

Electrochemical control of spatio-temporal patterns in the Belousov-Zhabotinsky reaction

(¹Graduate School of Integrated Sciences for Life, Hiroshima University, ²Graduate School of Advanced Mathematical Sciences, Meiji University, ³Graduate School of Environment and Information Sciences, Yokohama National University, ⁴Department of Chemistry and Biochemistry, Florida State University) ○Masakazu Kuze¹, Mari Horisaka¹, Nobuhiko J. Suematsu², Takashi Amemiya³, Oliver Steinbock⁴, Satoshi Nakata¹

Keywords: Belousov-Zhabotinsky reaction; Oscillations; Spatio-temporal patterns; Chemical waves; Nonlinear

The Belousov–Zhabotinsky (BZ) reaction, which self-organizes spatio-temporal patterns based on autocatalytic redox reactions, is a widely studied experimental system. The metal catalyst of the BZ reaction was loaded into a cation-exchange resin bead. We call this bead the BZ bead. Global oscillations (GO), which are the uniform oscillations in the entire bead, and traveling waves (TW), which are the propagating chemical waves from one end of the bead, were observed when BZ bead was immersed into a BZ solution without a catalyst (Fig. 1a). Previous study has reported that GO and TW could be selectively and reversibly generated by positive and negative values of the electrical potential, E , respectively.¹⁾ In this study, we found the hysteresis on the switching of the spatio-temporal patterns depending on the scanning direction of E . In addition, we discuss our results in the context of an increased concentrations of the activator, HBrO_2 , or the inhibitor, Br^- , to clarify the mechanism of switching between GO and TW.

The switching from GO to TW occurred near -0.2 V in negative scan, i.e., from $E = +1.0$ V to -1.0 V (Fig. 1b). On the other hand, when E was scanned from -1.0 V to $+1.0$ V (positive scan), the switching from TW to GO occurred near $+0.2$ V. In the negative scan, GO was maintained because oscillations in the bead were strongly affected by sufficient concentration of the inhibitor which accumulated near the positive electrode. On the other hand, TW was maintained at a small value of E due to the electrochemical production of the activator in the positive scan.

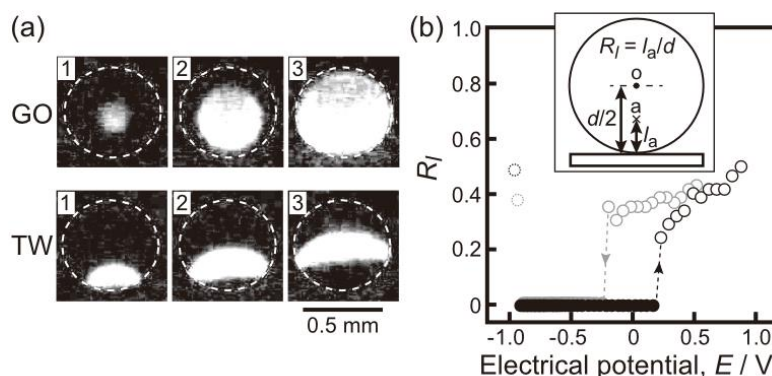


Figure 1. (a) Snapshots of GO and TW for the single bead (Time interval: 2 s). (b) The ratio (R_l) of the minimum length (l_a) between the generation point of the oscillations (a) and the surface of the plate electrode to the diameter of the bead (d) at the scanning of the electrical potential. Gray and black circles represent to the negative and positive scan, respectively.

1) M. Kuze et al., *J. Phys. Chem. A* **2019**, *123*, 4853–4857.