

### Rapid Formation of Lipid Vesicles by Using a Microfluidic Platform

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The membrane-based systems with an array of small aperture have proven successful in a wide range of applications such as quantitative control of diffusion or filtration and precise patterning of various nanomaterials. However, the most inorganic-based membrane system is difficult to be integrated with microfluidic applications for synthesis of nanomaterial due to its rigid nature. We report that a monolithically integrated, hierarchical polymeric membrane with various sizes of apertures can be utilized to form highly uniform lipid vesicles under quantitative control of molecular diffusion.

In addition, the possibility to synthesize monodisperse asymmetric lipid vesicles is of significant interest but challengeable for bio-inspired drug delivery system, in terms of efficient encapsulation of drug and precise targeting for drug. We demonstrate that one can take advantage of the above-mentioned polymeric membrane and microfluidic setup to generate highly uniform asymmetric lipid vesicles. Specifically, the sizes of the vesicles are easily controllable from micro- to nanoscale, which can be applied to various drug delivery and biosensor applications.