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Packaging paper coated with PLA

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Introduction

Eco-design is an approach to designing products with special consideration for the environmental impacts of the product during its whole lifecycle and is becoming a core design concept in packaging. (Birkeland, 2002). For packaging with short-life span is even more important to focus on material choice, to use materials from renewable sources, that are recyclable or compostable, and design for maximum sustainability and recoverability (Birkeland, 2002; McDonough and Braungart, 2009).

Protective paper packaging is mostly coated with petroleum-based derivatives such as polyethylene, waxes and/or fluor-derivatives, resulting in lost of its biodegradation and recyclability characteristics (Rastogi and Samyn, 2015). As alternative, naturally renewable biopolymers can be used as barrier coatings on paper packaging.

Problem Description

Polylactide acid (PLA), as one of the most promising biodegradable biopolymer was used for paper coating in our research, with a goal to obtain biodegradable protective paper packaging.

Methods

A commercial product, one side coated, woodfree flexible packaging paper was used as a reference paper. For our research, a base uncoated paper of the mentioned commercial product was supplied by the producer. By dissolving PLA pellets in the solvent dichloromethane two concentrations (15 wt% and 20 wt%) of coating solution were prepared. Coating was carried out on a lab coater (RK Print-Coat Instruments, Hertz, UK) using two wire-wound bars, No. 3 and No. 6, for depositing 24 and 60 µm wet film onto the substrate. Basic, optical and surface properties, air permeance and water absorbency were determined on coated and uncoated packaging papers.

Table 1

Sample identification and description

Sample identification	Sample description
BP	Base paper, uncoated packaging paper
BP-15-3	Base paper; coated with PLA solution with concentration of 15 wt%; bar No. 3
BP-15-6	Base paper; coated with PLA solution with concentration of 15 wt%; bar No. 6
BP-20-3	Base paper; coated with PLA solution with concentration of 20 wt%; bar No. 3
BP-20-6	Base paper; coated with PLA solution with concentration of 20 wt%; bar No. 6
CP	Commercial product; one-side coated packaging paper

