Electronic Supplementary Material (ESI) for Lab on a Chip.

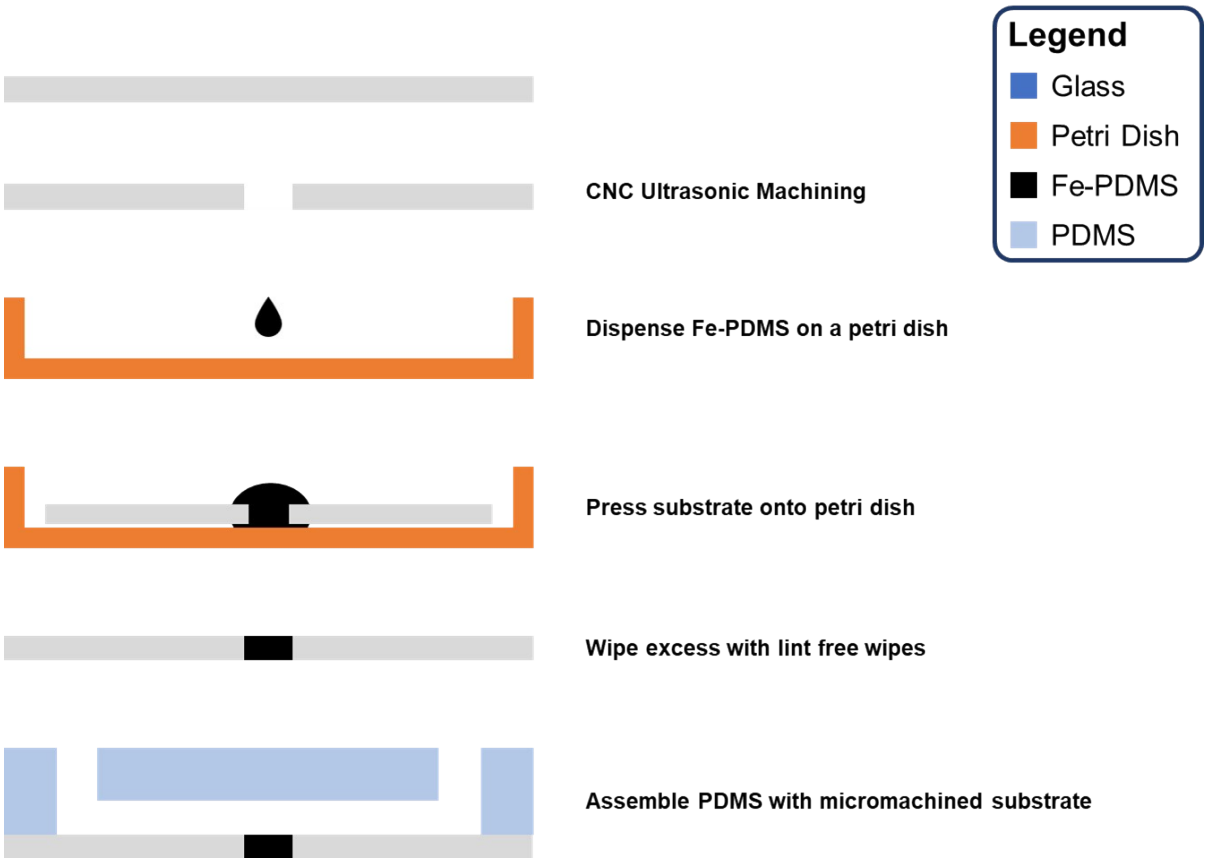
Supplementary Information

High-gradient Magnetophoretic Bead trapping for Enhanced Electrochemical Sensing and Particle Manipulation

