Self-Assembly and Self-Construction

Jerzy Maselko

Chemistry Department, University of Alaska Anchorage, 3211 Providence Drive Anchorage, AK 99508
USAafjm1@uaa.alaska.edu

Extended Abstract

The spontaneous increase of complexity in nature from the formation of elements, followed by the formation of compounds, both inorganic and organic, leading to the emergence of life -- from a single cell to multi-cellular organisms -- and the later formation of communities followed by the emergence of new technologies where complex structures are created by a humans is probably the most important property of matter.

One common property of self-construction is the formation of new entities. The formation of elements and chemical compounds are relatively well studied, so the next step is to study the transition from non-living to living matter. This requires formation of complex structures on a scale that begins with nanometers and increases. Most of this is done by "self-assembly," defined as a process that must be completed without external assistance and must include stochastic aggregation of pre-existing components. The formation of more complex structures inside cells and in multi-cellular systems requires a more complex mechanism. Here, the formation of structures requires a complex network of physical and chemical processes that are precisely organized in space and time -- the parts are constantly produced in hierarchy. The stochastic process of movement is replaced by the controlled movement of different parts (components) using different forces and different routes. This process can be seen in the formation of magnets in magnetic bacteria; functioning of xylem and phloem in biological plants; veins, arteries and the lymphatic system in animals; as well as tubes and pumps in industrial plants.

This complex spatio-temporal organization of chemical and physical processes that goes beyond the simple process of self-assembly can also be observed in chemical systems. The construction of complex forms is controlled by the complex network of chemical reactions. These chemical and physical processes may start in a defined place in space and time and be finished in another. This will be discussed in the case of precipitation pattern formation in simple, even two component inorganic systems like, Cu^{2+} - PO_4^{3-}, $Al^{3+,}$ silicate, Cu^{2+} - $C_2O_4^{2}$, Pb^{2+} - chlorite – thiourea, and Fe^{2+} - silicate.

Most of these structures are grown from a chemical seed that is immerged in a chemical solution. The initial study of this seed theory is based on studies of cellular automata and numerical studies of multi-cellular chemical systems development, which will also be presented.

The biological organism evolves forming structures of unbelievable complexity and precision in its construction process and in the functions of its controlling systems.

The emergence of man follows as the next important step in the self-construction of the universe. It has allowed the emergence of new construction technologies that have increased the number of constructed systems and their properties. As predicted by Leonardo da Vinci, we now have the capacity to create technology:

> ***"Where nature finishes producing its species, the man begins with natural things to make with the aid of this nature an infinite number of species."***
>
> ***-Leonardo da Vinci (1452-1519)***

A final important step for discussion regards the construction of computers, allowing for the mathematical modeling and, further, the construction of virtual universes.