Supplementary Information

Cascaded elasto-inertial separation of malignant tumor cells from untreated malignant pleural and peritoneal effusions

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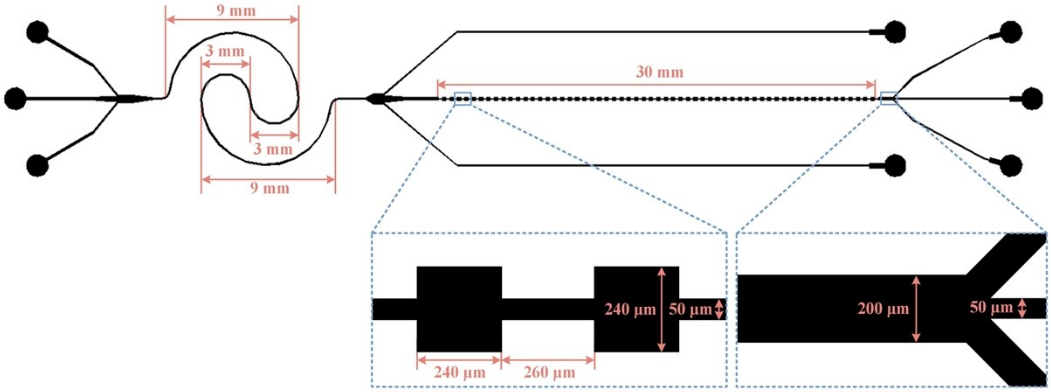

Figure S1. CAD drawing and detailed dimensions of interfacial elasto-inertial separation channel and symmetrical CEA channel.

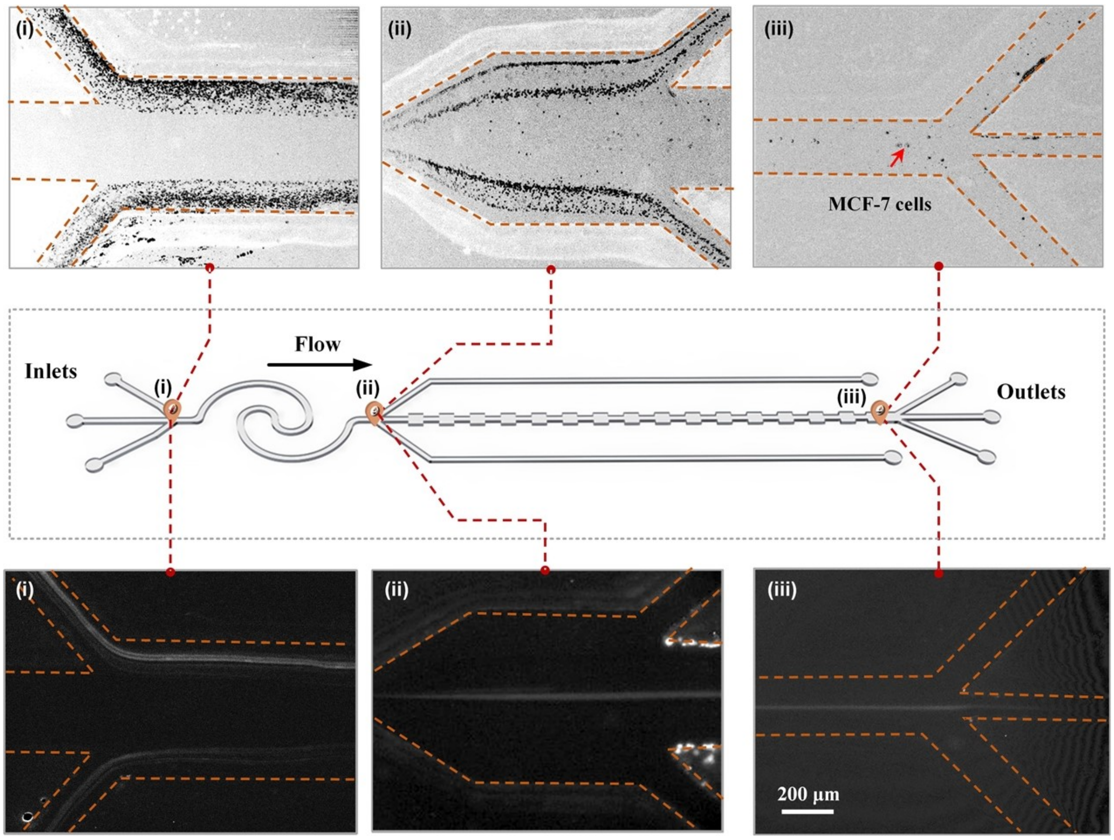

Figure S2. Bright and fluorescence images illustrating the cell distributions at the inlet (i), at the outlets of interfacial elasto-inertial separation channel (ii), and at the outlets of symmetrical CEA channel (iii). The tumor cells were stained before being spiked into the diluted blood samples. The fluorescent streams in the fluorescence images indicate the trajectories of the stained tumor cells. The concentration of tumor cells (MCF-7 cells) is ~10^3 cells/mL.

