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MEMS技術を用いたがん診断用マイクロ濃縮器の定量分析による設計

Quantitative Analysis Design of MEMS Based Micropreconcentrator for Cancer Diagnosis

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Outline

- Introduction
- Design
  - Microstructure
  - Array
- Simulation
  - Flow velocity simulation
  - Particle tracking simulation
- Fabrication
- Conclusion

Motivation

Breast cancer screening

- Mammography
- Ultrasound
- MRI
- Clinical breast examination

Disadvantage and risk

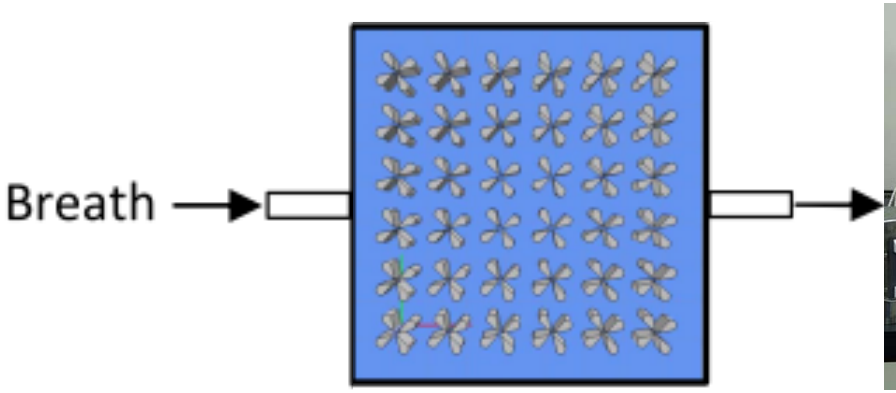
- Exposure of the X-ray
- Pain
- Oversight
- High cost

Breath Analysis

Ref. M.Phillips, et.al., "Volatie biomarkers in the breath of women with breast cancer" J.Breath Res. 4(2010) 026003

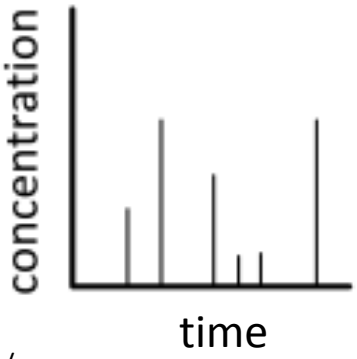
Introduction

- The cancer diagnosis by the analysis of volatile organic compounds (VOC) in breath



