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Editorial

Evolving soft matter: shape, dynamics and functionality

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The theme of this Special Topics issue, "Evolving Soft Matter: Shape, Dynamics and Functionality", refers to physical phenomena and their description where, for example, physics meets biology. Soft Matter was first introduced at a NATO Advanced Study Institute held in Geilo, Norway, in 1989 [1]. It was the first international meeting to be concerned with the growing area of soft matter, which is neither ordinary solids nor ordinary liquids, but somewhere in between. Soft matter or soft condensed matter is a subfield of condensed matter physics. This field comprises a wide range of physical systems that are structurally altered by thermal or mechanical stress of the magnitude of thermal fluctuations. They include colloids, granular materials, liquid crystals, liquids, polymers, foams, gels, and various biological materials. An important common feature in these materials is that physical behaviors predominantly occur at an energy scale comparable with room temperature thermal energy. *Evolving* soft matter emphasizes that the theme relates to processes like growth, expansion and transformation developing over time.

The motivation for choosing the subthemes Shape, Dynamics and Functionality was that each of these is a fundamental property essential for characterizing Soft Matter which is evolving. This will be discussed in more detail below.

(A) **Shape** is an important concept in biological materials. Besides having extraordinary physical properties, biological materials can also change shape and volume. These changes are important for organisms to form new tissues during growth and morphogenesis, which literally means "shape creation". This can also relate to repair and remodeling of old tissues as well as leading to effective force generation and motion as in muscles. The surrounding underlying tissues may also influence the growth and actuation of confined tissues. The shape aspect is thus an important feature to understand fundamental processes of growth and morphogenesis. Ideas stemming from such studies can also be used to design new materials in areas like medicine and robotics.

Examples of these phenomena are given in the papers by Holland et al. [2], Nouhi et al. [3], Gozen and Dommersnes [4] as well as Fossum [5] in this issue.

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(B) **Dynamics** in evolving soft matter occurs as nonequilibrium phenomena where local shape and curvedness changes in moving surfaces and interfaces as for example in growth, fracture, deformation, pattern formation, flocking behavior and morphogenesis in living matter. Practical applications are thus of vital importance in areas such as chemical engineering, material science, biotechnology, biophysics, plastic industry and food processing. To characterize such systems, non-invasive experimental techniques are needed such as neutron scattering, NMR methods, mechanical relaxation and dielectric broadband spectroscopy.

Examples of these phenomena are given in the papers by Shishkov and Hu [6], Lima et al. [7], as well as Gozen and Dommersnes [4] in this issue.

(C) **Functionality** of evolving soft matter is abundantly important in all biological materials. In addition, functionality is important in many applications like the use of foams, adhesives, detergents, cosmetics, paints, food additives, lubricants, smart materials and soft robotics. It is important to note that the functionality of soft matter critical to their macroscopic behavior manifest itself at the mesoscale level. It is thus typically a correlation between hierarchical mesoscopic structures.

Living organisms are made from materials unique to life: nucleic acids (DNA and RNA), proteins, carbohydrates, and lipids. The biological function they perform takes place in a complex interface made of units like biopolymers and membranes.

Examples of these phenomena are given in the papers by Trindade et al. [8], Agudo-Canalejo and Golestanian [9], Kitaoka et al. [10], Gozen and Dommersnes [4] as well as Fossum [5] in this issue.

The papers in this Special Topics issue thus reflect well the diversity of work in this area.

This special issue on "Evolving Soft Matter" originated at a recent "Geilo School" (GS) [11], the twenty-fifth GS in a series held every two years since 1971 [12].

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11. The Geilo School 2019, 11-21 March 2019, Geilo, Norway. A comprehensive list of lecturers, poster sessions and participants can be found in Evolving Soft Matter: Shape, Dynamics and Functionality (2019) IFE Report IFE/E-2019/015, ISBN: 978-82-7017-924-4
12. A list of previous Geilo schools may be found at https://ife.no/en/project/the-geilo-schools/