Docket #: S25-316

Label-Free Electromagnetic Cell Levitation Platform for High-Precision Sorting and Analysis

Researchers at Stanford have developed Electro-LEV, a microfluidic platform that uses programmable electromagnets to levitate and sort cells by their physical properties — with no fluorescent labels or antibodies required.

Isolating specific cell populations is fundamental to research and medicine, but current methods have significant drawbacks. Fluorescence-based sorting requires labeling that can alter cell behavior, while existing magnetic levitation approaches are static: once cells settle at their equilibrium position, there is no practical way to adjust them in real time. This makes it difficult to resolve closely overlapping cell populations.

Electro-LEV overcomes this limitation by integrating controllable electromagnets into a microfluidic channel. Dynamically tuning the current shifts cells to new levitation heights on demand, allowing the platform to distinguish populations that conventional levitation cannot separate. The platform has demonstrated substantial gains in sorting efficiency and viable cell recovery across a range of sample conditions.

Stage of Development : Prototype

Applications

- Label-free cell sorting instruments for life sciences research and clinical labs
- Drug discovery tools for analyzing heterogeneous cell populations in compound screening
- Clinical sample processing for enriching viable cells from complex or degraded samples

Advantages

- Up to 10-fold improvement in sorting efficiency over conventional magnetic levitation methods
- 18.8-fold enrichment of viable cells from low-viability samples, outperforming static approaches
- No labels or antibodies required, reducing cost and preserving native cell state

Publications

- Ramarao, M., Garcia-Gradilla, V., Unlu, M. B., et al. (2025). Dynamic and precise electromagnetic levitation of single cells. PNAS, 122(37), e2512246122.

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