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INFLUENCE OF COATING FORMULATION ON PHYSICAL-MECHANICAL PROPERTIES

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Abstract:
The aim of this contribution is the investigation of the influence of coating formulation on physical – mechanical properties; especially on the hardness of finished surfaces, the adhesion of the lacquers films to wooden substrates, the resistance of finished surfaces to impact, the resistance of finished surfaces to mechanical damage - the impact tests. Tensile tests on free coating films of the same lacquers have also been measured. In this study we investigated transparent nitrocellulose, polyurethane and UV curing high solid acrylic lacquers. The results reached in this study have confirmed the relationship between elastic modulus and the stress at break of free lacquer films and the physical-mechanical properties of finished surfaces.

Key words: *physical-mechanical properties; maximum force at break; tensile stress; hardness.*

INTRODUCTION

Wood, as a natural construction material in use, needs the protection of by coating films to keep its beauty, colour and integrity. Wood movements due to swelling and shrinking induce stress to the surface coating. Results of this stress, between the wood surfaces and coating films, are the decreasing quality of physical–mechanical properties. The aim of the study is based on the hypothesis that this is caused by the relationship between the physical-mechanical properties and the tensile properties of lacquer films.

In this contribution we present there are presented the results of our investigation of the influence of coating formulations on the physical-mechanical properties of furniture finished surfaces. Improving the durability and improving of the physical-mechanical properties of finished furniture surfaces is essential for prolonging the life of the furniture. The conclusions of this study have great influence, not only on the coating performance but also on the quality of wooden-based products. They can help to improve the physical-mechanical properties of finished surfaces of wood because it is supposed that he tensile stress of coating films has significant influence on the performance of finished surfaces. The tensile properties of coating films have not been assessed yet in correlation with physical-mechanical properties.

OBJECTIVE

The aim of this study was to identify the relationship between influence of tensile strength during the tensile stress at break of the tested lacquer coating films, and the quality of mechanical-physical properties of the finished surfaces coated with the tested lacquers.

MATERIAL, METHODS, EQUIPMENT

Five different lacquers were tested for the evaluation of the influence of different test parameters; this means that five different resins have been investigated.

1. nitrocellulose lacquer,
2. top solvent polyurethane lacquer
3. basic solvent polyurethane lacquer
4. acrylic water borne lacquer
5. UV curing high solids acrylic lacquer

Preparing the samples:

Each one of the tested coating materials was applied to a sample of chipboard veneered with

pine veneer. The amount of coating lacquer varied from 40g/m^2 (UV curing high solids acrylic lacquer) to 300g/m^2 (solvent polyurethane, basic solvent polyurethane lacquer, water borne lacquer and nitrocellulose lacquer).

Each one of the tested coatings was applied to on polyterephtalate foil by using the laboratory film applicator. The coatings were removed from the foil, in controlled environmental conditions immediately after drying/curing took place. The tested films were carefully detached by hand and cut size (using a scalpel). The size of the films was 10mmx50mm. The specimens were oriented longitudinally.

Test methods and standards used

- Adhesion Paints and varnishes cross-cut standard ČSN EN ISO 2409.
- ČSN 910277 Furniture. Testing the furniture surface coating. Method of determining the surface impact resistance.
- BS 3962 part 6 The resistance of finished surfaces to mechanical damage - the impact tests.
- ČSN EN ISO 2815 Buchholz indentation tests.
- Tensile tests were performed using a test device by of the company Instron 3365 Machine Serial Number Locator with measurement software Blue hills.
- ČSN EN ISO 527-3 Determination of tensile properties Part 3 The conditions for films and foils.
- ČSN EN ISO 527-1 Determination of tensile properties Part 1 General principles.

RESULTS AND DISCUSSION

On the figure numbers 1, 2, 3, 4, 5 and 9 we can observe the physical-mechanical properties of the tested finished surfaces of the chipboard samples veneered with pine veneer. In figure numbers 6, 7, 8, 10, 11 and 12 are the results of measuring the tensile stress at break, force at break and elongation of tested lacquer films. The mean values and standard deviations of assessed properties were determinate and calculated for elongation of the sample of the lacquer film in maximum force (F_{max}). The charts have shown the behaviour of the coating films during the tensile tests. Great differences in behaviour during testing have appeared especially among the water borne lacquer films and UV coating films. The stress curves of tested each one tested coating materials were very different in dependence of used resin.

