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Smart materials for smart production – a cross-disciplinary innovation network in the field of smart materials

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Abstract

smart³ is a cross-disciplinary network focusing on innovative and meaningful applications of smart materials. The network consists of engineers, designers and economists as well as material- and social scientists collaborating with small and medium sized enterprises.
As well as giving an overview on different smart materials, this conference contribution shows how engineers and designers have cooperated in creating product concepts within the strategic categories *smart production, smart mobility, smart health* and *smart living*. Design models will visualize the output of R&D projects. The smart³-network comprises a radical change of paradigms in product development by implementing smart material functions directly into the component structure. Hence functionality will already be achieved on the material level.

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Keywords: smart materials; design; innovation management; manufacturing network; design method; sustainable development

1. Introduction

The German Federal Ministry of Education and Research (BMBF) announced in 2012 a new research program called “Twenty20 – Partnership for Innovation”. Universities, research institutes and industries were encouraged to form transdisciplinary consortia to define prospective research fields that could address relevant future challenges. For us, it was the creation of the *smart³-network* focusing on innovative and meaningful applications of smart

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materials. The network consists of engineers, designers and economists as well as material- and social scientists collaborating with small and medium sized enterprises. The smart³-network comprises a radical change of paradigms in product development by implementing smart material functions directly into the component structure. Instead of separating the function from the structure, the integration of the functionality will already be achieved on the material level.

However, a successful paradigm shift on the product level can only be achieved if the paradigms of the separate academic disciplines are first overcome. Within the smart³-Network this has already been successfully achieved rudimentarily and has thus illustrated the added value of this change process.

2. Overview of smart materials

Functional materials, so called smart materials, have the ability to adapt to external environmental conditions i.e. they are able to change their properties through external physical stimuli so that, they are optimally adapted to their surroundings. These processes are accompanied by energy conversion processes. Thus, smart materials can for example, convert mechanical energy into electrical energy and vice versa. These properties predestine smart materials to act as sensors and actuators. They enable high functionality in simplified structures, already on the material level. Therewith, a new and better quality can be achieved in product design. The form stringently follows the function, the usability becomes intuitive and follows natural paragons.

As physical stimuli for example, electrical fields, magnetic fields, heat or light can be considered. The materials react by changing their geometry, their electrical resistance or their capacity. The variety of known smart materials is very extensive (see Fig. 1).

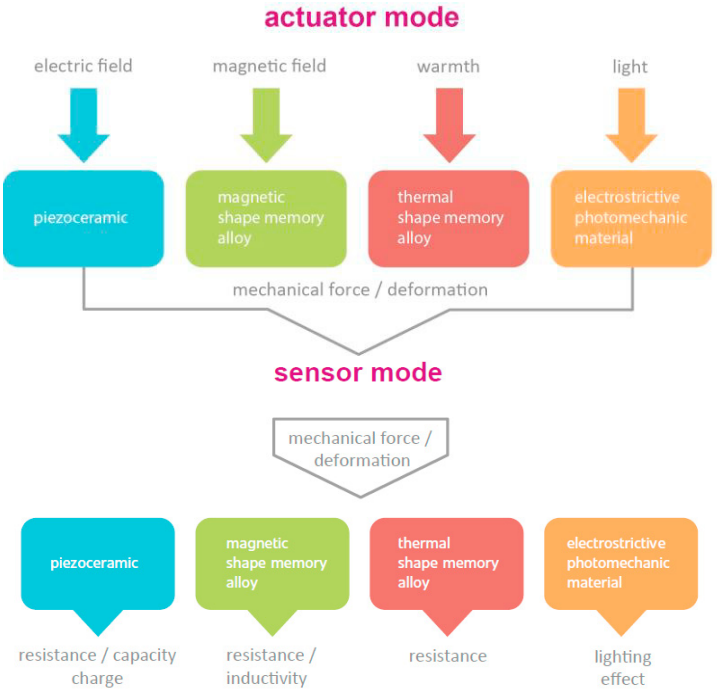

Fig. 1. Overview of smart materials

Therefore, the Consortium is specialized in four classes of materials:
Thermal **S**hape **M**emory **A**lloys (SMA), **M**agnetic **S**hape **M**emory alloys (MSM), **D**ielectric **E**lastomer **A**ctuators (DEA) and Piezoceramics. The technological maturity level of the 4 material classes are from a product point of view very different which has had ramifications on availability, semi-finished products, costs, production capacity and research requirements.