THE INFLUENCE OF COLD ROLLING ON THE PORE MORPHOLOGY AND FLOW RESISTIVITY OF POROUS ALUMINUM

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Materials with an open porosity are used in many applications, such as filters, acoustic absorbers or heat exchangers. For these applications the pore size and shape as well as the depending flow resistivity are important parameters and need to be adjusted for the specific case. The material parameters are usually defined by the manufacturing process and are therefore signature for different types of porous materials. In this study the porosity, pore shape and the depending flow resistivity of a given material are adjusted using a cold rolling process. The material chosen is a porous aluminum with a porosity of about 50% and relatively large pore, what allows to adjust pore size and porosity on large scale. The porous aluminum is produced using a salt infiltration technique and was received from “Exxentis”\(^1\). To ensure a good deformability a technically pure aluminum was chosen for the porous plates. By deforming the porous aluminum in a rolling mill, the plates are elongated and the thickness is reduced. This causes a reduction of the porosity due to closing pores and an elongation of the pores in the rolling direction along with the material flow.

To characterize the initial porous structure and describe the structural evolution during the cold rolling three dimensional X-ray scans for various degrees of deformation were taken. To analyze pore size and pore shape a line segmentation technique was applied to two dimensional images that were extracted from the 3D reconstructions. The 2D images were extracted in image stacks parallel to the three main surfaces of the rolled plate (parallel and perpendicular to the rolling direction). It was observed that porosity and pore size are decreasing with an increasing degree of deformation and that the aspect ratio of the pores is increasing. Even though the pores are closing during the rolling process, the X-ray scans show an open porosity even for high degrees of deformation. These results were compared to the evolution of the flow resistivity. The flow resistivity was measured in three orientations mentioned above for the initial and rolled plates, using the alternative airflow method (Method B DIN EN 29035). The measured values were divided by the material thickness to obtain a specific flow resistivity for rolled plates with different thicknesses. The specific flow resistivity is decreasing with an increasing degree of deformation. It was possible to confirm the open porosity for high degrees of deformation that was observed in the X-ray scans. This study shows that it is possible to adjust pore size, porosity and flow resistivity of porous aluminum using a cold rolling process.

The flow resistivity, perpendicular to the rolled surface, and the mean pore width, in planes parallel to the rolled surface, for different degrees of deformation are shown in Figure 1.

\[ 	ext{Figure 1 – Flow resistivity and pore width for porous Aluminum after cold rolling} \]

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