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Investigation of the functional properties of PVC and PET films used for finishing furniture fronts

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Abstract: *Investigation of the functional properties of PVC and PET films used for finishing furniture fronts*. In the study selected properties of PVC and PET films used for MDF surface finishing were examined. The average thickness of the PVC and PET films was respectively 388.9 and 379.4 µm. PVC films were characterized by significantly higher variability of weight loss, and thus higher Taber ratio variability in comparison with PET films. However, no significant difference between the abrasion resistance of PVC and the abrasion resistance of PET films was identified. The PVC and PET films were characterized by first degree scratch resistance. Depending on the load, the average scratches on the PET film were from 33 to 45% wider than on the PVC film. The relative hardness of the PET film was about 45% higher than the hardness of the PVC film.

Keywords: PVC film, PET film, furniture, abrasion resistance, scratch resistance, hardness

INTRODUCTION

Medium density fibreboards (MDF), along with particleboards, are among the most commonly used wood materials in furniture industry. In Poland in 2013, 2.48 million m^3 of MDF were produced (http://faostat.fao.org/). However, it must be borne in mind that this group included also ultralight fibreboards (UL-MDF), which are typically used for profile mouldings and insulation materials, as well as high density fibreboards (HDF) for floor panels. Easy machining of MDF allows for manifold applications of this material in the furniture industry. Using wood-based materials necessarily involves securing their surface with various types of protective coatings. Currently, the most popular method of finishing furniture fronts is gluing synthetic films onto them. The most commonly used materials are PVC and PET films.

Polyvinyl chloride (PVC) is a thermoplastic product of the vinyl chloride polymerization which can be applied to suspension, emulsion, mass or solution. Currently the dominant method is suspension polymerization. The polymer obtained with this technique is purer and easier to process (Yu et al. 2012). The resulting product is mainly used for manufacturing tubes, films and extruded profiles. Poly(ethylene terephthalate) is obtained by polycondensation of terephthalic acid and ethylene glycol. Due to its high strength properties, PET is used as insulation of electric motors, capacitors, wires and cables (Gupta et al. 2009). Polymeric materials are characterized by low surface tension and high chemical inertia. This results in low wettability and adhesion properties of the material (Huang et al. 2010, Pelagade et al. 2012).

The aim of the study was to determine selected functional properties (abrasion, scratch resistance, relative hardness) of PVC and PET films used to enhance the surface of furniture fronts made of MDF.

MATERIALS

The test specimens were taken from industrially manufactured furniture fronts. The PVC and PET films were applied onto 16 mm thick MDF of 650 kg/m^3 density. The study involved the investigation of the following properties of these coatings:

- thickness according to EN ISO 2808:2007,
- abrasion resistance according to EN ISO 7784-1:2006,
- scratch resistance according to EN ISO 1518-1:2011,
- hardness based on pendulum damping test according to EN ISO 1522:2006.

The film thickness was determined at 6 points of measurement. Abrasion resistance was tested with H10 rollers and measured for 6 specimens of each film after 200 cycles per specimen. Scratch resistance was tested on 10 specimens of each film. Blade loads applied were 1, 2, 3, 4, 5N. The hardness was measured for 6 specimens of each film by means of a pendulum damping test. In order to calculate the relative hardness, glass constant "b" of 430 was set. Its value was determined on the basis of arithmetic mean drawn from 6 measurements of pendulum damping on the reference glass plate. Statistical analysis of the research results was performed at the significance level of 0.05.

RESULTS

The average thickness of PVC and PET films amounted to 388.9 µm (standard deviation 21.3 µm) and 379.4 µm (standard deviation 20.9 µm) respectively. In view of the fact that the PVC and PET films showed no significant difference in thickness, it was assumed that this property would not affect the differentiation of other properties of the films.

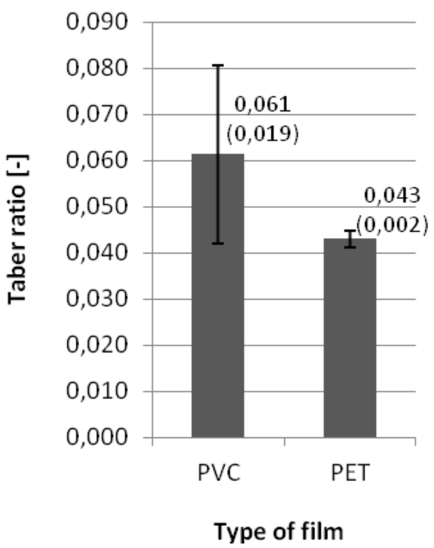

Figure 1. Taber ratio of the PVC and PET films (standard deviations in brackets)

Abrasion resistance of each film is shown in Figure 1. The mean Taber ratios for PVC and PET films amounted to 0.061 and 0.043 respectively; they were thus 30% higher for the PVC films than for the PET films. The PVC films were characterized by significantly higher variability of weight loss, and thus higher variability of Taber ratio compared with the PET films. However, no significant difference between the abrasion resistance of PVC and that of PET films was identified.

