Chemical Storage Units

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Oscillating chemical reactions occur far beyond thermodynamic equilibrium. The Belousov–Zhabotinsky (BZ) reactions are among the most thoroughly investigated of these. In the BZ reaction a dicarboxylic acid, for example, is oxidized by bromate in acidic solution. A redox-active species, whose oxidized and reduced forms differ in color, acts as the catalyst. Its periodic concentration fluctuations can be followed by the oscillating color change of the reaction mixture.

An unstirred chemical system whose molecules come into contact by diffusion is called a reaction–diffusion system. When an oscillating reaction takes place in a reaction–diffusion system, under appropriate conditions the two different colors of the redox system can distribute themselves in characteristic stationary structures called Turing patterns.

I. R. Epstein and his co-workers have developed a chemical storage unit based on a photosensitive BZ system. They produced a water-in-oil microemulsion of a BZ system in which a ruthenium bipyridyl complex acts as a catalyst. In the dark the system initially formed the usual Turing patterns. Intense irradiation led to the formation of bromide, which inhibited the reaction and caused the patterns to disappear.

If the light intensity was gradually increased, the patterns hardly changed until a critical light intensity (I_{sc}) was reached, upon which they suddenly disappeared. Reduction of the light intensity caused the pattern to spontaneously reappear at an intensity (I_c) below I_{sc}. In the interval between I_c and I_{sc}, the system was in a steady state, in which no new patterns could form and any patterns already present could not change. If the reaction solution was irradiated through a stencil, an image of the stencil formed on the surface of the microemulsion: Sections not exposed to light had a Turing pattern, irradiated sections did not. This image was retained for over an hour in the steady state.

If the reactants consumed in the BZ reaction could be continuously replenished, the image could be stored indefinitely. Resuming the irradiation would allow the image to be erased and replaced with a new one. In the opinion of the researchers, this fulfils the fundamental requirements for the production of chemical storage modules.

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