S1.4.3 - *Simulating the Microstructure of Nonwovens to Predict their Elasti-Plastic Behavior in 3D*

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The performance level of flat filter media is measured using the three filtration quality parameters: Dust holding capacity, filtration efficiency, and pressure drop [1]. They directly correlate to the microstructural properties of the filter media. Hence, new multi-layered filter media with gradual fiber densities across the thickness and increased filtration performances are developed based on filtration simulations and parameter optimizations [2]. To gain the necessary volumetric flow rate, it is often necessary to pleat the filter media to achieve the needed filter media area in the given design space. The highly anisotropic elastic-plastic material behavior of these nonwovens is challenging. At this point in the microstructural design process, the new filter media's effective mechanical properties are unknown. The ability to predict these anisotropic mechanical properties of a microstructural design is crucial to assess the new microstructural design's viability for further processing in the manufacturing process. Hence, a virtual lab to test the microstructural designs for tension, compression, and shear in all three spatial directions is needed.This presentation introduces a microstructural simulation model to predict the three-dimensional elastic-plastic behavior of nonwovens. Starting from a

representative volume element for the material structure based on micro-computed tomography, we validate the simulation results using an extensive 3D material testing program. The characteristic deformation behaviors under the load cases of tension, compression, and shear in the machine direction, cross direction, and z-direction are discussed. Finally, the dependency of the effective elastic-plastic deformation behavior on a limited number of selected microstructural parameters will be shown. This dependency allows for the usage of digital twins to predict the deformation behavior of virtual microstructure designs. 1) Klein, G.M., Banzhaf, H., Lehmann, M.J., Heininger, T., 2019. “Filtration in Fahrzeugen: Grundlagen und Beispiele zur Luft- Öl-, Kraftstoff- und Innenraumfiltration“, Die Bibliothek der Technik, Bd.398, Verlag Moderne Industrie, Munich Germany 2019 2) Gose, T., Kilian, A., Banzhaf, H., Keller, F., Bernewitz, R., 2019. “Augmented filter media development by virtual prototype optimization“, FILTECH 2019 – F3 - Advanced Filter Media Developments and Manufacturing Methods, Cologne Germany 201

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Kai Höss '40 grew up near Munich (Germany) and worked as a car mechanic for several years before going back to school to earn his high school diploma. After graduating from high school, Kai Höss moved to Stuttgart and enrolled in the aerospace engineering program at the University of Stuttgart, which he successfully completed with a master's degree. After working as a simulation engineer for a short time, he began his doctoral studies under the supervision of Prof. Siegfried Schmauder at the Institute for Materials Testing, Materials Science and Strength of Materials (IMWF) at the University of Stuttgart. At the same time, Kai Höss is working as an industrial student at the company MANN+HUMMEL GmbH in Ludwigsburg.

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