Particle design for functional devices

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Advanced materials with properties tailored on the molecular and mesoscales are expected to stimulate evolutionary advances and revolutionary breakthroughs in emerging key-technology areas such as information and communication as well as catalysis, energy, and transportation. The creation of tailor-made products made from nanoscale building blocks is one of the grand challenges in nanotechnology. Nanoparticles as building blocks are controlled by surface and interparticle forces. Therefore, the microscopic control of the interfaces is a key requirement for product design and handling of nanoparticles. This approach may create large effects, for instance in suspension rheology, by even minor system changes. We present a multi-scale view from the molecular level towards macroscopic effects and applications. These approaches are studied within the excellence cluster “Engineering of Advanced Materials – Hierarchical Structure Formation for Funtional Devices” which is funded for 5 years within the German excellence initiative. The vision of the CE is to bridge the gap between fundamental research and real-world applications of modern high-performance materials in key scientific and engineering areas. Based on a coherent methodological approach selected priority areas of research will be explored, including nanoelectronic materials, photonic and optic materials, catalytic materials or lightweight materials.
Various examples are presented for nanomilling and dispersion, continuous precipitation, structure formation in thin films showing that the same principles are applicable to a variety of applications. A case study will be presented for printable electronics. The rational design of tailored interactions between nanoparticles opens new opportunities in product design and process technology.

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