Adsorption/Desorption of Biomarkers

Ref.http://matdb.jaxa.jp/SaftyVerification/offgas2_j.html

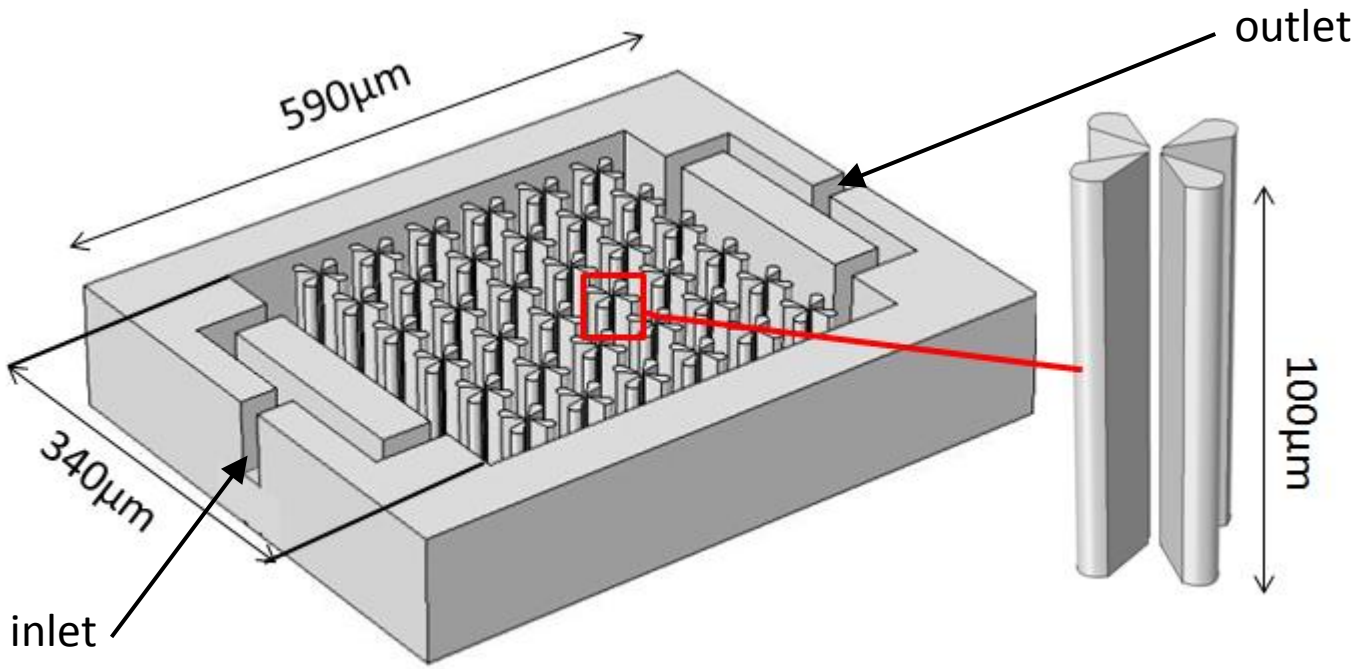


Detection / Analysis
→ Diagnosis

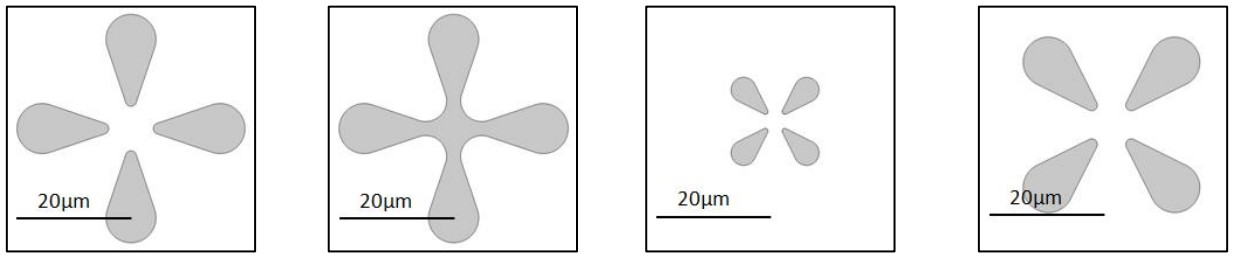
- Advantages of introducing a micropreconcentrator (microPC)
  - Increase of contact surface for biomarker
  - Reduce the concentrator

