3rd Workshop – "Process and Service life modelling"

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Abstract

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Self-healing laminates for surfacing wood-based panels

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Abstract

To stay competitive, the wood industry has to innovate and develop new surface protective systems for wood and wood based products in order to improve durability and facilitate maintenance. Many applications of wood products are determined by their special surface properties, which are influenced by the nature of surface material, processing parameters and usage conditions.

High pressure laminates (HPL) are a pratical solution for horizontal or vertical surfaces that require high physical, mechanical and chemical performances, with a high versatility and excellent decoration ability. Intensive applications as school furniture, laboratory and hospital worktops, decks and flooring for public buildings demand multifunctional surfaces with special properties as mar and abrasion resistance, self-cleaning, antibacterial, resistance to staining agents, resistance to UV light, etc. However, durability and reliability of the polymeric layer is still problematic because these materials are susceptible to induced damage when exposed to critical conditions or long-term use, and may develop microcracks with negative visual impact, which are impossible to remove in these thermosetting materials.[1] A possible solution for this problem may be development of HPL with self-healing properties.

Self-healing materials have the ability to regenerate microcracks independently of their location, restoring the structure and performance of the material, and, to some degree, minimizing negative visual impact of the damaged surface.[1] This approach allows obtaining more durable materials, with reduced maintenance costs and with a broader range of application in aggressive environments.[1]The concept of self-healing mimics the healing of biological injured tissue. It may be classified according to two aspects:[1]

- autonomic (without any external intervention) or non-autonomic (with external drive);
- extrinsic (requiring additional regeneration agent) or intrinsic (without additional regeneration agent).

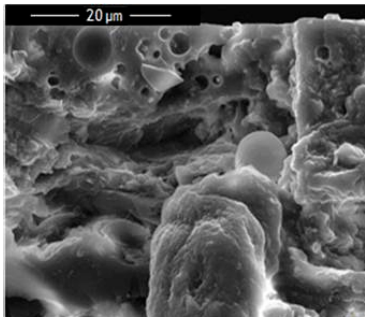
An autonomic extrinsic self-healing system for incorporation as an additive in the impregnation resin of the HPL decorative paper was studied in this work. The approach can be described as follows: (i) the healing agent (a drying oil) and an appropriate drying catalyst are encapsulated within the polymeric matrix, (ii) when the laminate surface is damaged, capsules rupture, releasing the healing and drying

agents by capillary action, (iii) upon contact with atmospheric oxygen, the healing agent undergoes crosslinking, promoting the repair of the cracked areas.[2]

Microcapsules of urea-formaldehyde (UF), having a mean diameter of 10±7 µm, with a core of linseed oil (self-healing agent) and cobalt solution (drying agent) were synthesized by *in situ* polymerization. These microcapsules were incorporated in the HPL decorative paper by impregnation.The feasability of microcapsule incorporation in the laminate surface (they should resist high pressures during hot-pressing) was confirmed by SEM (Figure 1a). The self-healing ability was assessed by evaluation of surface apperance and measurement of roughness after damage. The tests were done with 1, 2, 3, 4, 15 and 20 wt. % (relative to melamine-formaldehyde resin content) of microcapsules synthesis product loadings. The appearance of the laminates was also assessed.

High loadings (15 to 20 wt.%) affected the laminate's gloss. However, with loadings up to 4%, the appearance of the laminate was unchaged. The produced laminates were subjected to the scratch tests with two continue force: 2 and 4 N. The damage was measured evaluated right after the scratch (Z_1) and after 48 h (Z_2), using a contact stylus roughness tester. A self-healing efficiency criterium was established according to the following expression and Figure 1b presents the results obtained:

$$Self\text{-}healing\ efficiency\ (\%) = \frac{Z_1 - Z_2}{Z_1} \times 100$$



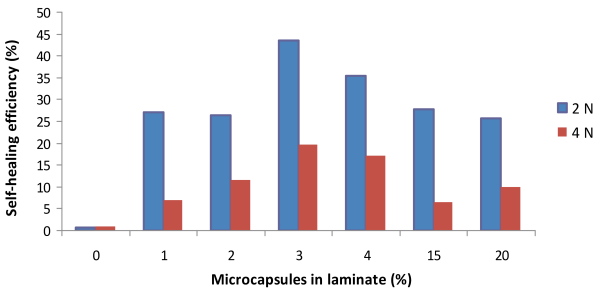


Figure 1: a) Cross-sectional SEM image of decorative paper, showing crosslinked resin loaded with microcapsules on the top layer; b) Self-healing efficiency in laminates tested.

A microcapsule loading of 3 % in the laminate gives the best self-healing efficiency results.These results show that formulation of self-healing HPL with microencapsulated regenerating agents is promising. Future work will involve optimization of healing efficiency and test of alternative healing agents and mechanisms.

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References

[1] Ghosh , S., Self - healing Materials: Fundamentals, Design Strategies, and Applications , Wiley - VCH , Weinheim, 2009.

[2] Suryanarayana, C., Rao, K., Kumar, D., (2008), Preparation and characterization of microcapsules containing linseed oil and its use in self-healing coatings, Progress in Organic Coatings, 63: 72-78.