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CHEMSYSTEMSCH Meet the Board

Systems Chemistry: Out of Equilibrium

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What is our research focus?

My group's research focusses on the design, synthesis and better understanding of molecules that self-assemble. We are particularly interested in the self-assembly of molecules formed by chemical reaction cycles that are driven by the consumption of energy. That topic of our research is highly inspired by biology; most biological molecular assemblies are driven by cycles that use the energy obtained by the hydrolysis of GTP or ATP. An example is the ATP-driven actin network which is pivotal for the cell's force-generating machinery.

We are interested in creating chemically driven molecular assemblies in order to create more sophisticated materials. For example, the materials we recently developed have an internal clock that is controlled by the rates of reactions. If a specific reactant runs out, the material's time is up and it autonomously decays. That has led to fun applications like self-erasing inks that write temporary messages, but also more serious ones like carriers that deliver drugs after a predetermined time. Besides more sophisticated materials, we believe the systems we develop are ideal models to help better understand the fundamental principles that distinguish living matter from inanimate matter.

What is the future of self-assembling molecules?

Due to our increasing understanding of non-equilibrium self-assembly and systems chemistry, I foresee that we engineer more and more sophisticated molecular assemblies. I hope to see many new systems in which hundreds of reactants form complex reaction networks of which some of the components can assemble into structures that catalyze or inhibit reactions in the networks. Only with such systems can we rival the complex behavior in materials that we associate with life, that is, behavior like autocatalysis and self-replication. With such systems, perhaps in a not so distant future, we can create synthetic forms of life entirely from the bottom up.

What should we teach students?

I am surprised to see that Supramolecular Chemistry is not always part of the curriculum of Chemistry students. The field has now been endowed with two Nobel prizes and is widely applied in industry and academia. Let us teach every chemistry student at least the basics of supramolecular chemistry.

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