Chemically controlled pattern formation in self-oscillating elastic shells

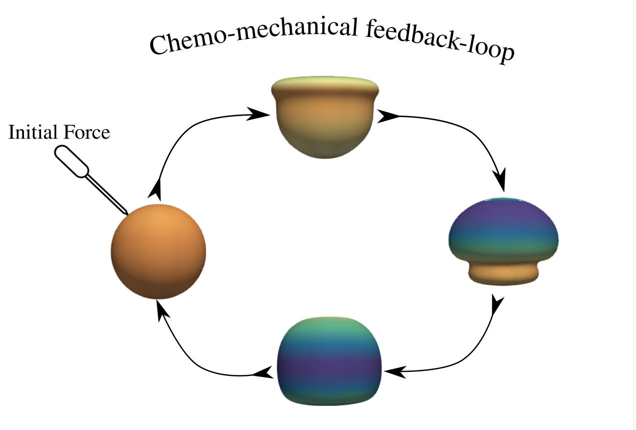

Figure 1: Autonomous responsive polymer shells that undergo morphological changes triggered by an initial deformation. The deformation causes a chemical wave that allows the intake of water leading to shell changes and dilutes the chemical concentration (from blue to orange) triggering another chemical wave. The process repeats in a feedback loop, generating diverse morphological shapes

Li, Siyu, Daniel A. Matoz-Fernandez, Aaveg Aggarwal, and Monica Olvera de la Cruz. *Proceedings of the National Academy of Sciences* 118, 10 (2021).

Work was performed at Northwestern University

Scientific Achievement

This work designs autonomous responsive elastic shells which swell and de-swell to generate specific dynamic patterns and morphologies induced by chemical reactions.

Significance and Impact

The coupling of chemical reactions with responsive gels has offered the possibility to create autonomous materials that convert chemical energy into mechanical energy and inspires the design of responsive shells to enhance the functionality of nanoreactors.

Research Details

- We first study the periodic reduction-oxidation reactions that cause swelling and deswelling of the gel. Combine the two-fluid model and shell elasticity model, we relate the chemical field to the target metric changes and investigate the local hydration impact on membrane morphological changes.

- We simultaneously incorporate the chemical dilution due to local deformation and study the reverse mechano-chemical feedback loop.

- We demonstrate the dynamic patterns triggered by an initial deformation and report a wide variety of morphologies and oscillation behavior that inspires the future design of mechanical stimulated materials with desired functionality.