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Research area:

Product aims / Paper, paperboard and board / Packaging paper and paperboard

Key words:

Pulsed laser machining, non-impact process, laser additives

Title:

ALasKa – Developing a process for the economical use of pulsed laser technology in machining paper and paperboard

Background/Problem

At present, there is a clear trend towards individual products in the paper and packaging industries. Circulations with personalized packaging are on the rise. In addition, the development of new high-tech materials such as microwave paperboard is an ongoing process. In order to address the new developments, high requirements are being placed on the machining processes for paper-based products:

• The further development of “non-impact processes”, i.e. the least possible material change or damage as a result of mechanical or thermal action during the process of machining paper, paperboard and board

• More degrees of freedom for producing design elements due to very fine and delicate structural sizes and high-quality cut edges

• The setting of predefined depths of ablation in machining paper as an additional design possibility for producing haptic features

• Fast and flexible machining

The afore-cited requirements can already be met in some instances using current CO_2 laser procedures, although the changes to the material during the machining process are considerable due to thermal and/or mechanical action. There is therefore an acute need for research designed to minimise the deficits mentioned above. On the one hand, it is important to optimise and further develop laser technologies for paper machining and, on the other hand, to upgrade the paper or board material especially for laser machining in such a way that optimum machining possibilities are given.

Research objective/Research results

The objective of this project is to develop a process for individual product design for the machining of paper and paperboard by means of pulsed laser beam systems. For a selective examination of the machining of paper using pulsed laser beams, the physical interaction mechanisms that occur during machining must first of all be analysed and understood. On this basis, the laser parameters can be adapted on the one hand and, on the other, the paper can be upgraded with additives so that damage to the material due to thermal input or mechanical action is minimised. An important parameter in the context of laser technology is the impact of pulse duration, since this variable correlates with the thermal energy input.

The process of machining paper by means of pulsed laser beams is to be sustainably improved by the addition of special additives. The important parameters in this respect are the concentration of the additive and the distributions in the composite material. By evaluating and weighting the various factors contributing to the machining result, the relationships between the laser parameters and the composition of the paper substrate contributing to the technical results can be understood. For lab trials different additives and pigments were already examined, e.g. barium sulphate, different binders and special laser active pigments. All additives showed a good processability. In addition the chosen laser active pigments as well as barium sulphate pigments showed very interesting results, as an enhanced ablation during the laser processes for example. Furthermore different commercial available paper and cardboard substrates were chosen and examined to reveal interactions between paper components and laser radiation. Using the knowledge gathered during the project paper processing without discoloration was possible, as well as fine gravures in paper substrates.

Furthermore, the necessary flexibility requirements for a non-impact paper machining technology will be fulfilled as well. Improvements are to be expected compared to previous classical machining procedures such as shorter change-over times during batch changes, reduced tool wear or reduced material consumption due to optimised laser parameters and/or the use of laser additives. A comparison made within the scope of the project between high-tech laser and high-tech paper for the chosen applications allows a cost-benefit analysis to be made and serves as decision-making support in designing an economical process.

Application/Economic benefits

New and especially more flexible machining procedures are of immense importance for the papermaking industry in Germany which consists of small and medium-size enterprises having little research and development capacities of their own. This allows them to maintain and improve their competitiveness. Smaller businesses in particular are specialised in individualised products with small product batches. It is of essential importance in this context to be able to change batches quickly and flexibly. Other competitive advantages result for the manufacturers of pulsed beam sources as well as special-purpose machines for the laser machining of paper. The sales potential is very high in this case, since short-pulsed CO_2 lasers have still experienced very little use in industrial applications until now. In the design and marketing sector, the results from this project will lay the groundwork for new ideas and developments regarding design possibilities for packaging (e.g. haptic elements), thus generating innovative marketing strategies.

Project period: 01.12.2014 – 30.11.2016

Remarks:

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