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Research area: Process aims

Process measuring and control technology

Key words:

Terahertz transmission measurements, fibre orientation, internal stresses, paper reshaping

TITLE:

Determination of internal stress states in non-transparent, fiber-based nonwoven materials

Background/Problem area

Many isotropic materials have the property of being birefringent under mechanical stress and thus to rotate the plane of polarization of incident light. These stresses that arise in manufacturing and treatment processes are usually frozen in the moldings and affect their properties. Weaknesses in the product usually occur in the areas of higher stress states. Knowledge of these vulnerabilities is a prerequisite to understand material failures, optimize production processes and increase product quality.

The state of the art revealed that both the level of development of Terahertz measurement in terms of robustness and practicality as well as the possibilities of spatial resolution and speed are sufficiently advanced to parallel access the basis weight, thickness and fiber orientation in comparatively thick materials. Linking THz measurement data and strength characteristics of substitute tests should give statements on more complex states of reshaped materials.

Objectives/Research results

The aim of the project is to develop a measuring method (incl. testing regime) for the evaluation of stress states in fiber-based materials, which are caused by reshaping processing methods. Therefore sufficiently resolved measurement data from a THz system with respect to the material thickness, basis weight, and fiber orientation will be linked to conventionally detected force measurements during or directly after the reshaping of the materials. From the combination of strength parameters and THz based measurement data mathematical models are to be created to represent the basis of simulation approaches and to improve forming processes.

Until now a setup has been developed to perform THz measurements on single spots, lines and areas. The samples used have to be of a flat surface with no 3 dimensional shapes. These measurements run automatically, using up to 5 motorized axes. The resolution has been set to 1 mm in x-y direction. From the data the fibre orientation can be calculated as main angle of the fibres as well as their relative intensity. Additionally the thickness and grammage can be calculated as well.

A fast software-based evaluation of the results out of raw data as well as a visualisation have been made. Based on one-dimensional and two-dimensional deformed paper samples comparisons of THz data and deformation pattern could be performed. Finally 3-dimensional samples were measured. Action have been taken to make the measurement more fast and insensitive against mechanical influences. Last steps had been the unification of deforming processes and THz measurement to get internal stress state date while stressing the material.

Application/Economic benefits

The research results will be especially useful in the fields of processing fiber-based materials to innovative lightweight construction and packaging products with high material and energy efficiency and for suppliers of optimized process materials for special applications.

The development in the field of forming technology is crucial to the use and dissemination of this technology in packaging segments with high demands on the quality of packaging and to the automation and machine availability. In this way material and machine technology will be made available with which a new generation of molded parts and thus new opportunities for packaging technical correspondingly innovative products can be achieved. From the results an economically significant competitive advantage can be generated and an efficient and reliable implementation of new packaging strategies by forming is expected.

Project period: 01.11.2014 – 31.10.2016

Remarks

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