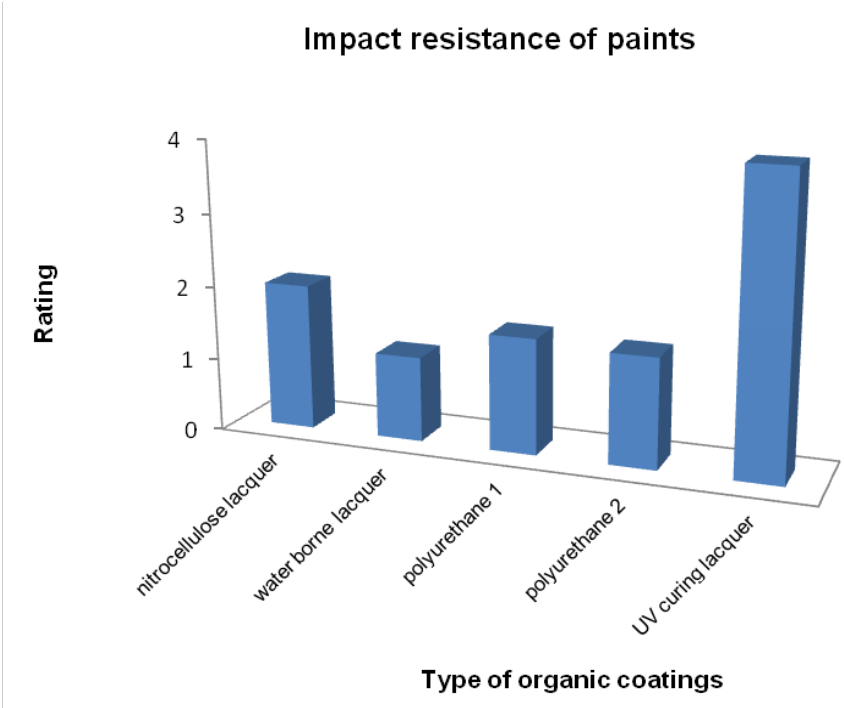

Fig. 1.
Impact resistance of paints.

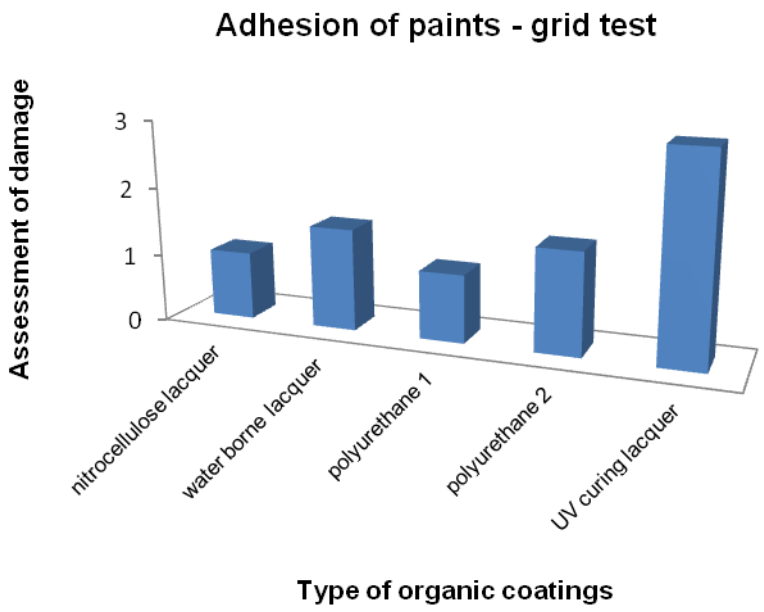

Fig. 2.
Adhesion of paints – grid test.

