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SYNTHESIS OF MULTI-COMPARTMENT NANOEMULSIONS FOR LOCALIZED CO-DELIVERY OF DIFFERENT CLASSES OF OIL-SOLUBLE DRUG MOLECULES

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Using two different highly non-equilibrium synthetic approaches, we have created new kinds of stable oil-in-water nanoemulsions composed of complex multi-compartment nanoscale droplets. Each nanodroplet contains three different types of mutually immisible oils in separate internal compartments. Consequently, each internal compartment can hold a different class of oil-soluble drug molecules. By analogy to Janus droplets, which contain two different immiscible oil types and are named after the mythological two-faced deity of doorways, we call these compartmentalized triple-oil droplets "Cerberus" droplets, after three-headed watch-dog in the same mythology. In a first synthetic approach, we combine three simple microscale oil-in-water emulsions, each made using a different oil type (aliphatic, aromatic, or fluoro siloxanes), and subject this mixed microscale emulsion to extreme flow conditions using a high-pressure microfluidic homogenizer. In addition to causing droplet rupturing towards the nanoscale, the extreme flow also overcomes the stabilizing interfacial repulsion of the water-soluble ionic surfactant, leading to flow-induced droplet fusion. The multi-compartment nanodroplets in these complex oil-in-water nanoemulsions are so small that optical microscopy methods cannot resolve the internal interfaces that separate the internal compartments. So, instead, we have developed the use of cryogenic transmission electron microscopy (C-TEM) to reveal the compartmentalization of these three oils inside the resulting Cerberus nanodroplets. In a second approach, we create Cerberus droplets using self-limiting droplet fusion reactions obtained by transiently destabilizing a mixed emulsion containing droplets of the three different oil types using an ionic amphiphile having the opposite charge. Based on these results, we create a classification scheme for different kinds of Cerberus droplet morphologies. In pharmaceutical applications, Cerberus nanoemulsions can be tailored to provide local co-delivery of a wide range of non-aqueous drug molecules, thereby overcoming limitations related to poor molecular solubility in certain oil types.

Biography

Thomas G Mason received his PhD from Princeton University (USA) in 1995. He completed a first Postdoc at the CNRS Paul Pascal Research Institute in Bordeaux in physical chemistry and a second Postdoc at Johns Hopkins University in chemical and biomolecular engineering. Following 6 years as a principal investigator research scientist in industry, in 2003, he joined University of California Los Angeles as an Assistant Professor of physical chemistry and physics. He was promoted to Full Professor in 2009. He has published more than 120 papers in peer-reviewed journals and is an Inventor on 15 issued patents. He has received Princeton's Joseph Henry Prize, Intel's New Faculty Award, and NSF's CAREER Award, and is a Fellow of the Americal Physical Society.

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