

## Biodegradation behaviors and color change of composites based on type of bagasse pulp/polylactic acid

### Abstract

In this research, appearance quality and decay resistance of polylactic acid (PLA) based green composites made from monoethanolamine (MEA) bagasse pulp, alkaline sulfite-anthraquinone (AS) bagasse pulp, bleached soda (BS) bagasse pulp, unbleached soda (UNS) bagasse pulp and raw bagasse fibers (B) were investigated. For the investigation of biodegradation behaviors, effect of the white rot fungi (*Coriolus versicolor*) on the neat PLA and composites with natural fibers during 30 and 60 days were studied. It was found that when the bagasse fibers were incorporated into composites matrix, percentage of weight reduction and stiffness of samples increased. In addition, the aforementioned weight loss of the composites made from bagasse pulp fibers were higher than those of made from raw bagasse fibers. This can be explained by the removal of non-cellulosic components such as lignin and hemicelluloses from the fibers by pulping process. Moreover, the results indicate the inferior of surface qualities of fabricated composites regarding to neat PLA. Depending on the fiber type, different reductions of the surface qualities were attained. However, the degree of color change of the composites made from any type of bagasse pulp fibers were lower compared with those made from raw bagasse fiber. Finally, as compared with the raw bagasse fibers, bagasse pulp fibers had better reinforcing capability.

**Key words:** biodegradability, green composites, fungal decay, bagasse pulp fiber, polylactic acid (PLA).

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## Effect of nano zinc oxide on physical and mechanical properties of wood plastic composites

### Abstract

In this study, the effects of nano zinc oxide on the physical and mechanical properties of wood-polyethylene composites were investigated. The composites containing 0, 1, 2 and 4 wt% zinc oxide nanoparticles were manufactured using an internal mixer and a laboratory press and then the flexural and tensile properties, hardness, water absorption and thickness swelling of the samples were evaluated. The results showed that using 2 and 4 percent nano zinc oxide significantly reduced the flexural strength, flexural modulus and tensile strength. The results also revealed that the hardness and tensile modulus of composites were negatively affected only in composites containing four percent nano zinc oxide. The evaluation of physical properties showed that incorporating nano zinc oxide (2 and 4 %) increased thickness swelling. In the case of water absorption, just 4 percent nano zinc oxide increased the values.

**Key words:** wood-polyethylene composite, nano zinc oxide, mechanical properties, physical properties.

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## The effect of type and mixture of resin on the properties of impregnated paper

### Abstract

This study was carried out in order to investigate the effects of different types and mixtures of resins on the impregnated paper properties. In this regard, pure urea resin (100%), mixture of melamine and urea resins with various combinations (60/40 and 70/30 and 50/50), mixture of nano-fiber cellulose with ratios of 1, 2 and 3 percent with urea resin and pure PVA (100%) were used to impregnate the newsprint basic paper of Mazandaran wood and paper industries. Immersion of samples in the impregnation step were done in two durations of 5 and 10 seconds. Next, melamine resin was used for surface coating and then absorption of resin in the impregnation and coating process was measured. The results showed that, with respect to absorption rate and surface properties of melamine paper, the best impregnation duration was 10 seconds (in the case of pure (100%) urea). In the combined treatment, adding up to 30% melamine to urea resin, as impregnation step resin, offers better properties in terms of stain resistance, cigarette resistance, resistance to cracking and resistance to hot water steam for resulting papers. By adding nanocellulose up to 1% in impregnation resin, better properties were obtained for melamine paper. Moreover, PVA as impregnation resin can offer similar quality compared to the pure urea in the resulting melamine papers.

**Key words:** impregnated paper, melamine paper, nanocellulose, urea-formaldehyde, melamine formaldehyde.

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## The effect of layer's moisture content and pre-heating by microwave radiation on physical and mechanical properties of laminated veneer lumber

### Abstract

The effect of moisture and pre-heating time by the microwave radiation were studied on the physical and the mechanical properties of laminate veneer lumber (LVL). The variable factors included moisture content of layers in the range of 3, 5 and 8 percent and the microwave radiation pre-heating times at levels of 0, 120 and 180 seconds. LVLs were made of 9 poplar layers, each with the thickness 2.5 mm that were bonded together using phenol formaldehyde. The frequency and the power of microwave radiation were 2450 (MHz) and 4000 (W), respectively. The results showed that the physical and mechanical properties of LVL decreased when moisture content of layers increased from 3 to 8 percent. In contrast, the pre-heating by microwave improved physical and mechanical properties at longer times. The positive impact of pre-heating by microwave radiation was much more evident on the layers with higher moisture content.

