TU Clausthal

CAMPUS
Funktionswerkstoffe und -strukturen

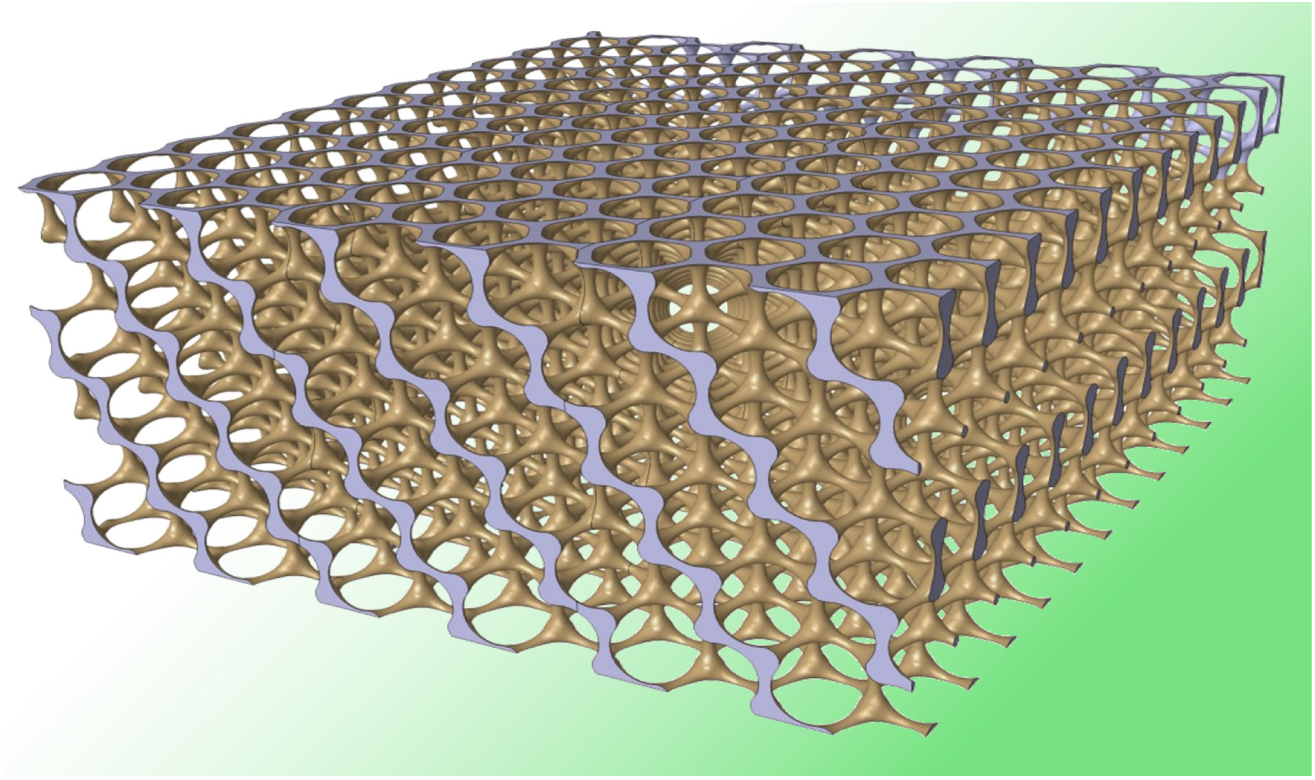
An Institution of TU Clausthal

In association with DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center, BAM

Campus Funktionswerkstoffe und -strukturen

(Campus for Functional Materials and Functional Structures)

A new research association of the Clausthal University of Technology



Partners, objectives and tasks of the new research network for material science

Three institutions have decided to closely collaborate in the field of advanced functional materials and functional structures:

- the **Clausthal University of Technology (TUC)** with multiple institutes oriented in material science
- the **Deutsches Zentrum für Luft- und Raumfahrt [German Aerospace Center] (DLR)** with its institute of composite lightweight structures and adaptive systems in Braunschweig
- the **Federal Institute for Material Research and Testing (BAM)** with its specialized department for materials engineering.

