Light controlled oscillations of interacting Belousov-Zhabotinsky droplets

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There are many studies on information processing with Belousov-Zhabotinsky (BZ) reaction [1]. A typical translation of spatio-temporal structures into information is based on the assumption that a chemical excitation corresponds to the logical "TRUE" state and the lack of it represents the logical FALSE. Within such representation information is processed via interaction of propagating excitation pulses. This interaction can be forced by a cleverly selected geometry of excitable (or oscillatory) and non-excitable regions in the medium. A system of droplets containing BZ reaction, encapsulated in an organic phase seems to be an interesting candidate for information processing medium [2]. A structure of droplets that can exchange excitation pulses, resembles an active assembly of biological neurons. One can expect that structures of droplets interesting for information processing can spontaneously appear at properly selected nonequilibrium conditions.

A photosensitive BZ reaction allows for easy control of propagating pulses. Illumination with a blue light inhibits the reaction and thus allows for modification of the oscillatory behaviour [3]. In our system, each droplet is individually illuminated through optical fibers. At dark the medium inside a droplet oscillates. At a high light intensity, the illuminated droplet has a single stationary state and we observe no chemical pulses within it. A short time after illumination is switched off, oscillations in a droplet reappear. This behaviour allows us to control system state with a specified activation sequence (mode). Stable modes in coupled droplets can be interpreted as states of chemical memory so study on their stability is important.

In this work we investigate systems composed of two and three coupled BZ droplets as potential candidates for a simple, chemical memory cell. We generate various initial conditions using time dependent illumination of individual droplets. The experiments show that for a pair of droplets only in-phase, synchronized mode is stable whereas in case of the triplets of droplets clockwise and anti-clockwise rotational modes reveal high stability. We believe that the information remembered by a chemical medium in form of rotational mode direction can be stored for a long period of time.

1. J. Gorecki, K. Yoshikawa and Y. Igarashi, *J. Phys. Chem. A*, **107**, 1664-1669 (2003).
2. J. Szymanski, J. Gorecka, Y. Igarashi, K. Gizynski, J. Gorecki., K. Zauner and M. De Planque, *Int. J. Unconv. Comput. vol. 7*, 185-200 (2011).
3. M. K. Ram Reddy , Z. Szlavik , Zs. Nagy-Ungvarai and S. C. Muller, *J. Phys. Chem.*, **41**, 15081-15085 (1995).