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Jensen, Marie Pødenphant; Ashley, Neil; Bodmer, Walter; Beckett, Jonathan; Mir, Kalim; Marie, Rodolphe ; Kristensen, Anders

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Injection moulded pinched flow fractionation device for cell separation

Marie Pødenphant Jensen[a], Neil Ashley[b], Walter Bodmer[b], Jonathan Beckett[c], Kalim Mir[c], Rodolphe Marie[a], Anders Kristensen[a]

[a] DTU Nanotech, Technical University of Denmark, Lyngby, Denmark
[b] Weatherall Institute of Molecular Medicine, Department of Oncology, John Radcliffe Hospital, Headington, Oxford, United Kingdom
[c] Genotype2Phenotype, The Magdalen Centre, Robinson Av, Oxford, United Kingdom

Motivation: A polymer lab on a chip device was used for enrichment of human cancer cells from blood cells. Since the experiments were performed on chip, the cancer cells were still intact and could potentially be investigated further on or outside of the chip. The used method relies purely on microfluidic principles and no external field needs to be applied. Also the chips were fabricated using injection moulding, which ensures that they can be mass produced at low cost.

Separation principle

Pinched flow fractionation (PFF) is a size-based continuous microfluidic separation method.

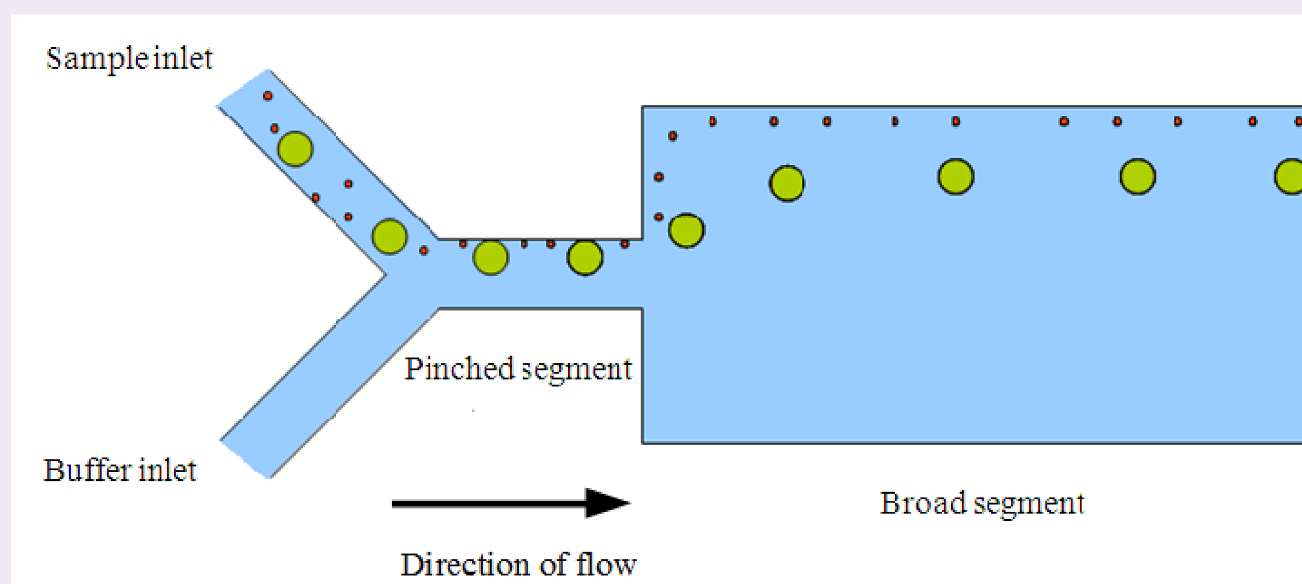


Fig. 1: Sketch of the PFF separation principle.

A sample containing particles with different sizes is pushed into the pinched segment where the cells are aligned. When entering the broad segment cells will follow a streamline according to their size, and can then be separated into different outlets. By varying the applied pressures the separation can be adjusted to the specific sample.
PFF has previously been used for separation of polymer beads[1] and blood cells[2] and for genotyping of DNA[3].

Design of PFF devices

Each chip has two PFF designs, the one used for the presented experiments is shown below.