Figure 2 shows the average film scratch width in relation to blade load. Both PVC and PET films were characterized by first degree scratch resistance (classification according to EN ISO 1518-1:2011). The blade loaded with a force of 1N made a scratch whose continuity exceeded 90%. In general, it may be stated that PET coatings were more susceptible to scratching. At the same time these films were characterized by higher variability of scratch width than the PVC films.

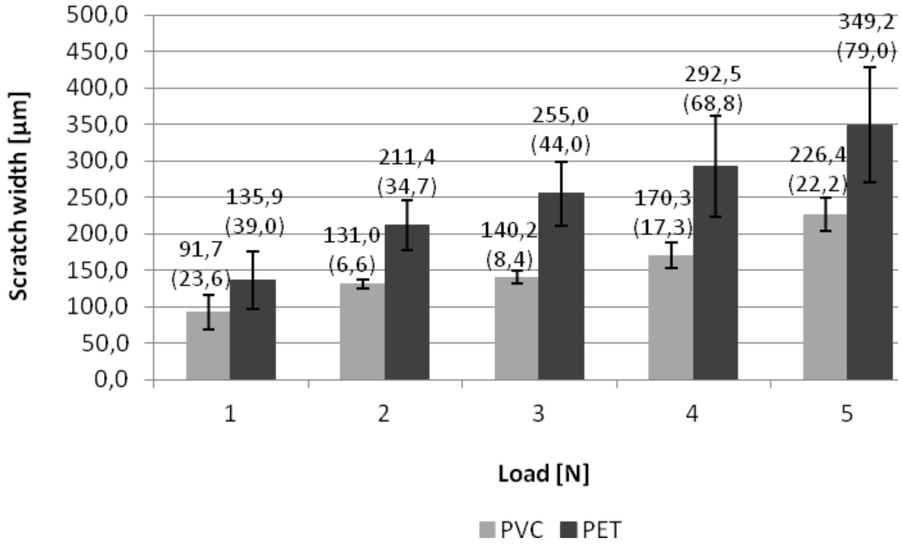

Figure 2. Scratch width on the PVC and PET films for specific blade load (standard deviations in brackets)

Depending on the load, the average scratches on the PET films were from 33 to 45% wider than on the PVC films. The analysis included the changes in scratch width made when the blade loads varied between 1 and 2N, 2 - 3N, 3 - 4N, 4 - 5N. The highest percentage differences in film scratch width were identified when the blade load changed between 1 and 2N. The width of the scratches on PVC and PET films at blade load of 2N was respectively 30 and 36% higher than at the load of 1N. In the other cases the differences did not exceed 25%. The width of scratches on PVC and PET films with blade load of 5N was respectively 60 and 61% higher than at blade load of 1N.

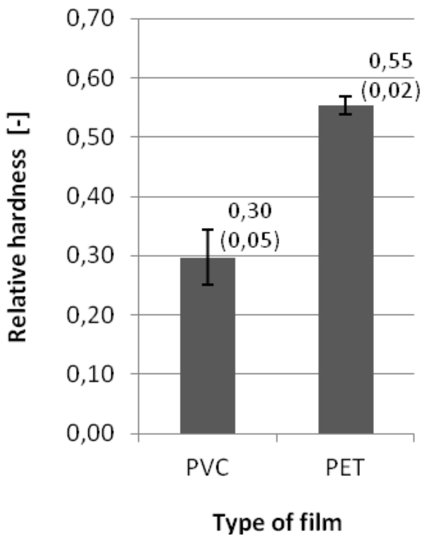

Figure 3. Relative hardness of the investigated PVC and PET films (standard deviations in brackets)

The relative hardness of the PVC and PET films is shown in Figure 3. The relative hardness of the PVC and PET films (defined with respect to the hardness of glass) was 0.30 and 0.55 respectively. The study showed that the relative hardness of the PET films was about 45% higher than the hardness of PVC films, and that the differences were statistically significant.

CONCLUSIONS

PVC films were characterized by higher variability of weight loss and lower variability of scratch width in comparison with PET films. However, no significant difference was observed between the abrasion resistance of PVC and that of PET films. Both PVC and PET films were characterized by first degree scratch resistance. Significant differences were observed between the width of scratches on the PVC films in comparison with those on the PET films, depending on blade load; similarly, significant differences were identified in the relative hardness of the films.

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Streszczenie: *Badanie użytkowych właściwości folii PVC i PET wykorzystywanych do wykańczania powierzchni frontów meblowych.* W ramach badań określono wybrane właściwości użytkowe folii PVC i PET wykorzystywanych do wykańczania powierzchni płyt MDF. Średnia grubość folii PVC i PET wynosiła odpowiednio 388,9 μm i 379,4 μm. Folie PVC charakteryzowały się znacznie większą zmiennością ubytku masy, a tym samym większą zmiennością współczynnika Tabera w porównaniu z foliami PET. Nie stwierdzono jednak istotnych różnic między odpornością na ścieranie folii PVC a odpornością na ścieranie folii PET. Folie PVC i PET charakteryzowały się pierwszym stopniem odporności na zarysowanie. W zależności od obciążenia średnia szerokość zarysowania na folii PET była od 33 do 45% większa niż na folii PVC. Względna twardość folii PET była o 45% większa w porównaniu z twardością folii PVC.

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