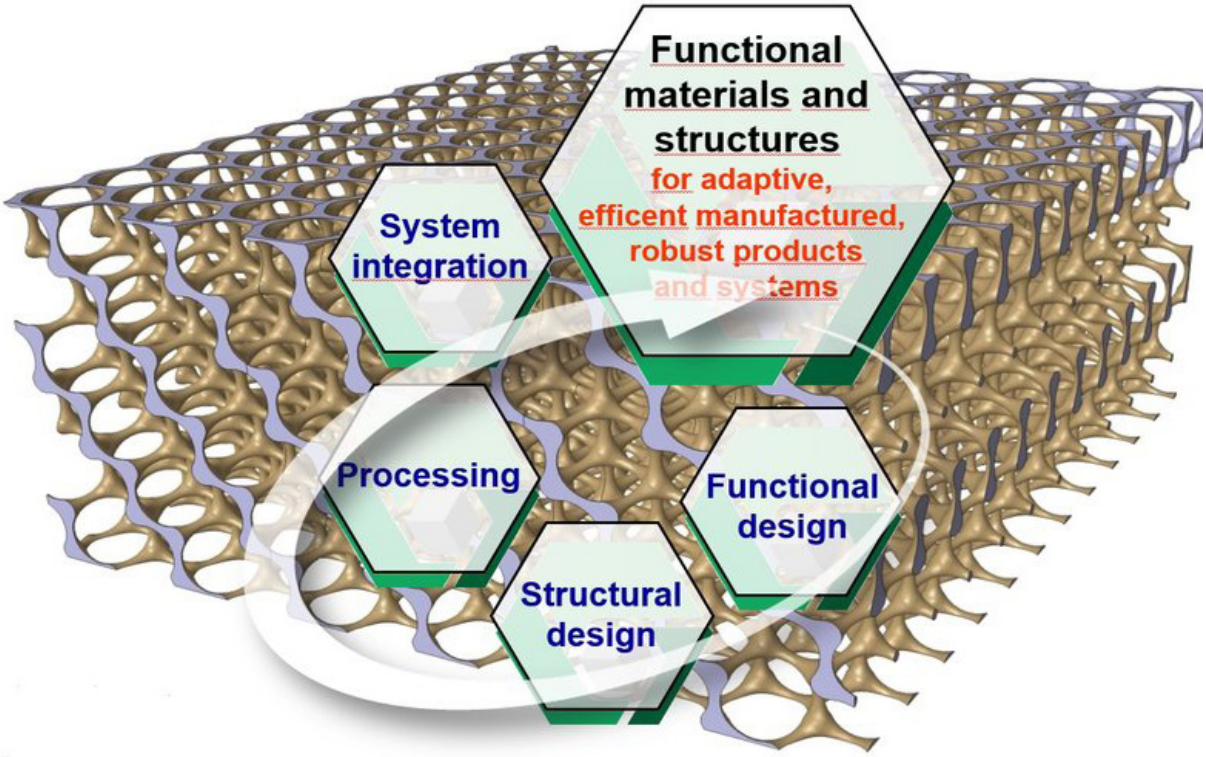
For this purpose, the cooperation partners have created a new research association as legal base, the so-called

Campus for Functional Materials and Functional Structures

Thus being a scientific institution of TUC, this campus is directly assigned to the executive committee of the Clausthal University of Technology. The common objective of the cooperating scientists is the

realisation of structural systems for adaptive,
efficient and tolerant high performance lightweight constructions.

Latter are the products of the development of functional materials and structures along a process chain, which includes the functional design, the structural design, the processing and the system integration.

