

The centrifugal microfluidic LabDisk platform for the automation of nucleic acid analysis and immunoassays

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Introduction

We present a centrifugal microfluidic Lab-on-a-Chip platform for the integration and automation of diagnostic and biochemical protocols, including nucleic acid analysis and immunoassays. The platform is based on microstructured two-layer plastic disposables which are processed by a rotary motor as the only active component. As processing instrument, custom-made prototypes as well as commercial platforms like lab centrifuges or centrifugal thermocyclers (Rotor-Gene platform, QIAGEN) can be used. Several LabDisk prototypes for different applications were developed.

Application examples

In a first example, 14 real time PCR reactions were performed in parallel in microstructured foil substrates. The detection of < 10 copies of the antibiotics resistance marker Exf A was demonstrated in a LabDisk featuring pre- and main amplification.

In a second example, isothermal amplification of DNA by recombinase polymerase amplification (RPA) has been demonstrated.

Automated testing of purified DNA samples with sensitivities < 20 copies and time to result of 20 min was achieved.

In a third example, a LabDisk for nucleic acid purification was developed. This allowed purification of a lysed suspension of Gram-positive or Gram-negative bacteria in less than 13 minutes with a yield of more than 30% compared to the theoretical maximum.

In a fourth example, a LabDisk for an ELISA immunoassay was demonstrated. A custom-made immunoassay versus Ricin was successfully automated in a centrifugal-microfluidic structure and showed a similar sensitivity of 20 ng/mL and processing time of 45 minutes compared to the manual protocol.

Conclusion

Overall, the development of a microfluidic platform for a large range of applications in the field of diagnostics and biochemistry is shown and the successful implementation of assays for DNA and protein analysis and sample preparation were demonstrated.