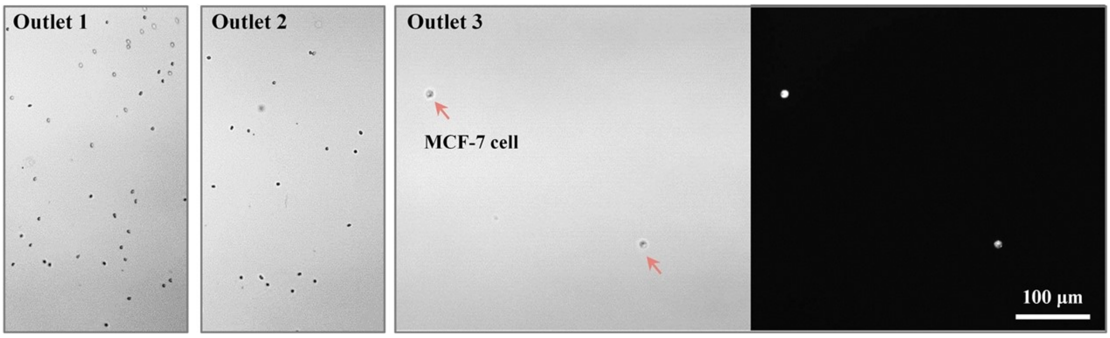

Figure S3. Microscopic images of the liquids collected from the three outlets of the CEICS device after separation using samples spiked with low-concertation tumor cells. To identify the tumor cells in the outlet 3, a fluorescent image of liquids collected from the outlet 3 is also provided. The concentration of tumor cells (MCF-7 cells) is ~10^3 cells/mL.

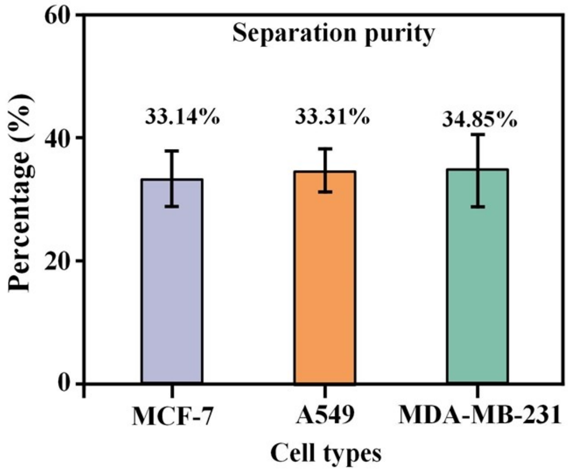

Figure S4. Purities of the collected tumor cells when separating tumor cells with concentrations of ~10^3 cells/mL from blood samples using our CEICS device.

Table S1. Detailed comparison between this paper and previous works on MTC separation by our group

Ref	Microchannel structure	Working principle	Lysis of RBCs（Yes/No）	Cell concentration of the blood cells	Recovery ratio of tumor cells (10^4 cells/mL)
1	Spiral microchannel with two inlets (using sheath fluids)	Inertial separation	Yes	5×10^5 cells/mL	~ 83.9%
2	Traditional spiral microchannel	Inertial separation	Yes	10^5 cells/mL	~ 85.29%
3	Symmetrical serpentine microchannel	Inertial separation	Yes	10^5 cells/mL	~ 93.30%
This paper	Integrated an interfacial elasto-inertial microchannel with a symmetric CEA channel	Elasto-inertial separation	No	10^6~10^8 cells/mL	~94.87%

Table S2. The summary of the research on interfacial elasto-inertial microfluidics

Authors (year)	**Selection of sheath fluids**	**Selection of sample fluids**	**Flow rate of samples**	**Confined particle size**	**Application**	**Performance**
Faridi et al.[4] (2017)	500 ppm PEO	PBS	0.5 μL/min	2 μm, 5 μm	Separation of WBCs from bacteria	Recovery ratio (WBCs) of 92%
Tian et al.[5] (2017)	100 ppm PEO	PBS	5 μL/min	1 μm, 2 μm	Separation of platelets from *Staphylococcus aureus*	Separation efficiency (platelets) of >90%
Yuan et al.[6] (2017)	PBS	1000 ppm PEO	2 μL/min	5 μm, 10 μm	Washing of Jurkat cells	Recovery ratio (Jurkat cells) of 92.8%
Tian et al.[7] (2018)	500 ppm PEO	Whole blood	7.5 μL/min	10 μm, 15 μm	Separation of tumor cells from whole blood	Recovery ratio (tumor cells) of >76.3%
Shi et al.[8] (2019)	150 ppm PEO	PBS	8.3 μL/min	10 μm, 15 μm	Separation of H1299 cells from blood cells	Separation efficiency (H1299) of ~100%
Shi et al.[9] (2020)	500 ppm PEO	100 ppm PEO	10 μL/min	10 μm, 15 μm	Separation of H1299 cells from blood cells	Separation efficiency (H1299) of ~100%
Zhang et al.[10] (2023)	1000 ppm PEO	PBS	1 μL/min	1.82 μm, 8.5 μm	Separation of *L. rhamnosus* from *E. coli*	Separation purity (*L. rhamnosus*) of 91%
Zhang et al.[11] (2023)	1000 ppm PEO	PBS	1 μL/min	1 μm, 4.8 μm	Separation of *E. coli* Clusters and Singlets.	Separation purity (*E. coli* Clusters) of 70.8%
Cheng et al.[12] (2023)	750 ppm PEO	250 ppm PEO	18.4 μL/min	5 μm, 15 μm	Separation of tumor cells from whole blood	Recovery ratio (tumor cells) of >77%
This paper	50 ppm HA	PBS	120 μL/min	10 μm, 15 μm	Separation of tumor cells from blood cells	Recovery ratio (tumor cells) of >94.8%

No.	Age	Sex	Cancer type	Sample
1	81	Male	Hemangiosarcoma	Peritoneal effusion
2	61	Female	Lung adenocarcinoma	Pleural effusion
3	80	Female	Lymphoma	Pleural effusion
4	57	Male	Liver cancer	Peritoneal effusion
5	75	Female	Ovarian cancer	Peritoneal effusion

Table S3. Clinical information of patients.

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