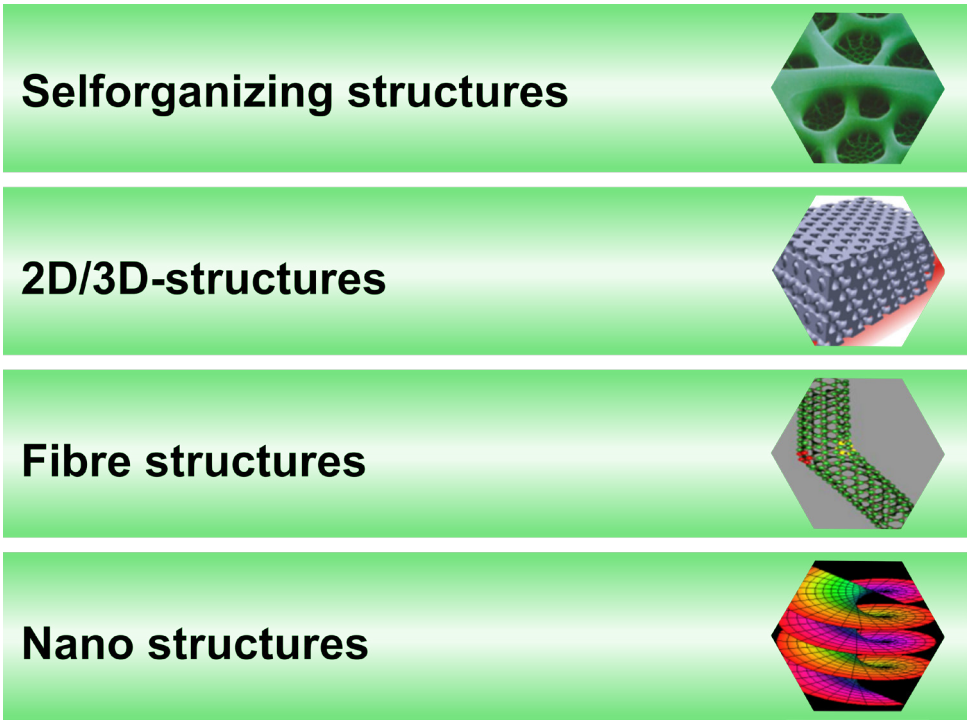


Tasks and project areas of the campus

Among the tasks of the campus are:

- the support of interdisciplinary development work and the execution of the interdisciplinary fundamental research on the field of functional materials and functional structures (up to the exchange of employees and registration of collaborative inventions)
- the funding of young academics on the basis of joint education in the framework of Bachelor and Master theses up to dissertations as well as
- the collaboration with other scientific institutions and innovative companies in the fields of research and education (involvement in special research fields, cooperative acquisition of governmental subsidies, coordination with corporations and scientific colloquia).

The project fields of the campus are guided by the following structural categories:



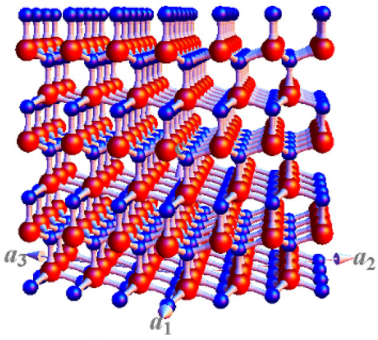
Functional Materials and Structures

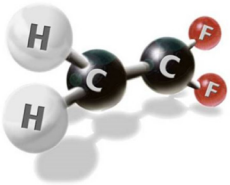
In material science it is common to categorize materials into construction materials and functional materials. Construction materials, also known as structural materials, are non-activatable materials which are primarily used due to their outstanding mechanical properties (such as strength, stiffness, density, hardness, etc.). A classical example for this is steel.

Functional materials however possess properties which allow an energy conversion inside of the material on the basis of physical effects. They can be used directly as material-based energy converter, or it is possible to modify their material properties deliberately and reversible. Functional materials are not assigned to one single material group.

Examples of functional materials are:

- piezoelectric materials
  (e.g. ZnO, BaTiO3, PVDF, KTN, KNN)
- optomechanical materials
  (e.g. LiNbO3, KTN, ZnO, SBN, Azo-polymers)
- shape-memory materials
  (e.g. NiTi, ZrO2, AuCd, CuZnAl)
- electro active polymers
  (e.g. CNT)
- electro- und magnetostrictions
  (e.g.PMN, Terfenol-D, Fe3O4).



