

A Chemical Reaction Network Drives Complex Population Dynamics in Oscillating Self-Reproducing Vesicles

Z. Zhang, M. G. Howlett, E Silvester, P. Kukura, S. P. Fletcher *J. Am. Chem. Soc.* **2024**, *146*, 18262 – 18269

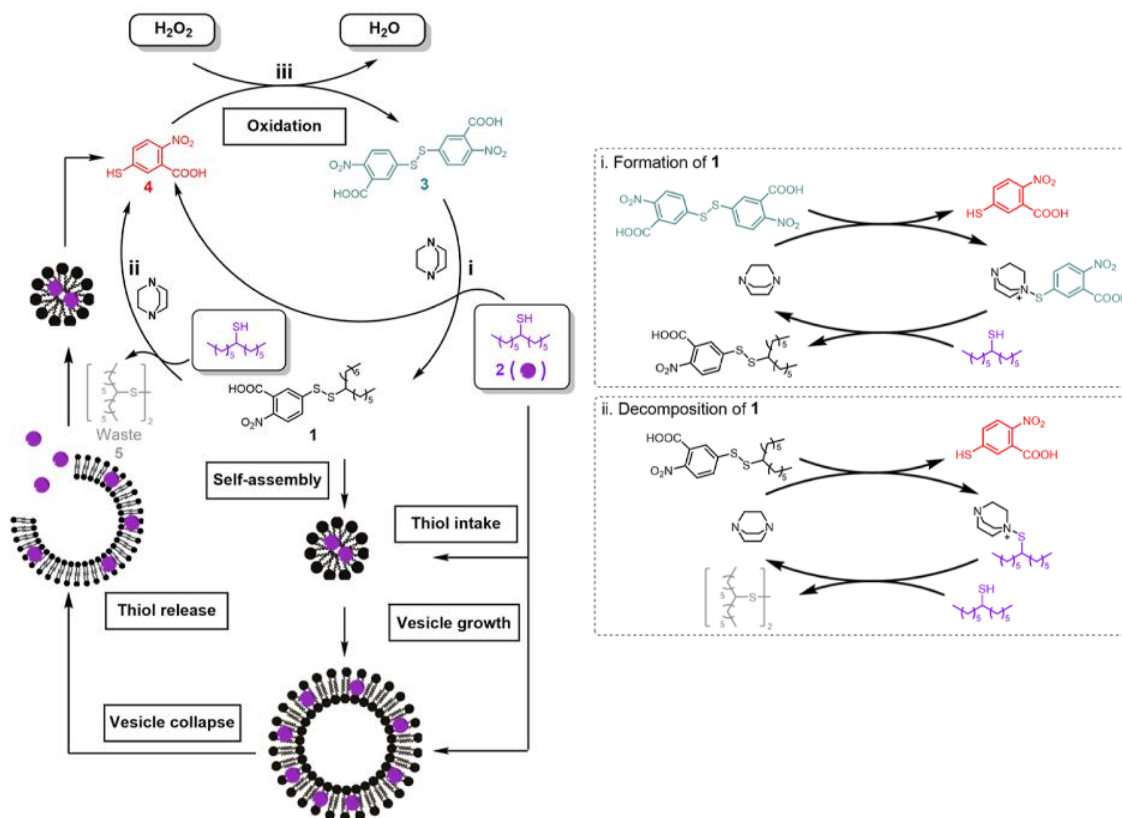


Fig 1: Chemical reactions and supramolecular events in the cycle of oscillating vesicles. (i) Autocatalytic cycle of the formation of 1, (ii) Autocatalytic cycle of the decomposition of 1

Who are the corresponding authors and what are their research areas?

Stephen Fletcher – Professor of Chemistry at the University of Oxford, UK

Author defines his research interest into three main topics including asymmetric synthesis, mechanistic studies and application and autocatalysis and origin of life.

What is the main claim of the article?

Based on related paper^{1,2,3}, this study shows an advancement on how a chemical reaction network (Fig. 1) allows self-reproducing vesicles oscillation behavior. The system could drive complex population dynamics within an oscillation pulse showing solid proofs in characterizing vesicle replication, growth or collision, decomposition and dormant or resting phase which reminisce of a reproductive cycle in living cells.

How is it demonstrated?

Key experiment of this work is mainly oscillation experiment. Author illustrated the work by showing several techniques to analyze the complex supramolecular event in real-time from oscillation experiments including kinetics investigation by UPLC (Fig. 2a), Particle count and particle mass approximation over time by

interferometric scattering microscopy and dynamic light scattering (Fig.2b) and lastly Cryo-TEM for vesicle imaging (Fig.2c).

