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Research area: Product aims

End products made of paper, paperboard and board // Carton products

Key words:

hydroforming, formability, formable paper, formable board, cardboard

TITLE:

Controlling the shear deformation capability of paper and board enhancing its formability

Background/Problem area

Increasing volume of cargo and the aim to present goods in a more and more appealing manner result in a rising demand for three-dimensionally shaped packaging solutions. These products can be manufactured by forming of natural fibre based based, plane, semi-finished products, such as cardboard. Forming capabilities of cardboard improved by progress in mechanical engineering in the last few years. Still the material inherent properties set narrow limits to its formability. Paper plates and carton board trays of minor height are state of the art products. Beakers or cups cannot be manufactured by forming (hydroforming, cupping, molding) so far.

The cooperation partners (PMV Darmstadt , PTS Heidenau) agree that shear deformation capability of cardboard is a key factor for controlling formability. Cardboard usually is a multi-layered material. By flexible connection of single layers its tendency to break during forming should decrease and wrinkling should happen more homogeneously.

Objectives/Research results

The project aims to improve formability of cardboard by introducing flexible layers into the sheet structure, primarily between the layers. In order to manufacture three-dimensional formed and further more complex formed packagings. This new cardboard shall offer a lower risk of breaking, unwanted wrinkling and improved processing properties.

Within the project papers including thermoplastic and friction reducing additives in a multilayer approach have been produced in laboratory and pilot scale as well. The generated materials were formed in a hydroforming process under room and elevated temperature. Multilayering as well as the addition of thermoplastic additives led to improved formability of those materials. Out-of-plane shear deformation has been investigated showing decreased shear moduli for modified paper materials.

As friction between paper and clamping device takes place during the hydroforming process, the coefficient of friction has been determined on a macroscopic scale. The measurement was carried out with a self-developed device, which can apply high forces and different temperatures. To get an impression whether small scale variations in the coefficient of friction may be of importance, a micro-friction tester delivered by UST was used. However, the results don't reveal any significant differences between boards good to form or those getting wrinkles and cracks.

In addition, the UST-device enabled the possibility to observe the elastic-plastic deformation behaviour at the paper-surface of the hydroformed samples. The obtained results still have to be interpreted, but conclusions concerning the stress-state at different locations in the paper during the forming-process are expected,

Application/Economic benefits

Industrial processors of cardboard and plastics profit from the development of a new, formable, semifinished cardboard. Its all-purpose formability shall provoke the development of new natural fibre based, three-dimensionally formed end-products. These packaging innovations shall strengthen the market position of small and medium enterprises.

Period of time: 01.06.2015 – 31.11.2017

Remarks

The RTD project IGF18030 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with PMV Darmstadt and the PTS Heidenau.