Development of Low Formaldehyde-Emitting Laminate Flooring by Nanomaterial Reinforcement

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Abstract

Nanoscience and nanotechnology have numerous advantages for wood or composite materials. Formaldehyde emission from laminate flooring is of great importance on human health. Developing low formaldehyde-emitting laminate flooring as an environmentally friendly material by nanotechnology application was aimed in this study. Formaldehyde based resin used to produce laminate flooring was reinforced with different nanomaterials. The overlay papers were impregnated with the nanomodified resin. The papers were used to manufacture the flooring materials. Formaldehyde emission analysis was carried out according to EN standard. The results obtained in this study showed that some nanomaterials significantly decreased formaldehyde emission of the laminate flooring materials. Using nanotechnology, it is possible to produce low formaldehyde-emitting laminate flooring.

***Keywords*:** A. Nanotechnology, B. Nanomaterial reinforcement, C. Formaldehyde emission, D. Laminate flooring.

Introduction

Laminate flooring is among composite wood products. Laminate flooring having sufficient surface performance is widely used as flooring materials in both residential and nonresidential applications. Laminate flooring materials are shown in Figure1 (Candan, 2012). Laminate flooring was found in 1977 by Pergo (Sweden). The first products were started to sell in Europe in 1984 while in the US in 1994 (WFCA, 2012).

Fig. 1 Laminate Flooring

Production capacity and using area of these composite materials are increasing year by year. Formaldehyde emission is disadvantage in applications and is a crucial performance property for laminate flooring. Nanotechnology has been identified as a technological revolution by scientists from all over the world. Nanoscience and nanotechnology have numerous advantages also for composite materials (Ciraci, 2005; Jones et al. 2005; Roughley, 2005). To overcome this disadvantageous, use of nanomaterials in manufacture of laminate flooring is of a great importance and novelty (Candan, 2012). In this study, development of low formaldehyde-emitting laminate flooring materials by nanotechnology was objected.

Materials and Methods

Materials

Kraft paper, HDF panels, decorative paper, and overlay paper were used to produce laminate flooring. The resin was melamine formaldehyde. Silica, alumina, and zinc oxide nanoparticles were used to reinforce laminate flooring.

Laminate Flooring Manufacturing

The papers were impregnated with melamine formaldehyde resin in a commercial impregnation line. After that the impregnated kraft paper was used as a balance paper in the bottom layer of the laminate flooring. HDF panel was placed on the kraft paper. Then, the impregnated decorative paper and overlay paper were placed over it, respectively, and then it was hot pressed in the short-cycle press line (Kastamonu Integrated Wood

Industry and Trade Inc., Kastamonu, Turkey). Manufacturing of the laminate flooring is shown in Figure 2.

Fig. 2 Manufacturing of Laminate Flooring (Photo: Candan)

The loading levels of the nanomaterials were 1% and 3%. The control laminate flooring material was also produced for the comparison. The panels were cut into the test samples. The experimental set-up of the formaldehyde emission test is shown in Figure 3.

Fig. 3 Formaldehyde Emission Test Set-up (Photo: Candan)

Formaldehyde emission tests on the laminate floorings were conducted according to TS 4894 EN 120 (1999) standard. Perforator and spectrophotometer were used to determine the formaldehyde emission properties of the nanomaterial reinforced laminate flooring in this study.

Statistical Analyze

To evaluate formaldehyde emission properties of the laminate flooring materials reinforced with nanomaterials, all multiple comparisons were first tested using an analysis of variance (two-way ANOVA) at $p<0.05$. Significant differences between the mean values of treated and untreated groups were determined using Duncan's multiple range test.

Results and Discussion

Formaldehyde emission results of the nanomaterials reinforced laminate flooring were shown in Figure 4.

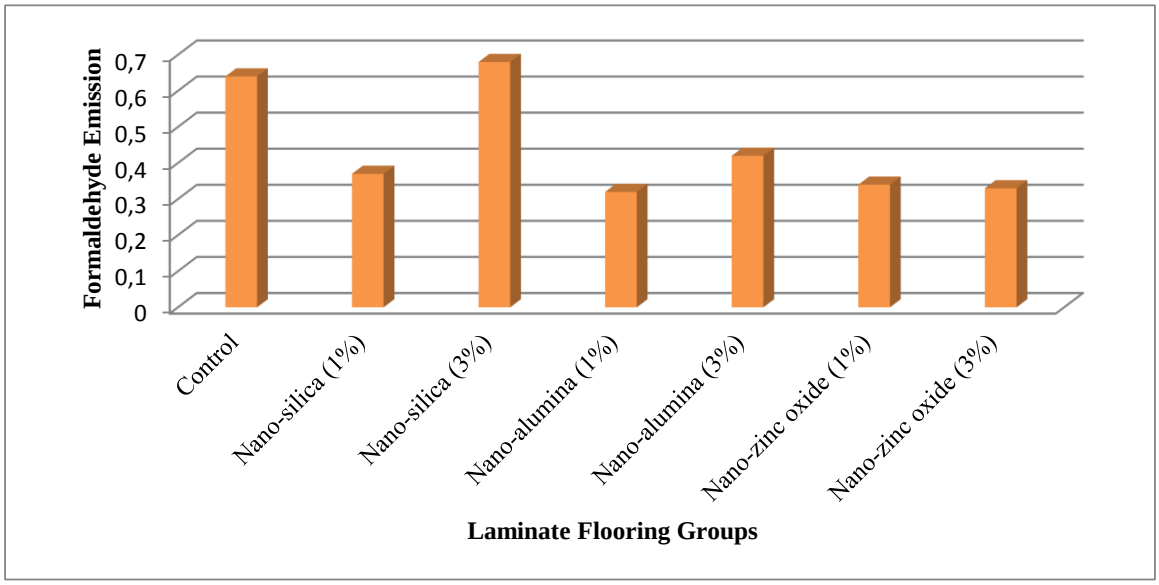

Fig. 4 Test Results of the Laminate Flooring Reinforced with Nanomaterials

The results indicate that the nanomaterials significantly affected the formaldehyde emission of the laminate flooring. All the laminate flooring groups reinforced with nanomaterials had lower average formaldehyde emission values than those of the control group's values, except nanosilica (3%) which was slightly higher than the control group.

The lowest formaldehyde emission value was determined in the laminate flooring reinforced with nano-alumina (1%). The formaldehyde emission values increased with increasing the nanomaterial levels for nano-silica and nano-alumina. There was no important change for nano-zinc oxide. The formaldehyde emission values of the laminate flooring with nano-silica (1%) were decreased by 50%.

Conclusions

Formaldehyde emission property is of a great important for laminate flooring materials because it could affect human health. The nanomaterial type and nanomaterial loading level significantly affected the formaldehyde emission values of the laminate flooring. The formaldehyde emission values could be decreased with using proper nanomaterial type or loading level. The result of this research indicates that nanoscience and nanotechnology could be used to develop laminate flooring materials having an enhanced property.

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