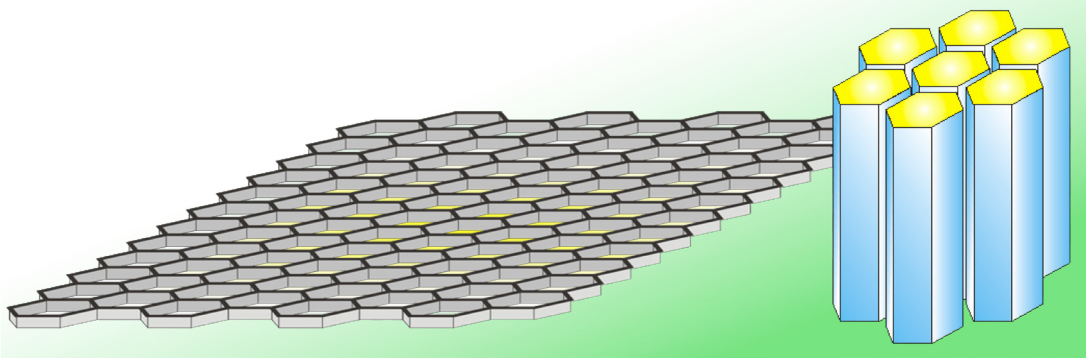


The phenomenon of **functionalization** of materials, present in both construction and functional materials, can be observed as soon as a special patterning of the component or its surface happened, such as generating adhesion on plain surfaces by the creation of hexagonal nano-beams. Therefore the campus has put functional structures additionally to functional materials as the main focus of its research fields, carrying both in its name.

Functional structures are materials with special structuring, resulting in a functionalization which exceeds the simple original mechanical application. Thus, functional structures are used to provide components with new properties. The potential of multifunctional utilization of these parts is especially high with functional materials. Those functional structures therefore can be interpreted as advanced special materials with a high degree of functionalization.

Examples for functional structures are:

- CNT-fibers
- double coil springs for vibration isolation of rear view mirrors on cars
- piezoelectric actuators in the form of honeycomb structures
- nano tubes and helical membranes made of piezoelectric zinc oxide
- piezoelectric nano composites
- bio-inspired and selforganizing or potential-based designs.

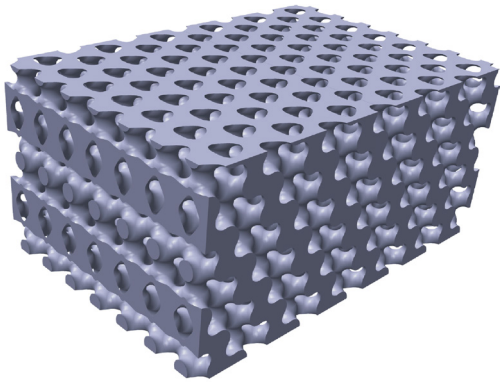


Research

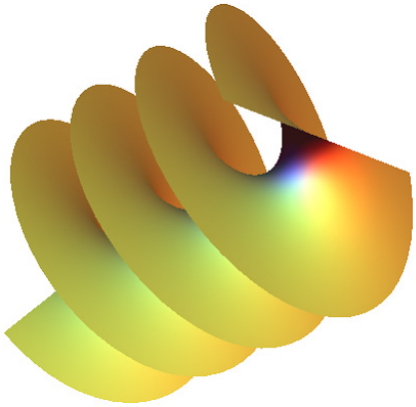
Recent research topics focus on following promising material systems:

- lead-free transparent photovoltaic piezoelectric systems (especially ZnO- and KNN-systems)
- fiber optic sensors in fiber-reinforced plastics
- biomaterials
- functional surfaces
- nano composites
- new carbon modifications (graphene, helicoid, catenoid)
- CNT-based fibers
- self-healing structures