Performance improvement of MEMS based microPC through quantitative analysis

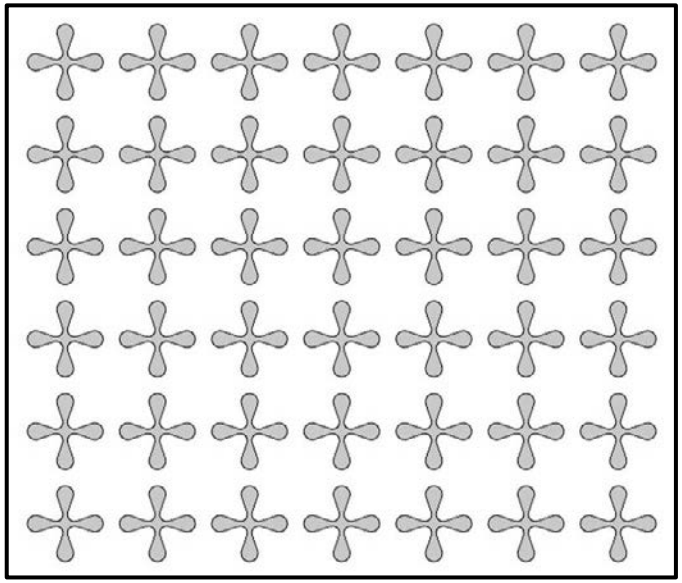
Design of microstructure shape



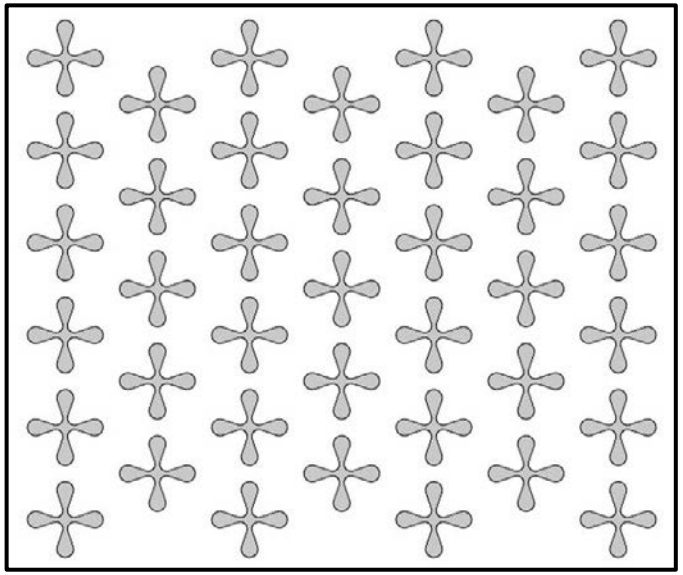
Flower leaf type microstructures



Design of array



Regulated configuration



Staggered configuration

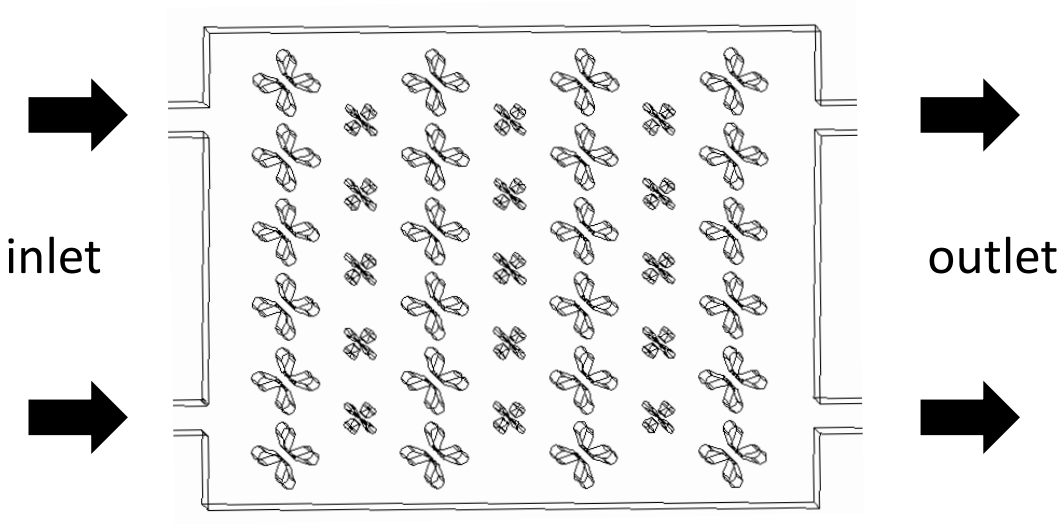
Optimization of microstructure by simulation

- Simulation tool : COMSOL Multiphysics
- Simulation conditions

- Flow velocity simulation
  - Fluid : N_2
  - Initial velocity : 1 m/sec
  - Pressure of outlet : 0 Pa