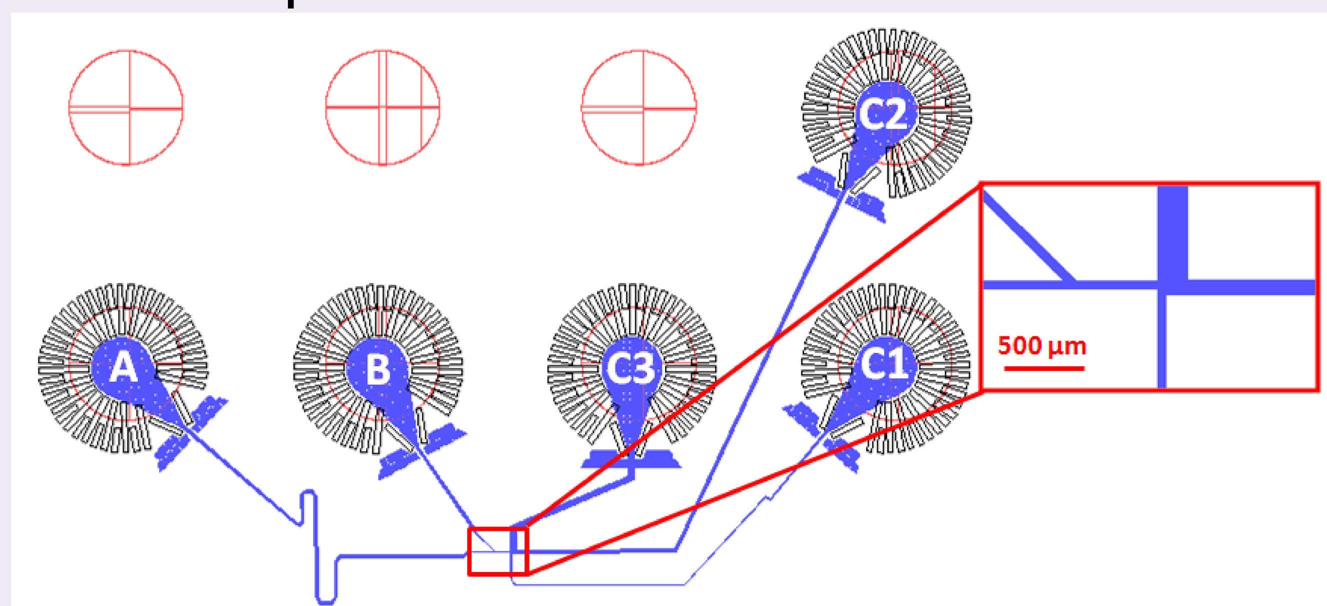


Fig. 2: Design of channels on each chip. The channels have a height of 30 µm and widths between 50 µm and 1000 µm. Samples are placed at inlet A and buffers at inlet B. Particles with a size below (above) a critical diameter d_c go to outlet C1 (C2). Buffer is collected in outlet C3.

Fabrication process

A nickel shim was created using standard clean room fabrication processes. It was then used for injection moulding of the micro channels. The injection moulded part was bonded to a 500 µm thick polymer foil using UV assisted thermal bonding.

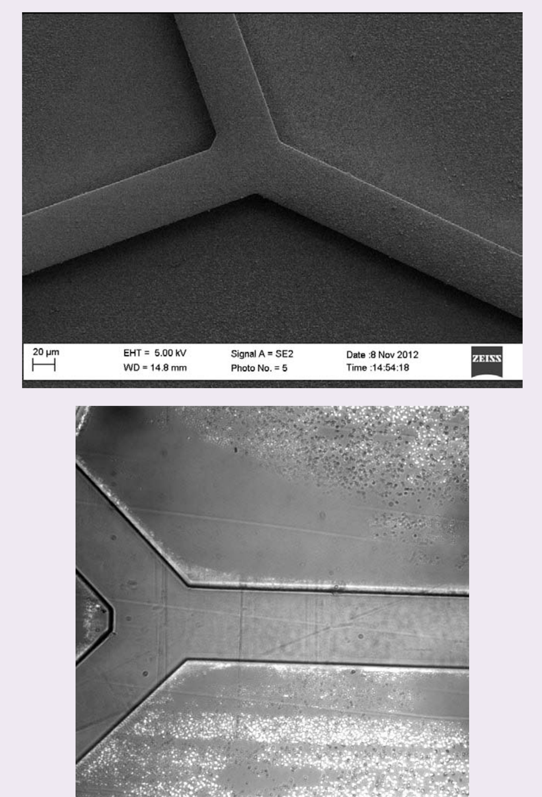
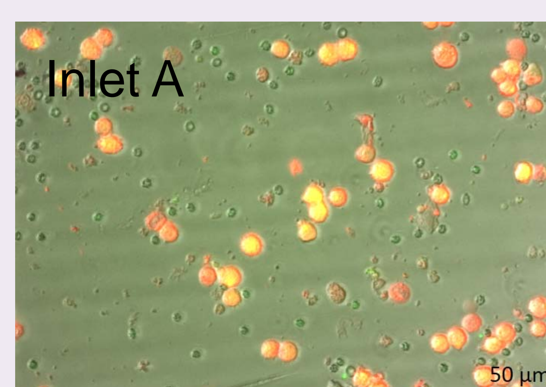


