Surface motion caused by ionic surfactant adsorbed to air-liquid interface during chemical wave propagation

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Abstract

Surface motion is observed during chemical wave propagation in the Belousov-Zhabotinsky reaction system [1,2]. Previous studies explained that the Marangoni effect due to the surface-tension distribution drives the surface motion [3,4]. Although a fluid flow observed in the bulk of liquid quantitatively fits the results of numerical experiments obtained with the Marangoni effect [3], the surface motion has not been clearly understood.

In this presentation, we propose a model for explaining the surface motion. The model does not assume the Marangoni effect, but the existence of ionic surfactant adsorbed to air-liquid interface. Figure 1 shows the situation of the surface motion caused by the ionic surfactant. On the one hand, there exists the coulomb repulsive force between two particles of the ionic surfactant; on the other hand, there exists the coulomb attractive force between the particle of the ionic surfactant and a portion of the chemical wave front charged positively. At the initial stage, most particles of the ionic surfactant are in the bulk of the liquid. Thus, the repulsive force between two particles is not effective, because the coulomb constant in the liquid is quite small, in comparison with that in the air. After a while, the ionic surfactant comes up to the air-liquid interface, which adsorbs the ionic surfactant. In this situation, the repulsive force becomes effective. Thus, the chemical wave front attracts particles of the ionic surfactant, and at the same time, particles of the ionic surfactant are repulsed by other particles being far from the wave front.

The model proposed here can explain several points, which have not been explained with previous models. The surface motion does not appear at the initial time, but appears after a duration of time. There exists the surface motion in the virgin area being far from the wave front. These two points are not explained with previous models [3,4].

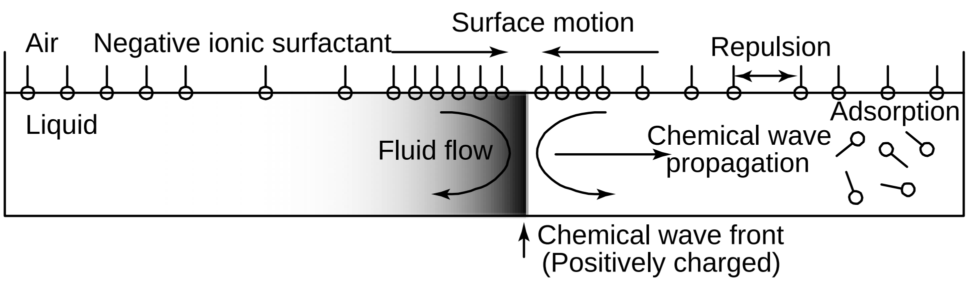

Fig. 1 Model for surface motion and fluid flow observed during chemical wave propagation.

References:

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[2] Sakurai et al., J. Phys. Soc. Jpn., **66**, 518 (1997)

[3] Matthiessen et al., Phys. Rev. E, **53**, 6056 (1996)

[4] Rongy & Wit, J. Chem. Phys., **124**, 164705 (2006)