitative Mitochondrial DNA Defect Profiling

Authors : Dar-Bin Shieh, Gwo-Bin Lee, Chen-Ming Chang, Chen Sheng Yeh, Chih-Chia Huang, Tsung-Ju Li

Abstract : Mitochondrial defects have a significant impact in many human diseases and aging associated phenotypes. The pathogenic mitochondrial DNA (mtDNA) mutations are diverse and usually present as heteroplasmic. mtDNA 4977bps deletion is one of the common mtDNA defects, and the ratio of mutated versus normal copy is significantly associated with clinical symptoms thus their quantitative detection has become an important unmet needs for advanced disease diagnosis and therapeutic guidelines. This study revealed a Micro-electro-mechanical-system (MEMS) enabled automatic microfluidic chip that only required minimal sample. The system integrated multiple laboratory operation steps into a Lab-on-a-Chip for high-sensitive and prompt measurement. The entire process including magnetic nanoparticle based mtDNA extraction in chip, mutation selective photonic DNA cleavage, and nanoparticle accelerated photonic quantitative polymerase chain reaction (qPCR). All subsystems were packed inside a miniature three-dimensional micro structured system and operated in an automatic manner. Integration of magnetic beads with microfluidic transportation could promptly extract and enrich the specific mtDNA. The near infrared responsive magnetic nanoparticles enabled micro-PCR to be operated by pulse-width-modulation controlled laser pulsing to amplify the desired mtDNA while quantified by fluorescence intensity captured by a complementary metal oxide system array detector. The proportions of pathogenic mtDNA in total DNA were thus obtained. Micro capillary electrophoresis module was used to analyze the amplicone products. In conclusion, this study demonstrated a new magnetophotonic based qPCR MEMS system that successfully detects and quantify specific disease related DNA mutations thus provides a promising future for rapid diagnosis of mitochondria diseases.

Keywords : mitochondrial DNA, micro-electro-mechanical-system, magnetophotonics, PCR
Conference Title : ICBBN 2018 : International Conference on Biotechnology, Bioengineering and Nanoengineering
Conference Location : Lisbon, Portugal
Conference Dates : April 16-17, 2018

Open Science Index, Biotechnology and Bioengineering Vol:12, No:04, 2018 publications.waset.org/abstracts/78727.pdf