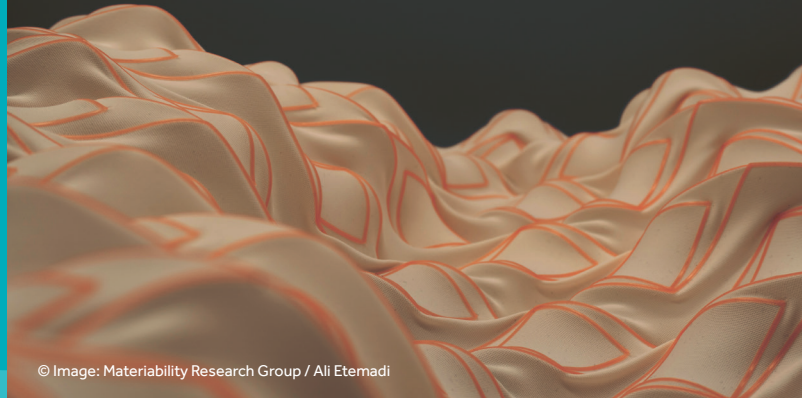




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Smart Materials: 4D Printing and Intelligent Interfaces

The Autonomous Materials research project investigates how dynamic and smart materials with shape-changing properties can be used to develop intuitive, multi-sensory interactions. The focus is on functional surfaces, realized through large-format 3D printing on textiles, which act as tactile interfaces between humans and technical systems through integrated sensors and actuators. Novel to this research is the integrated approach to the conception, design, and manufacturing of material and physical human-machine interfaces (PHMI) aimed at developing a holistic composite material. By combining material design, digital fabrication, and interactive control logic, large-scale material systems are developed that respond to environmental stimuli and human input — integrating light, shape change, and movement into unified, responsive experiences, to support perceived safety, trust, or emotional engagement in various application contexts.

Results, Checkpoints, Next Steps

The project work generates extensive material and process studies on shape-changing structures and 3D-printed textiles, with a particular focus on soft-robotic structures and 4D printing approaches. In these approaches, geometry, material combinations, and printing strategies are deliberately designed to enable time-dependent or stimulus-responsive shape transformations. The results are consolidated into a systematic material library, documented experimental series, and application-oriented demonstrators. These demonstrators showcase various functional principles — such as pneumatic, thermal, or mechanical

actuation — at full scale (1:1) and make them accessible for further research as well as for cooperation with industrial partners.

Funding

Autonomous Materials: Interface to the Technical System, Multisensory Interaction and for the Generation of Emotion, Safety and Trust

Project Number: ZS/2023/12/182019

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