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Abstract

Paper is an attractive material due to its low density, high strength, and especially its ecological compatibility. At present, paper processing into complex structures is mainly limited to energy-intensive forming processes and simple folding processes. Only a few scientific studies are available, especially with regard to forming-specific parameters and processes. The task of the research project is to investigate the material- and process-related fundamentals required for the formation of three-dimensional structures from the paper material. In addition to the optimization of the paper material and the identification of the material parameters that are decisive for the forming process, the optimization of the actual forming process represents a further objective.

Project description

Although paper is an attractive material from an ecological point of view, applications of spatial load-bearing structures made of this material have so far been largely limited to energy-intensive forming processes. The aim of this project is to establish the material and process fundamentals for the forming of paper, which has been identified as very promising in preliminary investigations. The focus is the experimental investigations of active-media-based forming (hydroforming) of paper and the creation of paper grades that are suitable for forming. Since there are only a few studies on the modeling of the forming behavior of papers, the corresponding fundamentals will be established on the basis of continuum mechanical approaches and numerical simulations will be carried out for this purpose. The required parameters will be determined as a function of moisture, fiber type and length, freeness, basis weight and fiber orientation. The project is expected to lead to improved paper grades and to technological foundations for new product classes with surprising properties.

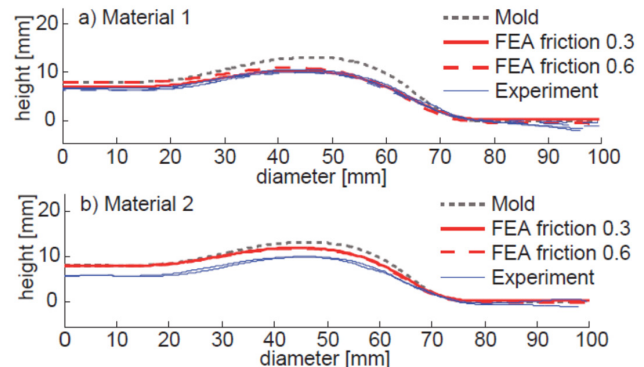
Results

Within the research project, fundamental knowledge was gathered with regard to the formability of paper. For this purpose, test equipment was set up specifically for paper testing. A special test rig should be mentioned here, with which not only a pneumatic bulge test (based on the hydraulic bulge test) but also forming tests in force ranges typical for paper are possible. For the tensile test typical in mechanical engineering, a geometry adapted to paper and its crack behavior was developed. Based on the material investigations, the following parameters were found to have a major influence on the mechanical

forming properties of paper:

- Moisture content of the paper
- Fiber orientation in the paper
- Pre-treatment of the fibers (e.g. cutting or kneading)
- Filler addition
- Procedure for semi-finished product production (e.g. type of drying)

With the help of the generated material data, initial simulation models are created. Using a rotationally symmetrical, doubly curved geometry, both the simulation models and the improvement of the forming properties of the developed materials were tested (Fig. 1).



[1] Comparison of the final shape

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Project partner