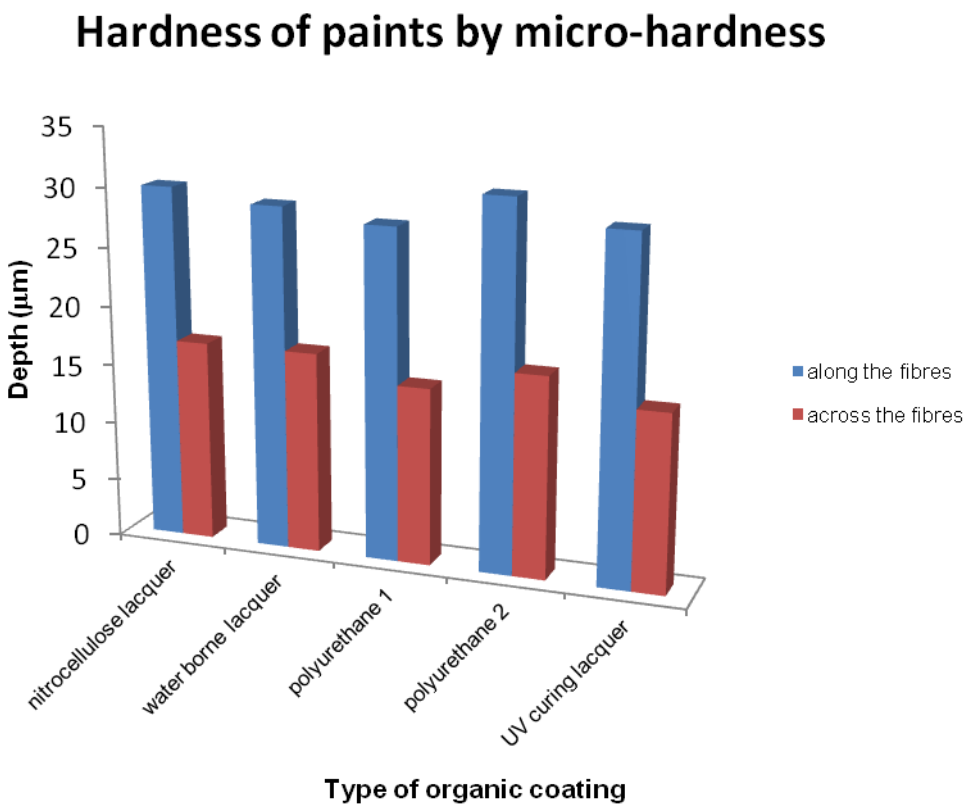

Fig. 3.
Hardness of paints – micro-hardness.

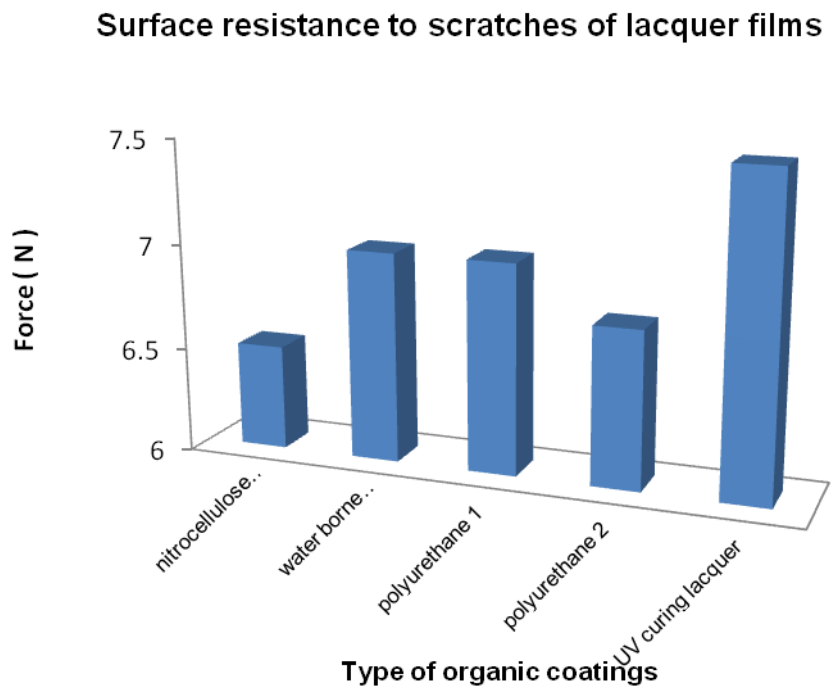

Fig. 4.
Surface resistance to scratches of paints.