**Key words:** pre-heating, microwave radiation, physical and mechanical properties, laminate veneer lumber (LVL).

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## Study of chemical components and bioactive properties of knot wood extractives from four endemic species of hyrcanian forests

### Abstract

Persian wingnut, Persian honeylocust, Persian ironwood and Persian alder are of four endemic and important species of Hyrcanian forests that the presence of bioactive components in them are initially been proven; however no comprehensive study has yet been done about their chemical components. Furthermore, bioactive phenolics are more in knot wood extractives than other parts of a tree. Hence, in this study, the amounts of extractives, carbohydrates, lignin, as well as antioxidant properties of acetonic extractives were calculated and the extractives components were identified via Gas Chromatography-Mass Spectrometry. The results demonstrated that the knot wood of Persian wingnut contains the most amounts of extractives, carbohydrates and phenolics and showed the highest ability against Diphenylpicrylhydrazyl radicals, while the knot wood of Persian honeylocust contains the most amounts of lignin and capability against chelating of iron ion. All of these four species presented superior scavenging capability against radicals compared with the synthetic antioxidant and butylated hydroxytoluene. Besides, phenolic and non-phenolic materials with different and interesting antioxidant properties were identified.

**Key words:** chemical components, extractives, phenolics, antioxidant properties.

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## Evaluation of bending performance of cross laminated timber (CLT) made out of poplar (*Populus alba*)

### Abstract

Bending strength is a critical property of cross laminated timber (CLT) in structural applications, especially in floor of multi-story buildings. Therefore, this study was targeted to evaluate the bending strength of CLT made out of poplar (*populous alba*). Polyurethane adhesive was used to construct CLT (300 g/m<sup>2</sup>). The thickness of used planks was 16 mm. The results indicated that modulus of rupture (MOR) and modulus of elasticity (MOE) of CLT with 45° alternating transverse layer were increased 14 and 15%, respectively in comparison with 90° layers. Also, modulus of rupture (MOR) and modulus of elasticity (MOE) of CLT consist of layers with 4cm in width were increased 14 and 5%, respectively in comparison with layers 9cm in width. It was concluded that by using thinner layers, and 45° alternating layer configuration, it is possible to construct CLT with an acceptable bending strength from fast growing trees such as poplar.

**Key words:** cross laminated timber, MOR, MOE, layer configuration, layer width.

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## Application of acetylated nanocrystalline cellulose in modified soy-based adhesive for plywood

### Abstract

Aimed to develop a formaldehyde-free adhesive that can compete with conventional adhesives in wood industry, soy flour (SF), an abundant, environmentally friendly and renewable material, was used. Using sodium hydroxide (NaOH), polyethylene imine (PEI) and acetylated nanocrystalline cellulose (NCC) at two levels (one and three percent by weight of the dry weight of SF / PEI) as modifying agents, different formulations were prepared. Modifying agents help to improve the soy adhesive properties. Physical properties of synthesized adhesives such as the solid content, pH, gel time and viscosity of adhesives were measured. Beech (*Fagus orientalis*) plywood samples were made by each formulation and their water resistance, dry and wet shear strength were measured in accordance with related standards. The results were compared with those of PF samples. Adhesive structural changes were evaluated with FTIR spectroscopy. With evaluation of acetylated NCC, modification of hydroxyl groups and replacing them to ester groups confirmed by FTIR spectroscopy, and the DS determined by titration was 0.34. X-ray analysis showed that the acetylation process reduced the crystallinity. Solid content and viscosity of adhesives were increased by adding modifying materials. Plywood samples with formulation of SF/PEI/NaOH/NCC in both two levels of acetylated NCC had shear strength and water resistance similar to PF adhesive. FTIR analysis indicated that NaOH denatures SF; amino groups buried inside the compact protein structure become available. Compared to SF/NaOH, SF/PEI/NaOH showed small shifts in absorbance peaks. Primary and secondary amines in SF/PEI/NaOH diminished or disappeared. Considering functional groups of SF and amino groups of PEI which have potential to react hydroxyl and carbonyl groups of acetylated NCC, hydrogen bonds within adhesive component were developed.

**Key words:** natural adhesive, soybean flour, plywood, cellulose nanocrystalline.

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## Determination of withdrawal resistance of staple joints constructed with various members of upholstered furniture

### Abstract

The goal of this study was to investigate the effects of joints members type (oriented strand lumber, plywood and poplar wood), penetration deep of staple (12 and 17mm), and adhesives (with or without) on face and edge withdrawal resistance of joints fabricated with staple. The main and secondary members of experimental specimens were joined together by one staple and were tested under withdrawal load test of face and edge. The results showed that joint member, penetration deeps and adhesive significantly influence the withdrawal resistance. Staple withdrawal resistance in the face was higher than that in the edge. Staple holding resistance increased with the increase of penetration deep and the withdrawal resistance of joints fabricated by adhesive was higher than those without adhesive. The joints made by oriented strand lumber exhibited better performance than other two members and joints made with poplar wood had higher resistance than plywood joints. The highest face (2326N) and edge (1265N) withdrawal resistances were obtained from joints prepared from oriented strand lumber with adhesive and 17mm penetration deep.

