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Research area: General aims

Production economy // Monitoring and control systems

Key words:

Terahertz spectroscopy, thickness, mono- or multi-layers

TITLE:

Development of a Procedure based on Terahertz-Technology to Measure the Thickness of Layers to Reduce Material and Energy Consumption

Background/Problem area

The share of multi layer paper products, especially with more than one functional layer, is rising. These layers are often made of new, innovative but also more expensive materials. As the expenses for these products rise and the opportunities to apply measuring devices shrink, the need for selective, online process monitoring is growing. State of the art measuring systems use several types of radiation and in all cases give only a summary signal. In case of two layer or multi layer products only the complete amount of the applied material can be measured or the measurement has to be performed after every single application of the layers. Non destructive, selective measurement of layer thickness of materials like paper is not possible. Especially in this field online measurement techniques are needed. Using terahertz-methods it is possible to quantify the thickness of certain layers in a multi layer material by analyzing the reflections at the different layers. Terahertz methods are at the moment in the state between laboratory and practical applications.

Objectives/Research results

The project aimed at the development of a procedure to measure the thickness and/or the grammage of certain layers of multi layer paper products. The procedure had to be capable to work online directly after the coating. Using the specific interactions of terahertz radiation with paper, coatings and plastic layers the type and thickness of the layers had to be calculated.

Technical aims were the optimization of terahertz measuring systems to reach the project coals, the development of new terahertz components to reach the state of an online system and the construction of apparatus to simulate online measurements.

Scientific aim had been the development of mathematical methods to calculate the number of different layers of a paper product and their thickness using terahertz signals as well as the use of multivariate methods to treat terahertz signals in specific ways. The Philipps University Marburg created after the identification of relevant parameter a metrological approach. Furthermore software was developed at PTS to analyse the THz-pulses in a detailed way and to obtain thickness related information. Based on physical laws, the calculation of sample thickness could be achieved for single layer papers and thin plastic material. In a second step the evaluation of multi layer materials was undertaken, so that the opportunities and limits of the THz-technique are known.

Generally speaking paper samples of a thickness-range between about 30 µm and 2 mm can be evaluated in terms of their thickness in an absolute way. Relative information on thickness is available even outside this range using simple mathematical procedures. The precision of the thickness-measurement is in some cases about 1 µm. This value is rising when the surface of a sample is not perfectly even.

Inner layers of compounds are not detectable in every case. If possible, the precision of the thickness-measurement is below the result of the whole compound.

Using several rolls of paper the opportunities of online measurements with THz-systems were analysed. These measurements showed that with the setup measurements can be undertaken with a precision of about 10 to 20 µm.

Application/Economic benefits

The results of the project can be used in the field of applied engineering, production, measurement, monitoring and automation techniques as well as in the industry sectors paper, printing and press. With the expected results of the project producers of measuring devices will be capable of developing specific measuring systems for paper and similar material on fast running production machines. Based on the results producers of automation systems can widen their product range.

The measuring system developed in this project should be of use for any producer of coated products. These often small and medium sized companies can replace or complement their monitoring devices.

After the transformation of the measuring system into a practical usable system the producers of multi layer products are potential users of the system. In a long term it is expected that common monitoring systems using radiation (e.g. x-ray) will be replaced by terahertz systems.

Producers of papers with barriers such as plastics are responsible to deliver 100 % save products. On the other hand they are interested in thin layers to save resources and money. These producers are also potential users of terahertz applications.

Project period: 01.06.2009 – 31.05.2011

Remarks

The research project IGF 16117BG was funded by the German Federal Ministry of Economics and Technology BMWi and was performed together with Philipps University Marburg, section physics.