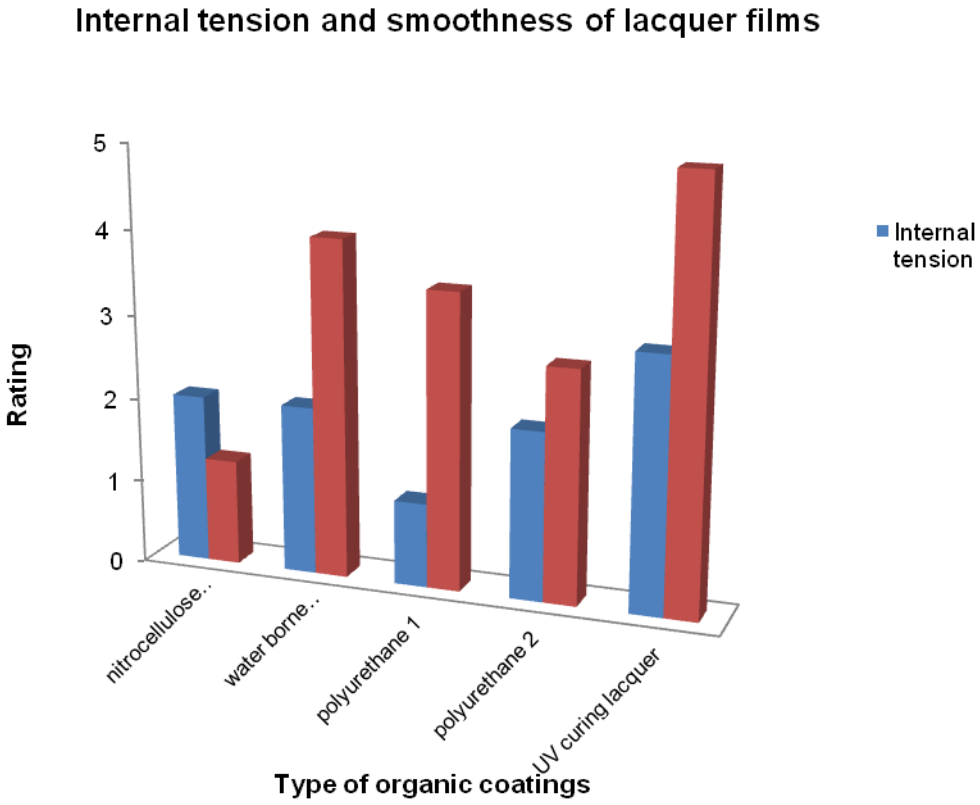

Fig. 5.
Internal tension and smoothness of lacquer films.

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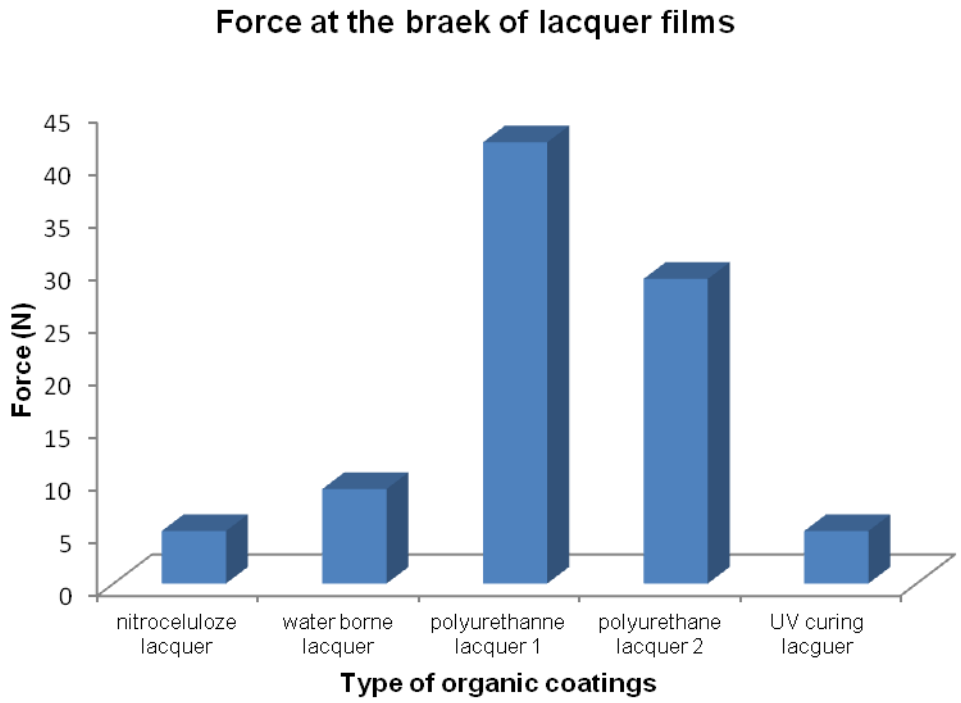

Fig. 6.
Force at the braek of lacquer films.

