Docket #: S14-340

Nanoparticle-based Emulsifier for Droplet Microfluidics

Researchers at Stanford and the University of Alberta have developed fluorinated amphiphilic nanoparticles that can be used to create low-cost, stable, bio-compatible droplets for microfluidics-based digital PCR or other high-throughput screening applications. These nanoparticles are dispersible in a variety of fluorinated oils and have key advantages over conventional surfactant systems (Figure 1a). First, they are resistant to leakage and cross-contamination of small molecules between the drops (Figure 1b). In addition, they provide a rigid interface to enable the culture of adherent cells such as fibroblasts and breast cancer cells (Figure 1c). Finally, the non-adsorbing and non-denaturing interface preserves enzymatic activity occurring inside the drops (Figure 1d and 1e). This technology offers an inexpensive alternative to traditional surfactant system with features that could enable new applications for high-fidelity biochemical assays.

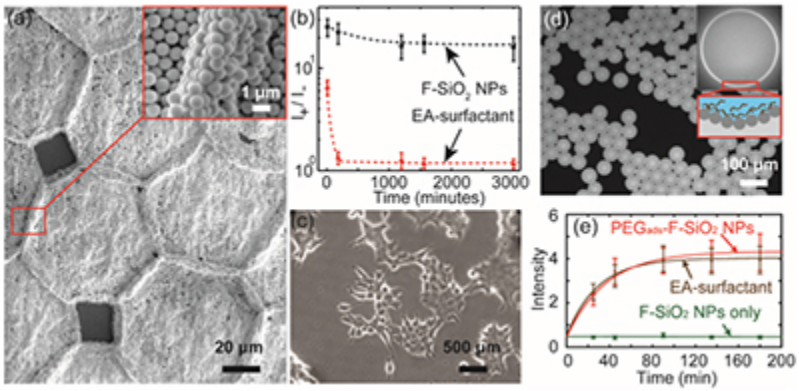


Figure 1. Fluorinated amphiphilic nanoparticles for high-fidelity droplet-based biochemical assays.

Stage of Research

The inventors synthesized the amphiphilic nanoparticles with various surface functional groups. They demonstrated low leakage, adherent cell growth and high enzyme activity.

Applications

- **Emulsion system for droplet microfluidics assays**, such as:
  - digital PCR
  - directed evolution of enzymes
  - high throughput screening of drugs toxicity
  - novel applications for high-fidelity assays and culture of anchorage-dependent cells

Advantages

- **Stable:**
  - uniform droplets can be generated with standard microfluidic droplet generators
  - drops stabilized by nanoparticles are stable against coalescence under typical droplet manipulations and storage conditions
- **Accurate:**
  - prevents cross-contamination due to droplet leakage
  - particles do not interfere with reagents inside aqueous drops
- **Bio-compatible:**
  - preserves enzyme activity with non-adsorbing and non-denaturing interface
  - provides rigid interface for fibroblasts and other adherent cells to attach and spread
  - non-toxic to bacteria or mammalian cells
- **Low-cost, simple synthesis:** silica nanoparticles and surface modifications are simple to synthesize compared to surfactants

Publications

- Ming Pan, Fengjiao Lyu and Sindy K.Y. Tang, "Fluorinated Pickering Emulsions with Non-adsorbing Interfaces for Droplet-based Enzymatic Assays", *Analytical Chemistry*, 87, 7938–7943, 2015
- Pan, M., Rosenfeld, L., Kim, M., Xu, M., Lin, E., Derda, R., & Tang, S. K. (2014). "Fluorinated Pickering Emulsions Impede Interfacial Transport and Form Rigid

Interface for the Growth of Anchorage-Dependent Cells." *ACS applied materials & interfaces*, 6(23), 21446-21453.

Patents

- Published Application: 20160114325
- Published Application: WO2016065333

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