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Research area: Product aims
Paper, paperboard and board // Technical speciality papers

Key words:
Organic conductors, sleekness

Title: Optimised foil-like surfaces on paper substrates for printed organic conductors

Background/Problem area

The development of printed electronics is one of the main goals of modern science with a continuous and massive growth in relevance. The production of simple conducting paths, transistors, sensors, OLEDs, batteries and energy stores to the point of solar cells, for example, requires high grade substrates with maximum smoothness, chemical resistance and barrier properties for all fields of application. Different research groups (PolyIC, Heliatec, Fraunhofer IMPS in Dresden, etc.) are currently developing technologies that allow the mass production of printed electronic conductors on flexible substrates. Up to now, plastic materials or metal foils have been used as the substrate because the smoothest papers available on the market do not meet the demands that have to be fulfilled in order to use a substrate for organic conductors (surface roughness of a cast-coated paper: 0.3 µm). Unevenness and porosity on the surfaces lead to defects in printed conducting elements. The foils used so far have a surface roughness of less than 40 nm (to less than 1 nm). Up to now, it has not been necessary to enhance the smoothness of paper surfaces because this would cause problems during conventional printing processes. Recently, with the establishment of curtain coating which is capable of producing a cost-efficient multilayer coating, innovative and competitive functionalisation and further development of paper for printed electronics has become possible. This is not only justified for the paper industry but even absolutely necessary.

Objectives/Research results

The aim of the research project is to develop a coating concept for multi-layer coatings on paper-based substrates to reduce roughness and waviness to the dimensions of the nano scale. One of the most important studies is to find out how far it is possible, generally speaking, to create an extremely homogeneous surface based on water-containing coating colours. The main parameters for smoothness and porosity such as particle size, shape, its distribution, parts of binder as well as the glazing process are well known for traditional smooth coatings although they only play a secondary role in this research objective. On the nanoscale, it is local differences in surface tension and effects during the drying process that play a principal role in light of existing findings. Local differences in surface tension inevitably cause local variations in contact angles at the interface which in turn cause lateral flow of the polymer solution (during the drying process as well) and inevitably produces irregular surfaces. In addition, it is well known that polymer solutions form crystalline domains while drying which cause rough structures on the surface depending on the drying conditions. No only do different citations point to these correlations but also the results of preliminary tests. Preliminary tests have been completed, and reference foils have been chosen as substrates for the polymer films as well as polymers, additives and pigments and other raw materials. The current work primarily involves estimating the topography of a variety of dried, water-based polymer films. Polymer (solutions) should be verified in terms of their potential to form homogeneous surfaces depending on the drying process. One of the next steps will be a surface topographic study using an atomic force microscope (AFM) in joint work with the Fraunhofer Institute for Photonic Microsystems in Dresden.

Application/Economic benefits

The results will allow a continued development of a high-end speciality paper into a mass-produced product in the same way foils developed. Such a product involves additional quality characteristics which make it possible to break into other new markets: foil-like surfaces provide ideal conditions for metalizing, multi-layered films provide a safety feature, high-gloss surfaces can be used for decor products, brilliant prints can be applied to high-quality packaging materials and other innovative products with new properties with high added value in a straightforward market.

Especially small- and medium-sized companies have gathered the essential experience, flexibility and therefore cost-efficiency to establish such new high-end products in the market and to install new production lines or expand existing ones. Therefore considerable business predominantly in profitable market segments with high added value may emerge for small- and medium sized companies.

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Remarks

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