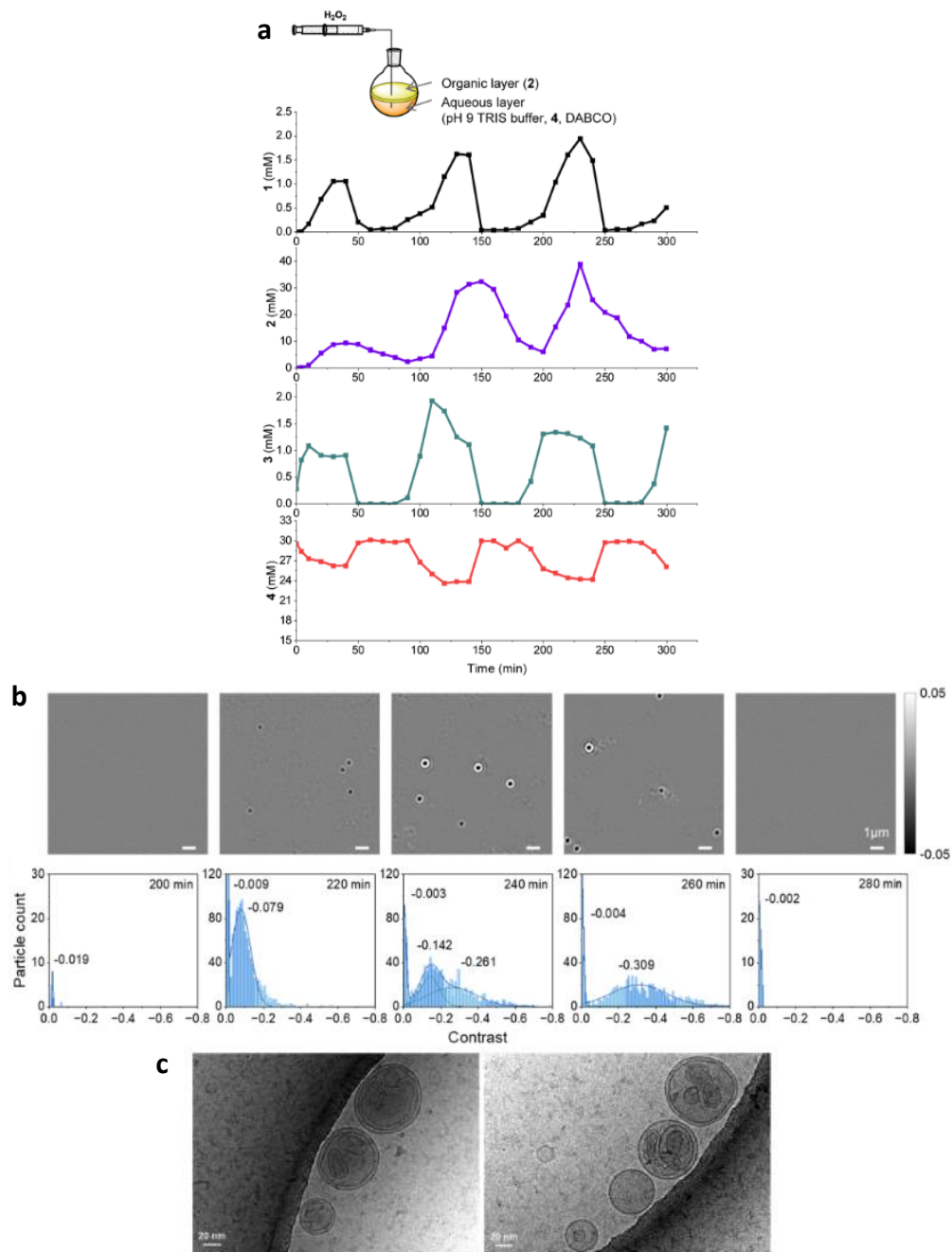


Figure 2. (a) Aqueous phase concentrations of **1, 2, 3,** and **4** as determined by removing aliquots of the reaction, quenching with 0.06 M aqueous maleimide and measurement by ultraperformance liquid chromatography (UPLC). (b) Top: iSCAT photos corresponding to the timepoint shown in pane. Bottom: fitted Gaussian curve of contrast distribution within one oscillation pulse where the changes in distribution suggest vesicles are growing (c) Cryo-TEM images of the vesicles of **1**. Images were recorded for 2.5 mM samples of **1** in a TRIS buffer (0.5 M, pH 9.00).

What are the typical experimental conditions?

Biphasic oscillation experiments: Organic phase – 0.5 mL of **2**, Aqueous phase – 4.0 mL of TRIS buffer (0.5 M, pH 9.00) with 23 mg of compound **4** and excessive 100 mg of DABCO.

Which are the key related papers?

1. S.M. Morrow, I. Colomer, S.P. Fletcher, *Nat Commun*, **2019**, 10(1), 1-9. – *Reported the self-replication of Micelle, 2-nitro-5-(disulfaneyl)benzoic acid 1.*
2. A. H. J. Engwerda, J. Southworth, M. A. Lebedeva, R. J. H. Scanes, Prof. P. Kukura, S. P. Fletcher, *Angew. Chem. Int. Ed.* **2020**, 59, 20361 – 20366 – *Investigation of chemically fueled out-of-equilibrium self-replicating vesicles based on surfactant formation.*
3. M. G. Howlett, A. H. J. Engwerda, R. J. H. Scanes, S. P. Fletcher, *Nat. Chem* 2022, 14, 805 – 810 – *An autonomously oscillating supramolecular self-replicator vesicles*