Foaming with infrared radiation on a large scale

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Currently an infrared radiation device is set up at the Fraunhofer-Institute for Machine Tools and Forming Technology (IWU). The infrared radiation device has been designed during the research project "Rapid infrared foaming of metallic parts in an industrial scale" in collaboration with the industrial partner XERION®. It has been funded by the Sächsische Aufbaubank (SAB). Objectives of the project are large scale flat foam panels such as sandwiches or metal foam plates.
The Fraunhofer-IWU uses for foaming the so called powder metallurgical route. That way foam is created starting with a mixture of metal powder and a blowing agent followed by an extrusion process that creates the precursor material for the foam production (FIGURE 1). The described foaming process needs a lot of energy for the precursor heating which is the final step of the foam production.

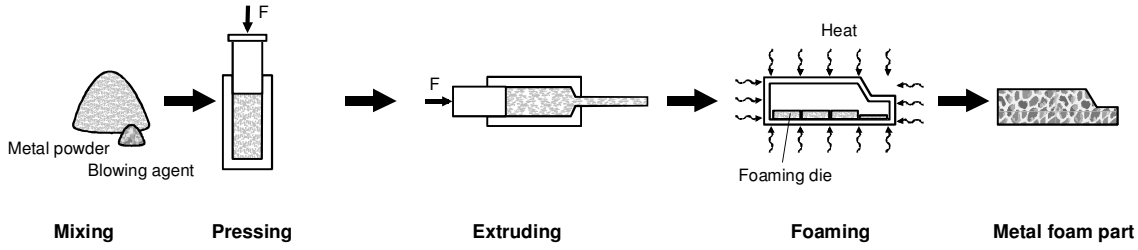

FIGURE 1: Process steps of the powder metallurgical route

Currently the process takes place in a large electrical heated furnace (FIGURE 2). That type of heating involves a lot of disadvantages. First one is the way of the heat transfer because the process is based on convection which is less effective than for instance radiation. On the other hand, no matter of the dimensional size of the foam part, it's necessary to heat the complete furnace. That way there is a need of a huge amount of energy that besides the necessary heating of the parts is associated with an immense waste of energy for heating additional space and material (FIGURE 3).
The objective of the infrared radiation device is to break new ground for the foaming technology. So a closed furnace is not needed anymore and radiation is used instead of convection for the heating process.

FIGURE 2: Electrical heated furnaces used for foaming

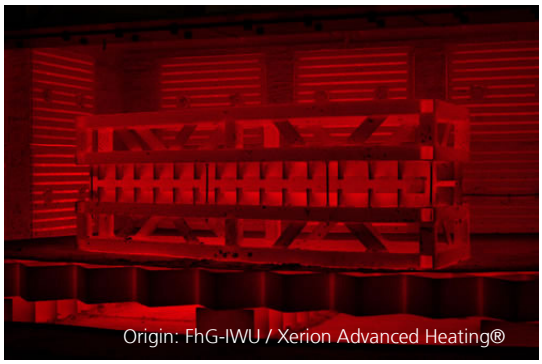

FIGURE 3: Heating the whole furnace needs a lot of energy

The irradiated area covered by the device is 2,500mm x 1,250mm, which is the middle size standard of the sheet metal industry. Final claim of the research project is to get the ability for foaming sandwiches and metal foam plates in that dimension. It is conceivable that the acceptance of metal foam sandwiches in industrial applications will be raise.

Another point for more acceptance are lower prices which will be reached by lowering the running costs of the production. The modular design of the device will help to save costs and energy. Background of the modular design is the use of 60 identical infrared modules (FIGURE 4). These modules are located in two levels below and above the sandwich or foam plate. By using this arrangement it is possible to select only the modules which face directly at the sandwich: small sandwich - less modules in operation; large sandwich - more modules will be used. The modular design also improves the metal foam quality. The keyword here is a homogeneous temperature distribution during the heating process. An intelligent control system behind the number of radiation modules has been installed to realise that.

FIGURE 4: Prototype of the infrared heating system

To achieve an almost homogeneous temperature all over the part different simulations has been set up. Parameters of the simulation have been for instance the distance between emitter and foam part, temperature of the emitter and distances between the different emitters. The parameter values have been varied within a defined area. There is no optimal solution for all kind of parts but some very good combinations have been found. One model and the resulting temperature distribution is shown in FIGURE 5 and FIGURE 6. As visible in FIGURE 5 the emitters around the foam plate should have a higher temperature than the emitters in the centre. The reason for that appearance can be found looking at the radiation of the foam plate to its surrounding area. That is only one fact that shows the need of a precise and selective temperature control of the panels.

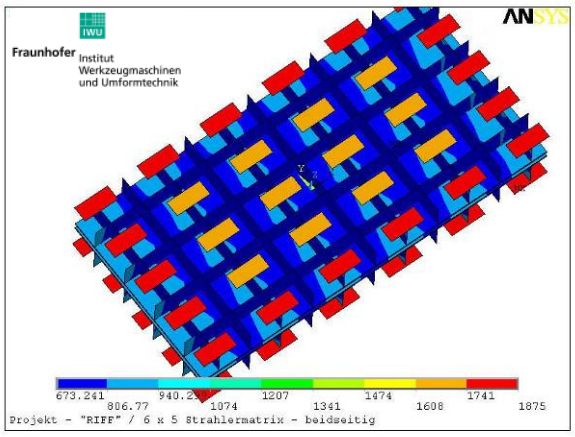

FIGURE 5: Simulation model of infrared heating module

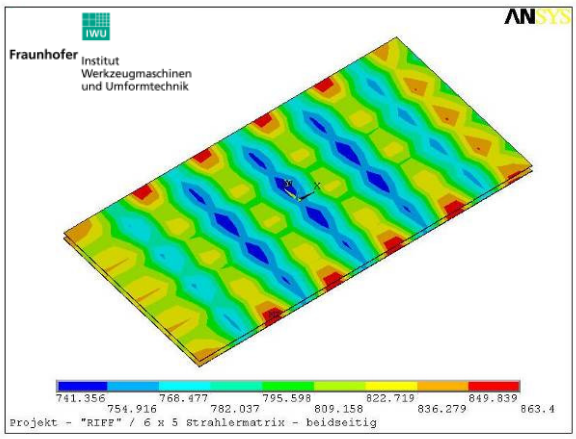

FIGURE 6: Temperature distribution in a foam plate

All the descriptions above show the advantages of the infrared heating device which are resulting in shorter production times, higher energy efficiency and better quality of the metal foam parts. The development realised during this project will help lowering the costs of metal foam parts which is main interest of many potential customers and that way the dissemination of cellular metals will improve a lot.