High-Frequency Welding of Particle Foams

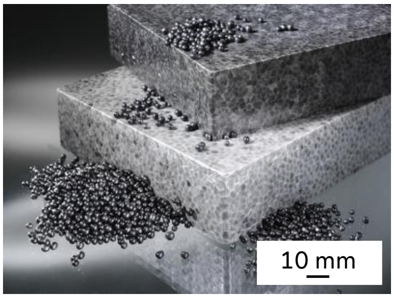
Motivation

By welding of particle foam beads complex and lightweight three-dimensional components with a homogeneous foam structure are produced (Fig. 1). For the manufacturing in the current state of the art process, the Steam-Chest-Molding process (SCM), hot steam is used to heat, soften and weld the foam beads to the desired geometry. This requires high volumes of water but also high amounts of energy to produce the necessary steam.

By the adaption of the high-frequency welding process, which is mainly used to weld thin foils, an energy and resource efficient alternative to the SCM-process is introduced. To allow the heating and welding of the foam beads, newly designed molds made of electrical insulating materials are required (Fig. 2), which are also one focus of research in the field of HF welding.

Application

Foam components combine low densities, good thermal and acoustic insulation as well as high energy absorption at impact. Therefore, the main applications of foam components are packing material, impact protectors in the field of automotive (Fig. 3) an insulation due to their low thermal conductivity.



[1]

Fig. 1: Particle foams – loose beads and welded components

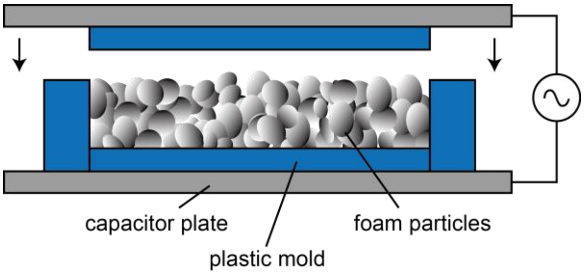


Fig. 2: schematic mold design for the high-frequency welding of foam particles

[2]

Fig. 3: Front bumper made of particle foam

[1]: Frauenhofer ICT
[2]: Engineered Foam Products

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Research focus

The heating mechanism in the high frequency welding process is based on the interaction of the materials with the applied electric field. To achieve good heating, frequencies in the Megahertz regime are used. At the same time, the chemical structure of the to be welded foam material is crucial for its heating potential. While materials with an high amount of dipoles (e.g. TPU or PVC) show good heating, polymers with an symmetrical or nonpolar structure (e.g. PE, PS or PP) hardly interact with the electrical field, resulting in insufficient heating.

However, the main amount of polymeric foam beads is based on nonpolar materials. Therefore, the main focus in the field of high-frequency welding is a modification of these materials to make them accessible to the process. This is done by the application of a heatable coating (Fig. 4). Inside the welding process, the foam beads are passively heated by their coating until a welding is achieved.

Main research results

By the application of a high-frequency heatable coating material (Fig. 5) the portfolio of processable polymeric foams is expanded. Since no additional water or steam is required during the heating and welding process the design of the molds may remain simple. Also the handing of the coated particles is similar to uncoated ones. Additional the coating is not restricted to a specific particle foam material.

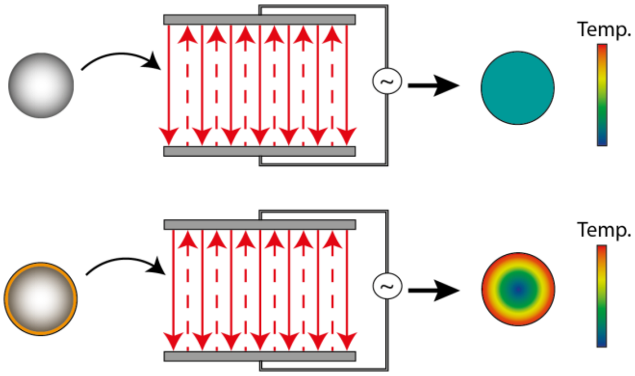

Fig. 4: *heating behavior of uncoated and coated (ePP/ePS) foam particles (schematic)*

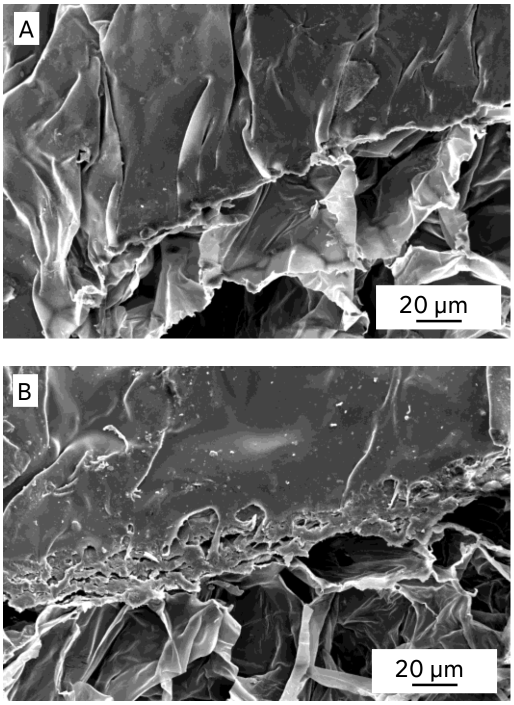

Fig. 5: *SEM-image of ePS foam particles:*
A) without heatable coating
B) with applied coating

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