Method of Making Multicomponent Nanoemulsions
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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 insolvency, which is a major contributor to the ineffectiveness of experimental drugs. Notably, oil-in-water nanoemulsions can be effective in improving the solubility, pharmokinetics, 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 Janus and 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


PATENT STATUS

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<td>United States Of America</td>
<td>Issued Patent</td>
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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Litho-particle Dispersions: Designer Particles with Customizable Shapes
- Process For Creating Stable Double Emulsions
- Massively Parallel Assembly of Composite Structures using Depletion Attractons
- Process for Directing Assemblies of Particulate Dispersions Using Surface Roughness
- Improved Treatment of Acute Metabolic Acidosis
- Measuring Size Distributions of Small-Scale Objects
- Mechanical Process For Creating Particles Using Two Plates
- Process For Recycling Surfactant In Nanoemulsion Production
- Process For Sorting Dispersed Colloidal Structures
- Novel Multi-Scale Pre-Assembled Phases of Matter
- Process For Reducing Sizes Of Emulsion Droplets
- Shape-Controlled Particles Having Subparticle Geometrical Features
- Reacting Molecules and Colloids Electrophoretically