Results

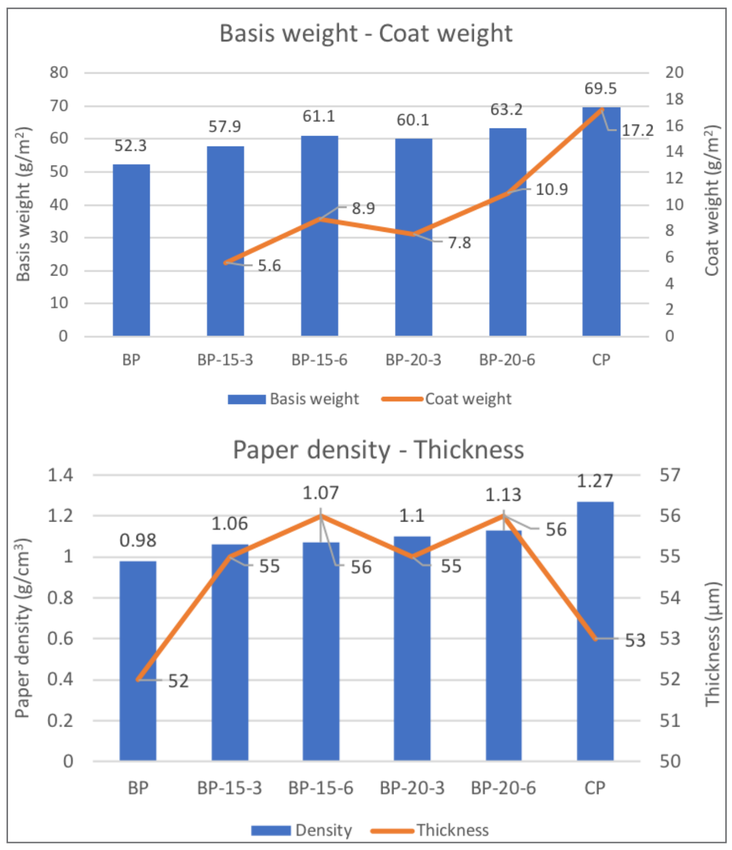

Figure 1

Technological properties of paper samples

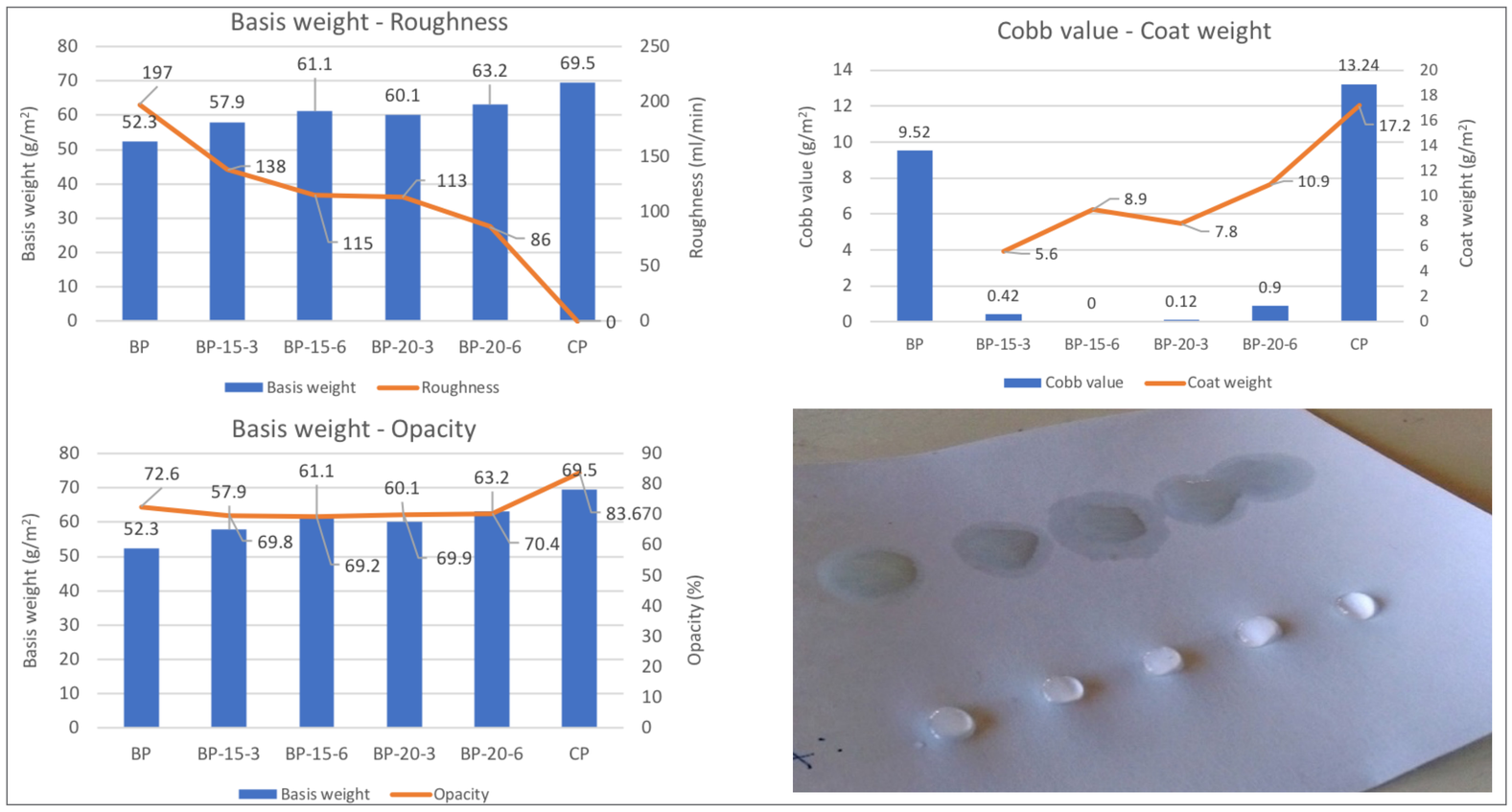

Figure 2

Surface properties of paper samples

Table 2

Colorimetric properties of paper samples

Sample	L* (/)	a* (/)	b* (/)	ISO brightness (%)
BP	96,07	0,635	0,938	83,9
BP-15-3	95,65	0,656	1,102	82,4
BP-15-6	95,41	0,655	1,045	82,1
BP-20-3	95,75	0,654	1,021	83,2
BP-20-6	95,35	0,637	0,718	82,6
CP	93,5	1,179	–1,226	81,1

Discussion / Conclusion

Coat weight is in very high correlation with the basis weight, thickness and paper density (Figure 1). The smoothness of paper surface was raised with coating, but mainly barrier properties improved, especially barrier properties to water (Figure 2). With increasing coat weight, the surface roughness decreased. Coating with the PLA solution closed the surface, which resulted in very low water absorptiveness into the surface and no water absorbency due to capillary action.

Already, lower concentration of PLA solution (15 wt%) and lower volume of wet film deposited (bar No. 3) resulted in excellent paper barrier properties to water. The top side of the paper is completely covered with the PLA polymer, and even reverse side of the paper is partly coated (Figure 3). PLA solution obviously penetrated into the paper and closed also the pores in the paper.

This was confirmed by the measurement of air permenance, which showed that no air has penetrated through the paper.

With coating a small decrease in ISO brightness is seen, also the color differences between base paper and coated samples are negligible, ΔE is bellow 1 (Table 2).

Comparison with the commercial packaging paper has shown that similar surface properties and even better barrier properties to water were obtained.

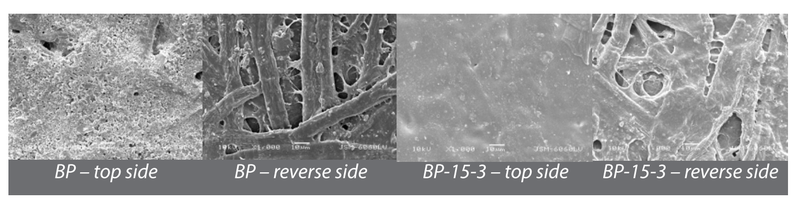

Figure 3

SEM images of paper surface

REFERENCES

Birkeland, J.: "Design for sustainability", London, Earthscan, 2002.

McDonough, W., Braungart, M.: "Cradle to cradle : remaking the way we make things", London, Vintage, 2009.

Rastogi, V.K., Samyn, P.: "Bio-Based Coatings for Paper Applications", Coatings, 2015, 5(4), 887–930

ACKNOWLEDGMENTS

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