A paper-integrated microfluidic device for the preparation of monodisperse microcapsules and microvesicles

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BRIEF DESCRIPTION

Many applications, ranging from *in vivo* cell culture growth to drug delivery, rely on microcapsules to encapsulate and protect cells or molecules until their desired release. These microcapsules are typically generated in immiscible fluid, which must be depleted before they can be effectively used. Researchers at UCI have recently developed a paper-based microcapsule extraction technique that is quicker, cheaper, and less damaging than conventional methods.

SUGGESTED USES

- Liquid phase exchange of hydrogel microcapsules from oil phase to aqueous phase
- Multiplex analyte detection
- Controlled delivery systems in cosmetics, pharmaceutical, and food industries

FEATURES/BENEFITS

- Single step extraction process without external purification procedures
- Utilizes commercially-available hydrophobic filter paper
- Inexpensive, disposable, and suitable for mass production

TECHNOLOGY DESCRIPTION

Microencapsulation is a common method in a variety of fields for containing and protecting systems of interest until they are required to be released/utilized. In *in vivo* studies of cell growth, for example, entire cells are encapsulated in hydrophilic polymer beads (hydrogels) which protect them from immune response and damaging external forces. The generation of these microstructures leaves them suspended in an oil phase, which must be removed to bring them to application in aqueous phase. The current state-of-the-art method for this removal relies on repetitive steps of centrifugal purification. However, this technique must be conducted off-chip (externally performed), leads to low recovery yields, and reduces size uniformity of microcapsules. For cell-encasing microcapsules, this process provokes cell death.

The technology consists of a lab-on-a-chip platform generated using soft lithography and the layer-by-layer assembly scheme. The user's oil-based precursor solution, containing any solid matter of interest, is passed through a flow-focusing junction to generate the monodisperse microcapsules. The microcapsules then pass through an outlet chamber, which is lined with hydrophobic filter paper. The filter paper absorbs the oil phase without disturbance of its contents. The microcapsules are resuspended in a water-based salt solution (phosphate-buffered saline), undestroyed and ready for application or delivery.

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OTHER INFORMATION

KEYWORDS

Microfluidics, Lab-on-a-chip, Microcapsules, Microvesicles, Single-cell encapsulation

CATEGORIZED AS

- **Agriculture & Animal Science**
  - Devices
- **Medical**
  - Delivery Systems
  - Devices
  - Diagnostics
  - Research Tools
  - Therapeutics
- **Research Tools**
  - Cell Lines

The present invention describes a rapid and one-step process of oil extraction. Hydrophobic to hydrophilic phase exchange is achieved in a single, on-chip step. This high-throughput method maintains cell viability and size uniformity of microcapsules, thereby increasing recovery yield as fewer microstructures are destroyed.

RELATED CASES

2017-201-0

STATE OF DEVELOPMENT

The invention is complete in concept, preliminary experiments, and simulations. Currently in design optimization stage for generation of microcapsules as well as for encapsulation of single cells within microcapsules.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,090,653	08/17/2021	2017-201

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