AN INTEGRATED, CENTRIFUGALLY-DRIVEN MICRODEVICE FOR FORENSIC STR PROFILING THROUGH ELECTROPHORETIC DNA SEPARATION

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Conventional DNA analysis currently performed throughout the forensic community relies heavily on labor-intensive and time-consuming methodologies, as well as expensive and non-portable instrumentation that often require highly-skilled and trained personnel. This has accentuated an important need for an inexpensive, rapid, and integrated platform capable of performing human identification DNA analysis in a forensic setting. Over the last decade there have been several technologies that have focused on delivering solutions to these requirements and necessities. While some have demonstrated full integration of the human ID process, the methodologies and instrumentation required remain non-portable and expensive, which has led to limited implementation in the forensic field. To alleviate these obstacles, we have developed several individual microfluidic devices for DNA extraction[1], amplification[2,3], and electrophoretic separation[4] to ultimately address the required parameters for cost-effective, portable, and rapid DNA analysis. Once optimized individually, all devices culminated in a novel and unique multi-level device that included integrated gold leaf electrodes, a custom designed cyclic olefin copolymer (COC) separation domain, and novel architecture that facilitates DNA extraction, STR-PCR (10 loci kit provided by Promega), and snap cooling that ultimately leads to a sample (consisting of PCR product and internal lane standard) that is electrophoretically separated. Through the use of centrifugal force, viscous polymer loading was demonstrated in an 80 x 80 µm channel, with subsequent separations showcasing full electrical connectivity, non-bubble formation, good peak signal and resolution. Complete DNA separations were completed in <8 minutes using an effective separation length of only 5 cm. Successful separations of STR fragments on the device were done with high resolution, leading to all alleles being called correctly through conventional STR analysis software. Current research is focused on increasing robustness, speed, and separation resolution (1 base) of the device.

1. Analyst, 141, 4667-4675, 2016.
2. Analytical Methods, 8, 7331-7340, 2016.
3. Analytica Chimica Acta, 980, 41-49, 2017.
4. Lab on a Chip, 16, 4569-4580, 2016.