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Vacuum-integrated Microneedle Platform for Enhanced Interstitial Fluid Collection

Stanford researchers have developed an innovative vacuum-integrated microneedle platform designed to enable efficient and reliable collection of dermal interstitial fluid (ISF) for diagnostic and biomarker analysis.

Interstitial fluid contains valuable biomarkers reflecting physiological and pathological states, making it an attractive alternative to blood sampling for diagnostics and monitoring. However, current ISF collection methods often suffer from low fluid yield, slow collection times, and complex tubing systems, limiting their practical use in clinical and decentralized settings. In many microneedle-based devices, limited surface area and inefficient flow mechanisms prevent collection of sufficient sample volumes for downstream analysis.

This innovative technology addresses these challenges by integrating a microneedle array directly with a vacuum-assisted collection mechanism, creating a closed system that improves fluid extraction efficiency while minimizing system complexity and dead volume. The platform combines a high-surface-area microneedle array, a direct microneedle-to-vacuum interface, and a sealed low-resistance fluidic pathway connected to a standard vacuum collection tube. When applied to the skin, the vacuum generates a controlled pressure differential that passively drives ISF through the microneedles and into the collection tube.

This compact, self-contained platform enables rapid ISF sampling, potentially within minutes, while maintaining reliable fluid yield and ease of use, supporting applications in diagnostics, biomarker monitoring, and decentralized healthcare settings.

Stage of Development
Proof of Concept

Applications

- Blood-free diagnostic testing
- At-home health monitoring
- Drug testing and clinical trials
- Medical research and biomarker studies
- Diagnostics in low-resource settings

Advantages

- Collects more fluid quickly and reliably
- Simple vacuum-assisted sampling
- Closed system helps prevent contamination
- Compact design with minimal fluid loss
- Easy-to-use, single-use device

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