Solute-driven Online Preconcentration in Lateral Flow Assay (SOP-LFA) devices for ultrasensitive biochemical testing

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Lateral flow assays (LFAs) are paper-based analytical devices (PADs) widely used in medical diagnostics, food, and environmental safety. These test strips enable rapid, on-site analysis without the need for specialized equipment, making them cost-effective and portable. However, standard LFAs struggle to detect analytes at low concentrations typical of early-stage diseases. Preconcentration techniques can significantly enhance sensitivity, but existing methods requiring voltage supply compromise the simplicity and portability of LFAs. We propose a novel approach using diffusiophoresis (DP), a solute-driven electrokinetic phenomenon, to concentrate analytes on PADs without external power. By harnessing the spontaneous electric field generated at the interface between lower and higher ionic strength electrolytes, we aim to achieve online, electrokinetic, and power-free preconcentration. In standard colorimetric LFAs, this technique could dramatically improve detection limits. Mobile, coloured nanoparticles, conjugated to detection reagents, will bind to target analytes, and this complex will then bind to immobilized capture reagents at the test line. Based on DP studies in microchannels, preconcentration factors exceeding 10^4 might be achieved at the test line, potentially leading to over a 10,000-fold improvement in LFA sensitivity without compromising its portability, simplicity, or ease of fabrication and use.

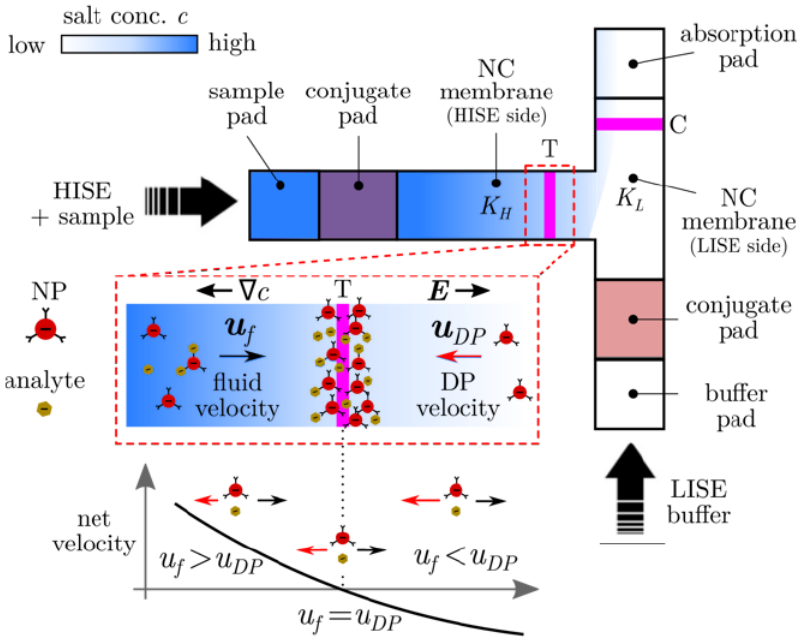


Fig. 1. Working principle of the LFA devices.