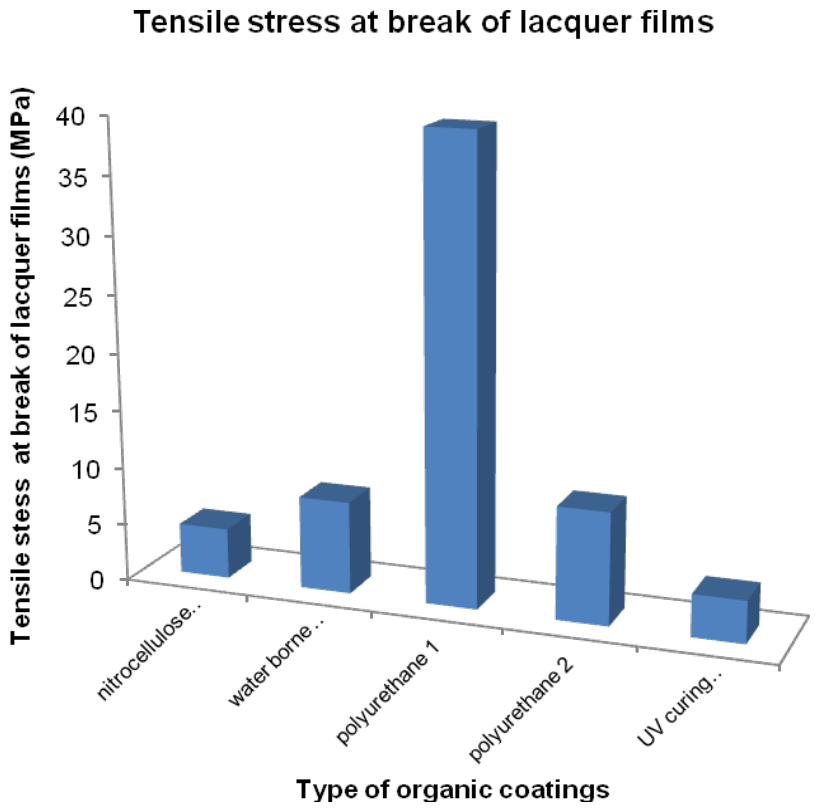

Fig.6.
Tensile stress at the break of lacquer films.

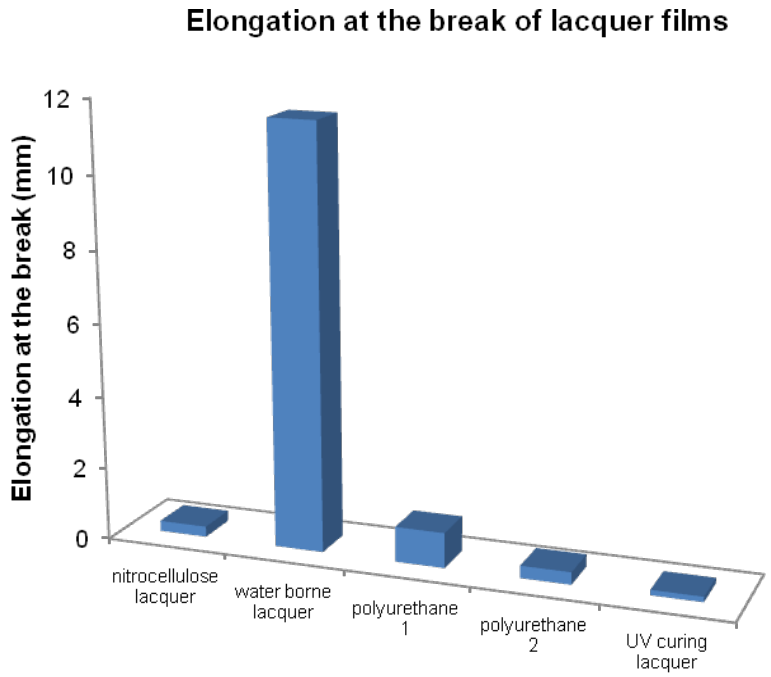

Fig. 7.
The elongation at the break of lacquer films.