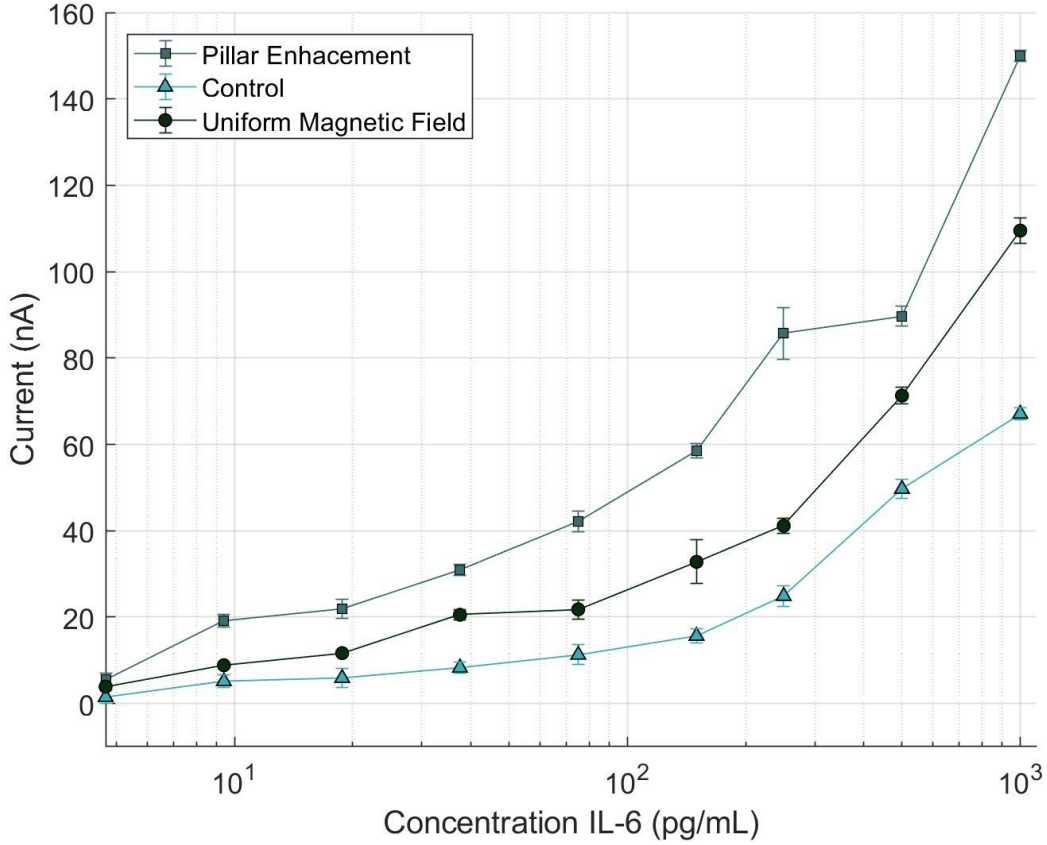
Pablo Morales Navarrete[a, *], Kai Chun Eddie Tjon[a], Zahrasadat Hosseini[a], Jie Yuan[a]

[a] Department of Electronic and Computer Engineering, Hong Kong University of Science and Technology, Clear Water Bay, N.T., Hong Kong

[*] Corresponding Author, email: pmn@connect.ust.hk



Supplementary Fig. S1: Fabrication steps for the proposed device



Supplementary Fig. S2: Plotted absolute maximum current values for CA under a large range of IL-6 concentrations. Values were obtained after performing e-ELISA experiments under different magnetic confinement scenarios.

