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Self-sustained motion of microcapsules on a substrate controlled via the repressilator regulatory network HENRY SHUM, VICTOR YASHIN, ANNA BALAZS, University of Pittsburgh — We design microcapsules that undergo self-induced motion in a fluid along a substrate and are able to collectively self-organize when controlled by a biomimetic signaling network. Three microcapsules act as localized sources of distinct chemicals that diffuse through the fluid. The production rate of each chemical is modulated by a regulatory network known as the repressilator: each species represses the production of the next in a cycle. We show that this system can exhibit sustained oscillations. We then allow the diffusing species to adsorb onto the substrate, altering the surface interaction energy. Gradients in surface energy lead to motion of the microcapsules. We find that regulation via the repressilator gives rise to qualitatively different outcomes. Chemical oscillations can facilitate aggregation of the microcapsules and the aggregate can undergo sustained translational or oscillatory motion. Numerical simulation of the fluid flow, microcapsule dynamics and concentration fields is achieved by a combination of the lattice Boltzmann, immersed boundary and finite difference methods. We assess the role of hydrodynamic interactions by comparison with a simplified model that assumes a constant drag coefficient relating the force on a microcapsule to its velocity.

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