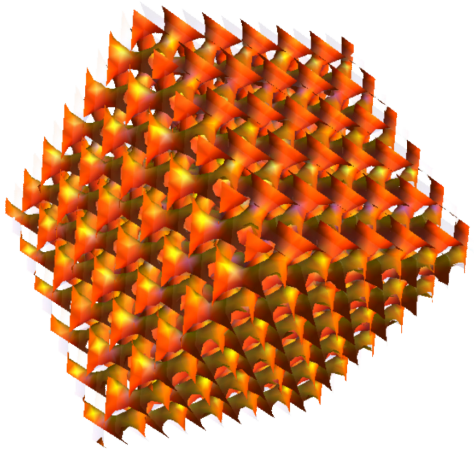
- additive production processes



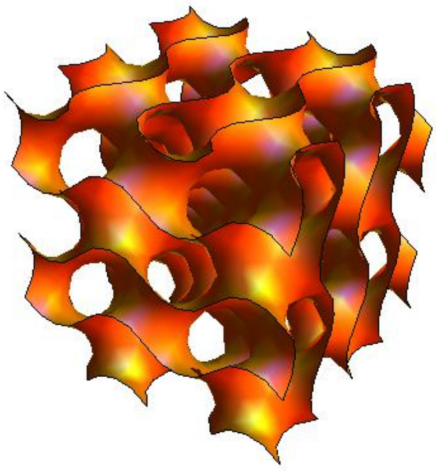
- Photronic© materials („adaptronics with photons“)