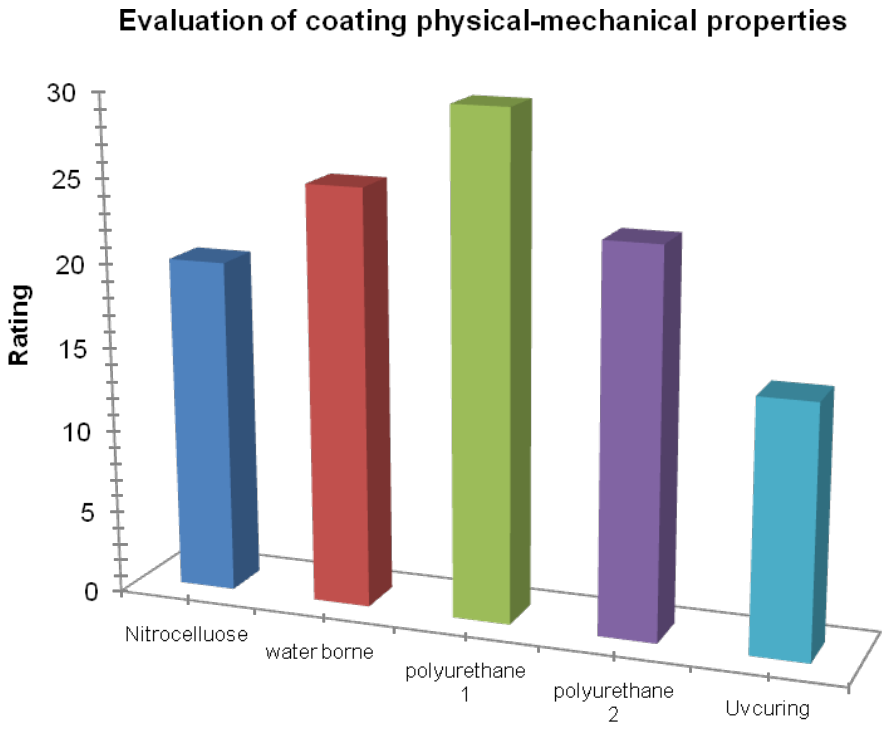

Fig. 8
Evaluation of finished surfaces physical-mechanical properties.

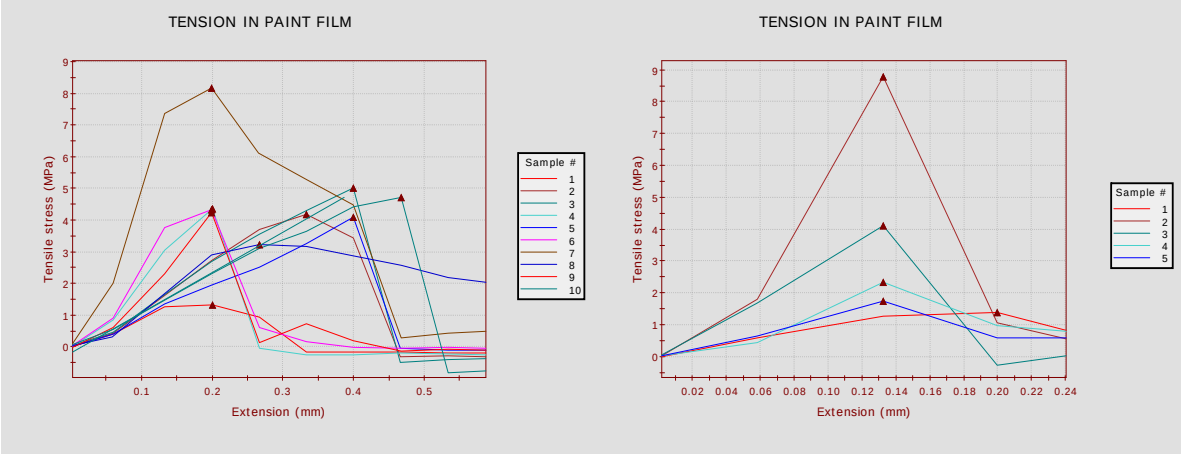

Fig. 9.