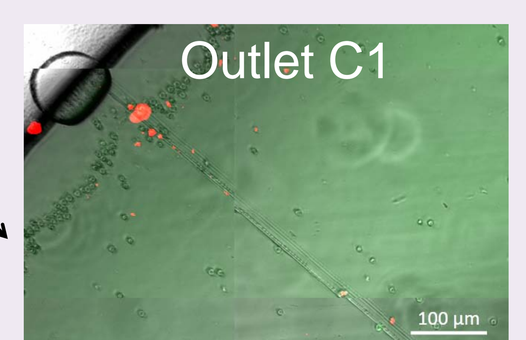
Fig. 3: Pinched segment on nickel shim (top) and bonded chip (bottom).

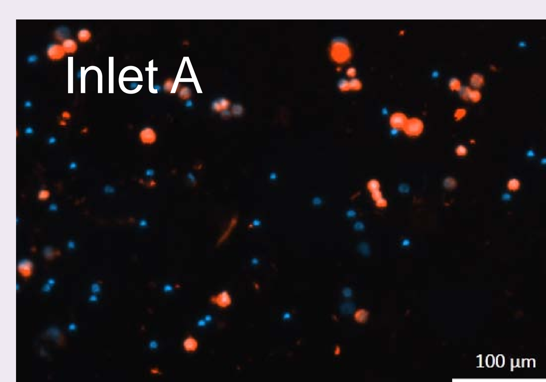
Results

A sample of whole blood and a sample of white blood cells were spiked with tumour cells and placed in the chip.

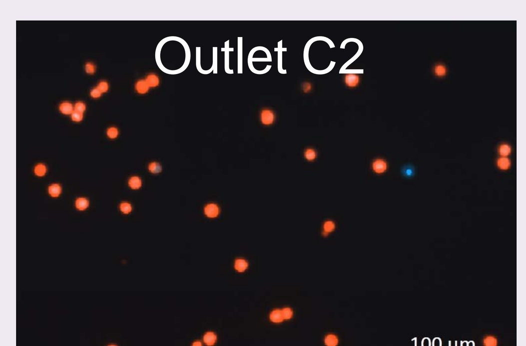


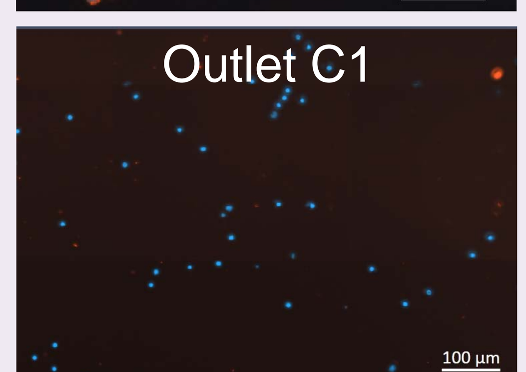
Pinched segment





Pinched segment





	Blood cells C1	Cancer cells C1	Blood cells C2	Cancer cells C2
Whole blood sample	1500	8	5	175
White blood cell sample	551	14	21	189

Tab. 1: Count of cells in outlets C1/C2 after separation.

Presenting Author:
Marie Pødenphant Jensen
Ph.D. Student, DTU Nanotech
Email: mpoje@nanotech.dtu.dk

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