- nano structured actuators



- diamond like high performance

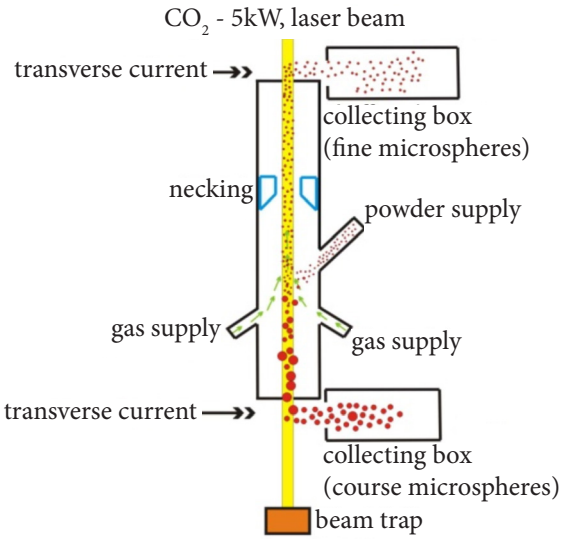


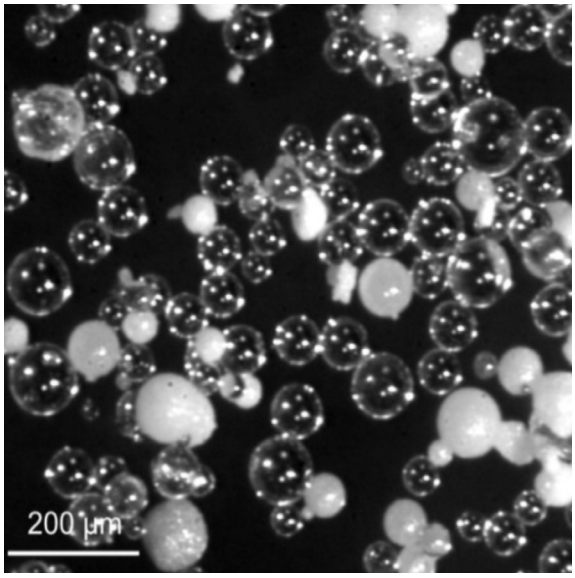
- selforganized forming processes

Research projects of the campus

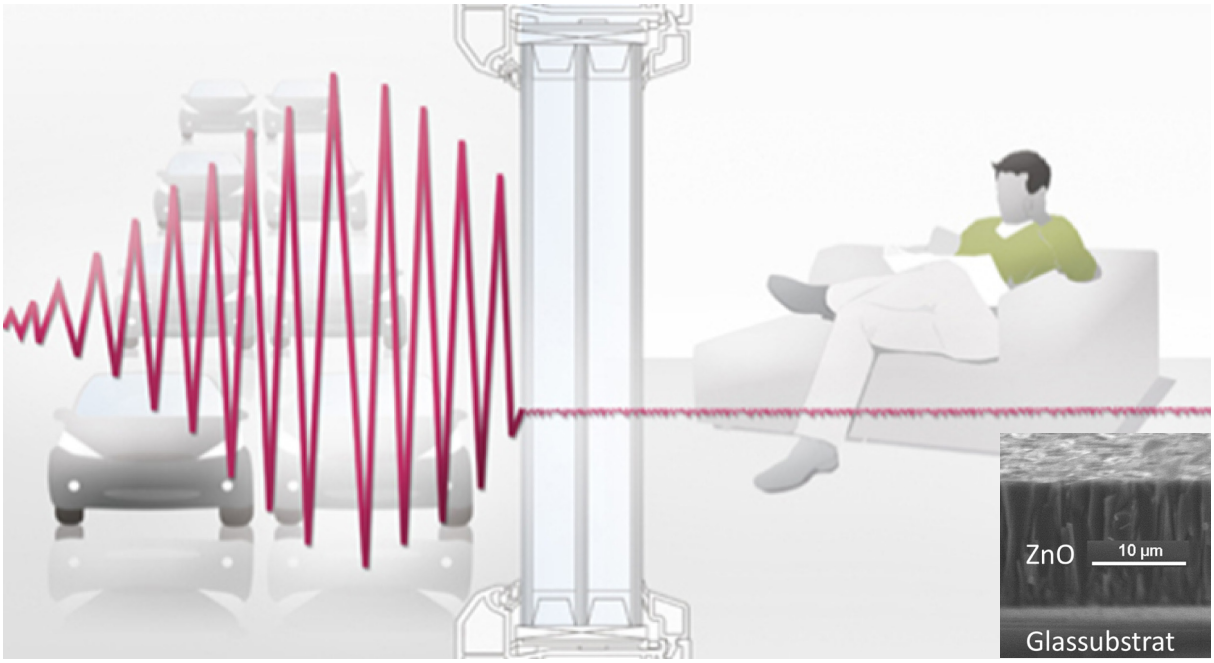
The first cooperative **research projects** already demonstrate the effectiveness and the efficiency of our successful collaboration in attractive fields of research up to the foundation of new main research focus. At this, the **Campus for Functional Materials and Functional Structures** is the basis to join the individual fields of competence. Amongst the first research projects are:

- lead-free transparent ceramics made of laser fused micro-spheres





- multifunctional self-cleaning windows with transparent photovoltaic and active noise protection via transparent piezoelectric zinc oxide



Fields of Application

The array of possible fields of application of functional materials and structures includes many technical areas:

- aerospace
- energy engineering
- traffic engineering: automotive engineering, high-speed trains, shipbuilding
- communications
- medical engineering
- building and plant construction, architectural glass industry
- optics
- sensor systems, measurement technology, form measurement
- robotics, handling technology, manufacturing automation, nano positioning
- sports industry
- air conditioning and heating systems

Possible products and product improvements of the new campus:

- sound, shock and vibration absorbers
- energy harvesting systems
- structural health monitoring systems
- structure compliant actuators for adaptronics
- transparent sensors, bio- and gas sensors
- optical transistors and computers
- switchable transparencies, touch screens
- active window panes
- implants
- harmonic scalpels, micro-surgery
- supersonic shavers
- mobile phone vibrating alert
- adaptive skis and snowboards, tennis rackets
- de-icing systems
- injector nozzles
- active chassis
- pressure bearing
- adaptive robot systems
- precision optics
- form measuring machines
- vibrating shoe inserts
- dynamic stable binoculars ...

Persons of contact

The accession of further partners to this cooperation is possible for non-university and university research facilities. This, the decision-making on new projects and research topics, the briefing on the process of ongoing projects and much else is governed by the steering committee of the Campus Funktionswerkstoffe und -strukturen.

Based on the fields of competence new technical dialogues with industrial developers and users are sought by the three cooperation partners. Special industrial working parties promote this transfer of technology.

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