Fraunhofer CPM

FOSTERING THE PARADIGM SHIFT IN MATERIALS RESEARCH

International Conference on Programmable Materials

27 - 29 April 2020, Berlin

Symposium

Mechanical metamaterials

Mechanical metamaterials and programmable materials have the potential to initiate a paradigm shift in materials science and engineering. Through the design of their complex inner structure, properties of metamaterials outperform technological materials (e.g., directing light or sound around objects by altering local properties). Programmable materials go way beyond that: the mechanical behavior the material can be design to act like a system assembled from many components. Programmable materials can initiate a paradigm shift in the handling of materials by replacing technical multi-material systems consisting of e.g. sensor, controller, actuator and power supply with a single locally configured one.

Programmability in materials results from a specific combination of **logical elements** (e.g. **IF** T > 80 °C **THEN** stiffness = 10 GPa, **ELSE** stiffness = 1 GPa), **material storage** (e.g. **bistable or multistable** mechanical or molecular states) and the **ability to process functions** (e.g. transverse contraction as a function of strain in x-direction). With such elements in place, the response of a material to an external signal or loading condition can be programmed. The behavior of the material can then either be triggered externally (by applying an electric field or by pressing a specific point) or the programmable material can, for example, adapt automatically and in advance to changing conditions.

The symposium aims to bring together experts:

- Topology elementary cell designs for specific surface, interface and bulk properties (e.g. stress transfer, Young's modulus, Poisson's ratio, acoustic and damping properties).
- Structural mechanical mechanisms (e.g. bistability, anisotropic mechanical properties) and their mechanical description at different hierarchies.
- Scaling of mechanical properties (size effects, scaling effects of mechanical properties from different manufacturing methods).
- Complex mechanical behaviors (e.g. adaptivity, self-healing) by design and their impact on system functionality.

At last, we will discuss how the interaction of mechanisms can be implemented into a design process to enable complex responses. The aim is to design programmable materials so that they actuate in a predetermined way. The ability to predict complex behavior will allow program materials to replace components in systems. Therefore, they can be used to replace elements or simple technological systems based on sensors, processors, actuators, and structural or mechanical parts in the future.

Symposium organizer
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