

## Method of Making Multicomponent Nanoemulsions

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### INVENTORS

▶ Mason, Thomas G.

### OTHER INFORMATION

#### KEYWORDS

Oil-in-water nanoemulsions,  
multicompartment nanoemulsions,  
drug delivery systems, Cerberus  
nanodroplets, Janus nanodroplets,  
multidroplet flow-induced fusion,  
multicomponent compartmentalized  
nanoemulsions

#### CATEGORIZED AS

- ▶ **Medical**
  - ▶ Delivery Systems
- ▶ **Nanotechnology**
  - ▶ NanoBio

#### RELATED CASES

2014-182-0, 2007-574-0, 2008-433-0,  
2008-625-0, 2019-954-0, 2014-705-0

## SUMMARY

Researchers from UCLA's Department of Chemistry & Biochemistry have developed a novel method of making deformable, multicomponent oil-in-water nanoemulsions to create a single delivery system for multiple drugs or other insoluble molecules.

## BACKGROUND

A recent analysis estimates that the current cost of developing a new drug is approximately \$5 billion. This large cost is due to the expensive regulatory process, but also the fact that 95% of experimental drugs fail to be effective or safe, making it necessary to spend billions of dollars to make several drugs at once. To overcome this, researchers have diverted attention from creating new drugs to optimizing current drugs for improved delivery.

Drug delivery in particular is of great interest since delivering a proper amount of medicine to the target is a major pharmaceutical and biotechnology industry bottleneck. Consequently, recent efforts have shifted from creating new drugs to optimizing current drugs for improved delivery. One major challenge to traditional drug delivery is drug insolubility, which is a major contributor to the ineffectiveness of experimental drugs. Notably, oil-in-water nanoemulsions can be effective in improving the solubility, pharmacokinetics, and stable formulation of drugs. However, there are still difficulties in making such emulsions at the nanoscale, particularly in low-flow conditions. Overcoming these production issues would make them a viable and useful candidate for drug delivery systems and potentially improve the repertoire of available drugs not previously suitable for clinical use.

## INNOVATION

Researchers in the laboratory of Dr. Thomas Mason at UCLA have developed a process for making multicomponent oil-in-water nanoemulsions that have identifiable compartments as well as defined interfaces between different immiscible oils within the same droplet. In particular, two types of nanoemulsions are created: two-component linear Janus nanodroplets and three-component linear-engulfed Cerberus nanodroplets. This technology is able to create Janus droplets of less than 100nm and the first linear-engulfed three-component Cerberus droplets, including sub-micron and nanoscale Cerberus droplets.

This technology offers possibilities for the localized delivery of different types of oil-soluble drug molecules and combined nanoscale droplets of several different types of drug molecules (that may not all be soluble to a high degree in the same type of oil) to the same site. Additionally, it may be possible to combine the current low-flow method with flow-induced fusion, a prior method from the same inventors. Compared to other fusions of microscale droplets through similar approaches, this method is massively parallel, offering higher throughput. The overall sub-micron and nanoscale dimensions make these multi-compartment droplets capable of pharmaceutical applications that would otherwise be out of reach for micron-size and larger scale droplets made by other methods.

## APPLICATIONS

- ▶ Drug delivery applications in pharmaceuticals
- ▶ Delivery of water-insoluble molecules
- ▶ Delivery of fluorinated drug molecules
- ▶ Delivery of both aromatic and aliphatic molecules

## ADVANTAGES

- ▶ Novel method of creating Janus droplets in which the overall droplet radius is sub-100nm
- ▶ First method to produce linear-engulfed three-component Cerberus droplets, including sub-micron and nanoscale overall sizes
- ▶ Multicomponent ability to create combined nanoscale droplets that ensure delivery of several different types of drug molecules
- ▶ Multicomponent droplet formulations can include fluorinated oils for the delivery of fluorinated drug or imaging molecules
- ▶ Droplets are dominantly polar + non-polar, allowing delivery of both aromatic and aliphatic molecules

## STATE OF DEVELOPMENT

- ▶ The approach has been tested and is viable in producing sub-micron and nanoscale droplets.

▶ Oil emulsification and loading of drug molecules (including fluorinated molecules) has also been demonstrated, where the relative amounts of drugs and oil used can be controlled. Current work is focused on making Janus and Cerberus droplets for topical and intravenous applications.

## RELATED MATERIALS

- ▶ [Cerberus nanoemulsions produced by multidroplet flow-induced fusion. Langmuir. \(2013\)](#)
- ▶ [Self-limiting droplet fusion in ionic emulsions. Soft Matter. \(2014\)](#)

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,890,585	02/06/2024	2019-954
United States Of America	Issued Patent	10,285,940	05/14/2019	2014-182
United States Of America	Issued Patent	9073022	07/07/2015	2008-625

## RELATED TECHNOLOGIES

- ▶ [Ultrastable Nanoemulsions In Disordered And Ordered States](#)
- ▶ [Process For Recycling Surfactant In Nanoemulsion Production](#)

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ [Measuring Size Distributions of Small-Scale Objects](#)
- ▶ [Process For Recycling Surfactant In Nanoemulsion Production](#)
- ▶ [Novel Multi-Scale Pre-Assembled Phases of Matter](#)
- ▶ [Ultrastable Nanoemulsions In Disordered And Ordered States](#)
- ▶ [Mechanical Process For Creating Particles Using Two Plates](#)
- ▶ [Process For Sorting Dispersed Colloidal Structures](#)
- ▶ [Shape-Controlled Particles Having Subparticle Geometrical Features](#)

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