- Particle tracking simulation
  - Particle numbers : 500
  - Drift time : 0.1 sec
  - Adsorbed velocity : 1.5×10^{-8} m/sec

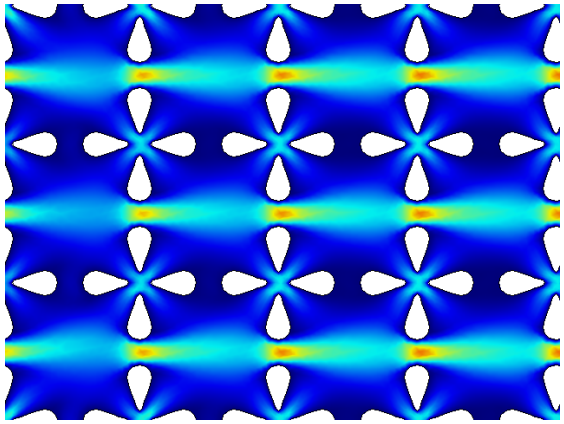
Particle tracking simulation (blue dot ; particle)



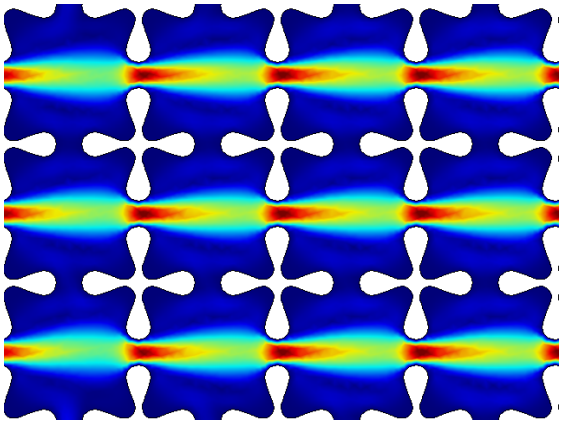
Optimization of microstructure by simulation

- Simulation results

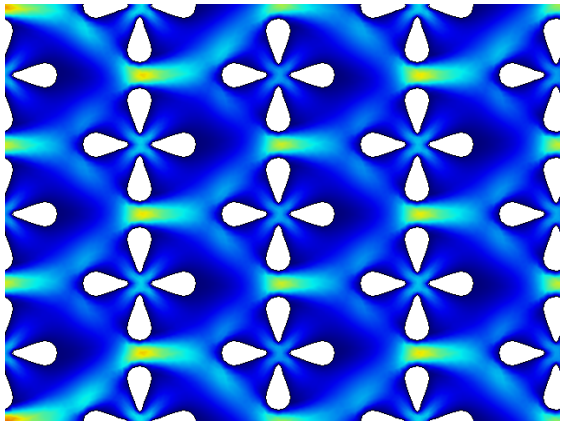
  Flow velocity distributions by microstructure shape and array