a-Tensile tension in samples of lacquer films; films nitrocellulose

b –Tensile tension in samples of lacquer UV curing lacquers

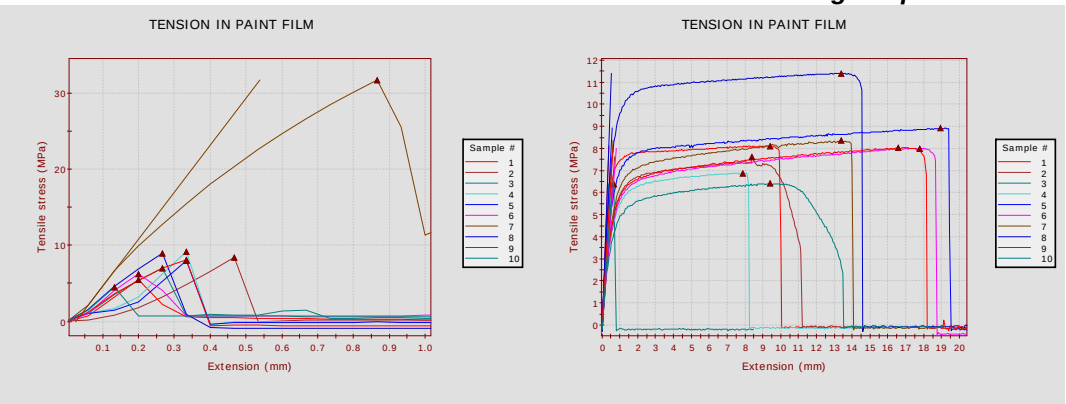

Fig. 10.

a –Tensile tension in samples of lacquer films polyurethane-2K

b –Tensile tension in samples of lacquer films water borne lacquer

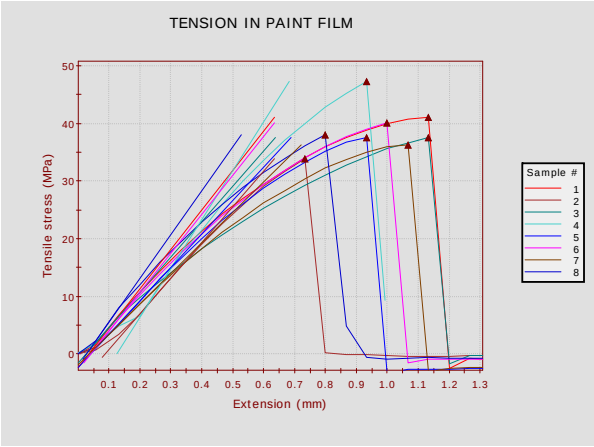

Fig. 11.

Tensile tension in samples of lacquer films of polyurethane-1K.

CONCLUSIONS

In this contribution we achieved very important results. When we have compared the results of physical –mechanical properties of finished surfaces and the results of tensile stress at break of lacquer films, we found the relationship between tensile stress stresss and physical-mechanical properties. The results of physical-mechanical properties are summarized in Fig. 9, the results of the assessment of tensile stress of coating films are expressed in Fig. 6 and the forces at break of lacquer films are shown in Fig. 7, and when we put them together we compared all results. These achieved and compared results confirmed our hypothesis about the relationship between the physical-mechanical properties of lacquers films and the

ultimate tensile stress of free coating films.

The coating film of the polyurethane lacquer 1K delivered the best results during the investigation of physical-mechanical properties of finished surfaces and kept the highest tensile stress at the break of lacquer films. UV curing lacquer films provided the worst results in both of the testing methods (physical – mechanical). When we compared both of Figs. 6 and 7 to the results in Fig. 9, we could see the relationship between the tested physical-mechanical properties of finished surfaces and lacquers films made from the same coating materials.

The harmonization of the tensile test conditions for free wood coatings is mandatory before talking about threshold values or limits for mechanical properties. This study has shown that it is very important to investigate the tensile stress of free coating films during the development of coating materials.

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