	Principle Of Operation	Direction of Externally Applied Magnetic Field	Channel Height	Concentration Area (W x L)	External Magnetic Flux Density	Average Particle Velocity	Capture Efficiency
This Work (Low Power)	External Electromagnet with Soft Ferromagnetic Elements	Height of Channel	80 μm	80 μm * 500 μm	9.5 mT	1 mm/s	98%
This Work (High Performance)	External Electromagnet with Soft Ferromagnetic Elements	Height of Channel	80 μm	80 μm * 500 μm	29 mT	4 mm/s	100%
Gajasinghe[1] IEEE Sensors Journal (2016)	Microelectromagnets	/	30 μm	1 mm * 1 mm	/	0.245 mm/s	~95.2%
Sun[2] Scientific Reports (2017)	Microelectromagnets	/	100 μm	6 mm * 5 mm	10 mT	0.333 mm/s	~70%
Lefebvre[3] Micromachines (2020)	Microelectromagnets	/	50 μm	100 μm * 3 mm	8 mT	0.666 mm/s	/
Tarn[4] RSC Advances (2013)	Permanent Magnets	/	Circular Channel, 100 μm in diameter	100 μm * 1.5 mm	578 mT	1.062 mm/s	100%
Bu[5] Sensors & Actuators A Physical (2008)	External Electromagnet with Soft Ferromagnetic Elements	Height of Channel	80 μm	200 μm * 9 mm	50 mT	1.7 cm/s	91%
Feng[6] Microfluidics and Nanofluidics (2018)	Microelectromagnets with Soft Ferromagnetic Elements	Height of Channel	100 μm	1 mm radius	/	0.208 mm/s	~96%
Mekkaoui[7] Microfludics and Nanofluidics (2018)	External Permanent Magnet with Soft Ferromagnetic Elements	Height of Channel	100 μm	1 mm * 10 mm	300 mT	9.7 mm/s	~99.7%
Do[8] Lab On a Chip (2008)	External Permanent Magnet with Soft Ferromagnetic Elements	Width of Channel	50 μm	1 mm * 2 mm	/	0.16 mm/s	/
Chen[9] Nanoscale (2018)	External Permanent Magnet with Soft Ferromagnetic Elements	Width of Channel	100 μm	500 μm radius	5.4 mT	0.02 mm/s	/

Table S1. Magnetic particle trapping performance comparison table.

Supplementary Video S2: Magnetic bead capturing with fabricated magnetic micropillar. When the magnetic source is activated, the beads can be confined to a specific location. The externally applied magnetic flux density is 29 mT with an average particle speed of 2 mm/s.\

Supplementary Video S3: Successive release and capturing of magnetic beads post-magnetic confinement.

Supplementary Video S4: Magnetic bead capturing with fabricated magnetic micropillar at externally applied magnetic flux density of 29 mT with an average particle speed of 4 mm/s.

References

1 Gajasinghe, Rajapaksha W. R. L, A. Toprak, S. U. Senveli, Y. A. Yildirim, M. Jones, Tan Ince and O. Tigli, *JSEN,* 2016, **16**, 7572-7580 (DOI:10.1109/JSEN.2016.2600944).

2 X. Sun, Z. Feng, S. Zhi, C. Lei, D. Zhang and Y. Zhou, *Scientific Reports,* 2017, **7**, 12967-8 (DOI:10.1038/s41598-017-13389-x).

3 O. Lefebvre, H. H. Cao, M. Cortés Francisco, M. Woytasik, E. Dufour-Gergam, M. Ammar and E. Martincic, *Micromachines,* 2020, **11**, 257 (DOI:10.3390/mi11030257).

4 M. D. Tarn, S. A. Peyman and N. Pamme, *RSC advances,* 2013, **3**, 7209-7214 (DOI:10.1039/c3ra40237a).

5 M. Bu, T. B. Christensen, K. Smistrup, A. Wolff and M. F. Hansen, *Sensors and actuators. A. Physical.,* 2008, **145-146**, 430-436 (DOI:10.1016/j.sna.2007.12.014).

6 Z. Feng, S. Zhi, L. Guo, M. Wei, Y. Zhou and C. Lei, *Microfluid Nanofluid,* 2018, **22**, 1-9 (DOI:10.1007/s10404-018-2107-8).

7 S. Mekkaoui, D. Le Roy, M. Audry, J. Lachambre, V. Dupuis, J. Desgouttes and A. Deman, *Microfluid Nanofluid,* 2018, **22**, 1-10 (DOI:10.1007/s10404-018-2141-6).

8 J. Do and C. H. Ahn, *Lab on a chip,* 2008, **8**, 542-549 (DOI:10.1039/b715569g).

9 H. Chen, C. Chen, S. Bai, Y. Gao, G. Metcalfe, W. Cheng and Y. Zhu, *Nanoscale,* 2018, **10**, 20196-20206 (DOI:10.1039/C8NR06367B).