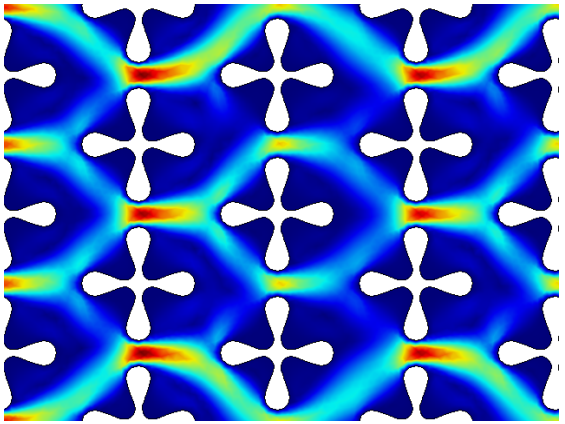
model A



model B



model C

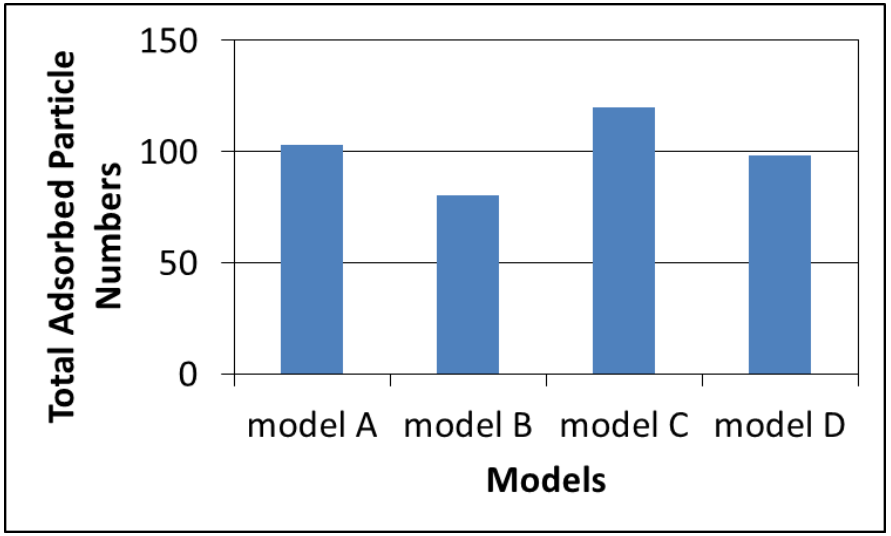


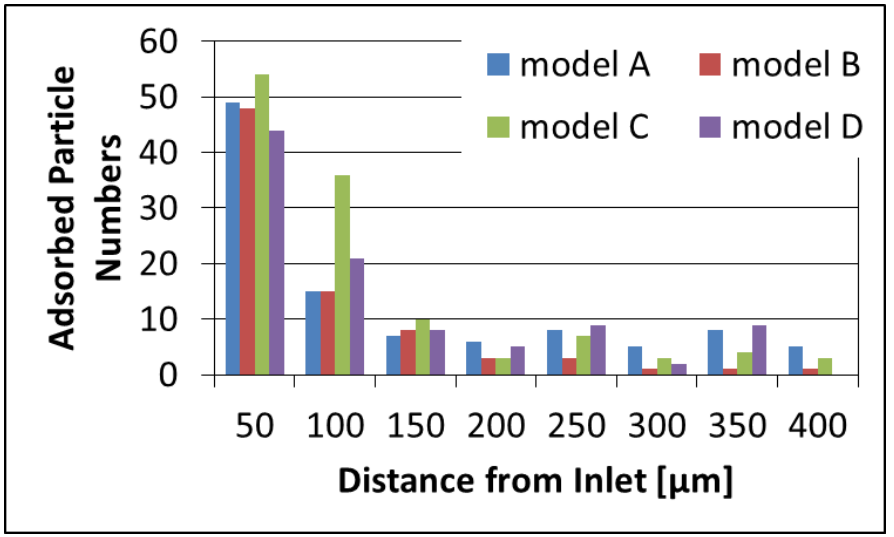
model D

Optimization of microstructure by simulation

- Simulation results

  Quantitative analysis by particle tracking simulation

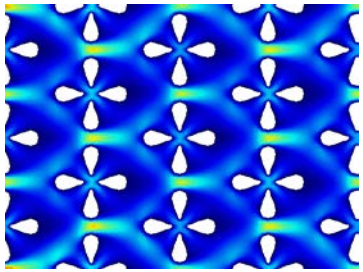




- Model C showed the best performance
- Model C could be showed 50% better performance than model B

Conclusions

- We proposed new microstructure and its array to improve micropreconcentrator performance.
- Design study was performed by quantitative analysis, which gives explicit and clear criterion on the evaluation.
- Model C (staggered configuration with Type A microstructure) showed the best performance for all simulation studies.



- We fabricated micropreconcentrator based on MEMS technology .
- As a future work, we will measure and evaluate our fabricated device.