DNA capture and elution in a magnetic droplet manipulation system

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The miniaturization of processes for bioanalysis is an area of vast potential for droplet based microfluidic systems. The small selfcontained samples help to reduce reagent consumption and processing time. In addition, the use of small droplets decreases the contact interfaces with the manipulation platform, which minimizes problems of biomolecule adsorption to sidewalls. Recent reports present droplet manipulation systems based on a range of different actuation principles. Among those the magnetic actuation offers the advantage of long range and large force. In addition, magnetic particles can not only be used as force mediators, but also as mobile substrates for the biomolecules.

In our two-dimensional droplet manipulation system we are able to pass a small droplet loaded with magnetic particles can be passed through a series of immobilized sample and reagent solutions. This enables us to introduce bioanalytical protocols, known from macroscopic procedures onto a chip. The actuation force is generated via the interaction of the changeable magnetic field topography over a printed circuit board (PCB) consisting of overlapping layers of square coils and magnetic particles inside the droplets [1]. In this work we present a setup for the capture and elution of DNA using our 2D magnetic droplet manipulation system. Following a purification protocol, the DNA is at first captured via binding to the magnetic silica-particles and extracted from the sample droplet. Afterwards the magnetic particles with the DNA are passed through a series of washing steps, where any transferred contaminants originating from the initial sample droplet are removed. Finally the DNA is eluted from the particles in a suitable buffer and can thus be detected either on- or off-chip.

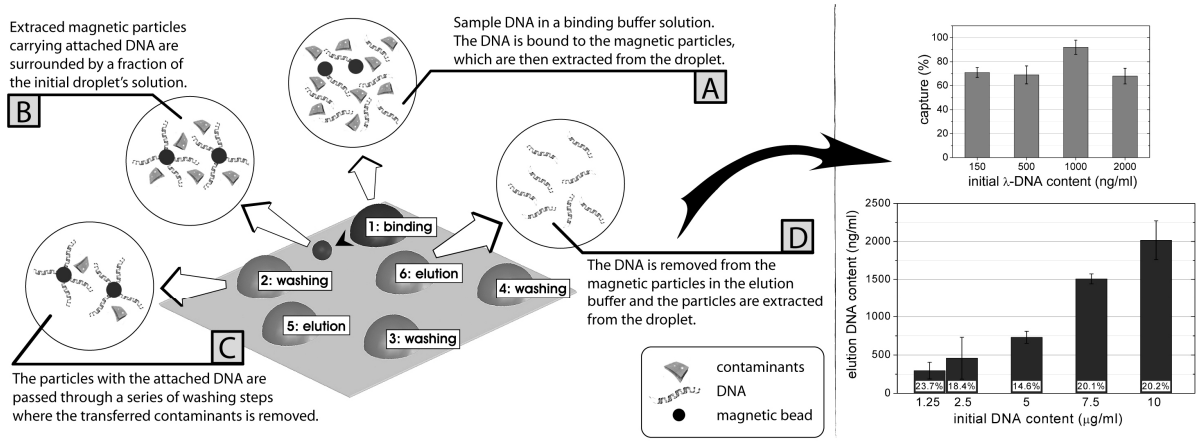

Figure 1: Left) Schematics of the DNA isolation procedure on the chip, Right) Diagrams showing the capture efficiency (top) and the DNA recovery in the elution buffer measured off-chip (bottom).

We demonstrate the proposed procedure using *HinD*III-digested lambda-DNA and magnetic silica particles and a macroscopic bead-based DNA-purification protocol. Our results show, that the system performs as well as macroscopic systems, while requiring significantly less reagent volume and less analysis time. We observed capture rates of 70 %-90 % at room temperature and measured a DNA recovery in the elution buffer of up to 50 %, when using on-chip fluorescent detection.

Our experiments present the two-dimensional magnetic droplet manipulation as a promising platform for miniaturized bioanalysis.

[1] U. Lehmann, S. Hadjidj, V. K. Parashar, A. Rida, and M. A. M. Gijs, "Two Dimensional Magnetic Manipulation of Microdroplets on a Chip", Proc. Transducers'05, IEEE, pp. 77-80, 2005.