Spontaneous deformation of oil-water interface induced by the generation of a surfactant aggregate.

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Generation of elastic aggregates is one of mechanisms of biological motility; generation of F-actin gel from G-actin is essential for the formation of pseudopod in amoeboid motion. Genetic information often gives a control on such biological process, but also physical mechanism itself, known as dissipative structure, should give relevant contribution for the control. We can have better understanding on such physical mechanisms through the construction and the analysis of a physico-chemical model system that mimics certain biological process. For this purpose, we have previously constructed an oil-water system with two surfactants[1,2]. An organic phase containing palmitic acid (PA), where a solvent was tetradecane, was placed on an aqueous phase containing stearyltrimethylammonium chloride (STAC). In this setup, the interface between the aqueous phase and the organic phase spontaneously deforms in a continuous manner. The deformations are spherical and their extension and retraction typically takes 10 s. This process (blebbing) occurs in an arbitrary area at the oil-water interface and continues for typically 1 hour.

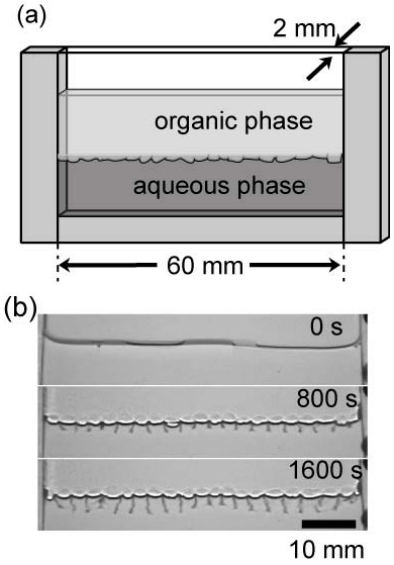

Fig: (a) Experimental setup. (b) Typical manner of pillar-like aggregate formation.

Blebbing of oil-water interface can be understood in terms of the generation of an aggregate composed of STAC and PA in the aqueous phase according to our mathematical model [1]. Appearance of aggregates in the aqueous phase was confirmed with small angle X-ray scattering (SAXS) at BL-15A in PF, KEK, we measured the microscopic structure of the aggregates, and it was suggested the aggregates have lamellar structures with an interlayer distance of around 40 nm [2].

In the above measurement, we put the organic phase on the aqueous phase in acrylic cell whose thickness was 2 mm (Fig. (a)). While observing the aggregate, we found that the pillar-like structure of aggregates was generated at the oil-water interface accompanied with the interfacial motion (Fig. (b)). The pillar-like structure was about a few submilimeters in width. It was observed that the pillar was pushed downward, i.e. into the aqueous phase from the oil-water interface. Despite that the microscopic structure of aggregates was determined through the previous SAXS measurement, the relation between the interfacial motion and pillar-like structure has not been understood. This is due to the fact that the precise position of X-ray beam has not been controlled. In this paper, we executed SAXS measurements using a microbeam of X-ray at BL-4A in PF, KEK, where the precise control of beam position in a sample is possible. In the measurement, the beam was scanned horizontally 1 mm below from the oil-water interface. Through the measurement, it was found that the direction of lamellar in the aggregates with in a pillar like structure strongly ordered in parallel to the oil-water interface.

[Reference]

[1] Y. Sumino, H. Kitahata, H. Seto and K. Yoshikawa, *Phys. Rev. E* **76**, 055201 (2007).
[2] Y. Sumino, H. Kitahata, H. Seto, S. Nakata and K. Yoshikawa, *J. Phys. Chem. B* **113**, 15709 (2009).