**Key words:** oriented strand lumber, withdrawal resistance, upholster furniture, staple joint, poplar wood.

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## An investigation on anatomical and mechanical properties of vascular bundles in Date palm (Case Study: Ahvaz countryside)

### Abstract

The objective of this study was to investigate the biometry of vascular bundles and their roles in the physical and mechanical properties of date palm. To prepare experimental samples, three date palm trees (*Phoenix dactylifera*) with the average diameter of 47 cm were cut in Ahvaz (Khoozestan Province, Iran). Cubic samples with dimensions of 2 cm (tangential) × 2 cm (radial) × 2 cm (longitudinal) were taken from different heights of a trunk (2, 5 and 7 meter). The biometry of trunk tissue (number, diameter and cross-cut area of single vascular bundles), as well as physical (density) and mechanical properties (vascular bundles tension strength and modulus of elasticity) were studied. The results showed that the calculated total area of vascular bundles was maximum for outer samples (near the bark; 33% of total area) and the values gradually decreased to 27% for inner specimens (around the pith). Moreover, the number of vascular bundles increased from inner to outer parts of trunk. The same trend was also observed from lower to higher heights of a tree; however considering diameter and cross-cut area of a single vascular bundle, no distinct trend was observed. Regarding the mechanical properties of vascular bundles, the results revealed that tensile strength and modulus of elasticity were higher for the specimens close to the pith in comparison with the samples near the bark. Finally, the highest correlation was found between mechanical properties of vascular bundles and their position in the transversal direction of date palm stem.

**Key words:** date palm, vascular bundles, tensile strength, modulus of elasticity (MOE).

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## The effect of nanoclay on physical and mechanical properties of particleboard made from urea-kraft lignin- glyoxal green adhesive

### Abstract

In this study, a nontoxic aldehyde with high boiling point entitled glyoxal was used for reaction with urea and kraft lignin to prepare a green adhesive entitled urea- lignin- glyoxal (LUG). The prepared LUG resin was used in particleboard manufacturing. Then, the influence of nanoclay addition on various properties of particleboard made from LUG resin was investigated. For this reason, the kraft lignin (10 wt%) was used instead of second urea in urea- glyoxal resin synthesis. After synthesizing LUG resin in acidic condition and measuring physicochemical properties of the prepared resins, the prepared LUG resin was mixed with the 0.5, 1 and 1.5% of nanoclay via mechanically stirring for 5 min at room temperature. Then, the prepared resin was used in particleboard manufacturing. The physicochemical properties of the prepared resins such as viscosity, gelation time, solid content and density as well as physical (water absorption) and mechanical (internal bond strength and flexural properties) properties of manufactured panels were measured according to standard methods. Also, x-ray diffractometry (XRD) was used to investigate the distribution of nanoclay in LUG resin. The results of physicochemical test indicated that gelation time of the LUG resin is slower than that of UF resin. Addition of nanoclay from 0.5 to 1.5% accelerated the gelation time of the prepared resins whereas the fastest gelation time was related to the LUG resin containing 1.5% nanoclay. Moreover, XRD analysis indicated that nanoclay could well be separated when mixing with LUG resin. Based on obtained result, the addition of nanoclay significantly decreased the water absorption content of the manufactured panels. The internal bond strength and flexural strength of the panels was increased by adding the nanoclay. Finally, it must be noted that the addition of nanoclay had no significant effect on flexural modulus of the manufactured panels.

**Key words:** nanoclay, urea- lignin- glyoxal resin, XRD analysis, particleboard.

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## Use of soy flour-tannin adhesive for particleboard (dry condition)

### Abstract

In this research, soy flour- tannin adhesives were successfully used in particleboard preparation. Two types of tannins i.e. mimosa (as condensed tannin) and chestnut (as hydrolysable tannins) were used for soy resin modification. For this purpose, mimosa and chestnut tannins were added to soy adhesive with 5, 10 and 15 percent based on dry weight of soy flour. 9 percent Glyoxal was used based on dry weight of tannin to accelerate the tannin reaction with soyflour components. Prepared soy-tannin adhesives were used in particleboard manufacturing with 350×300×14 mm<sup>3</sup> dimension and 0.7 g/cm<sup>3</sup> nominal density. Results of viscosity measurement showed that the addition of each tannin decreased viscosity of soy adhesive. In this study, result of thermo-mechanical analysis indicated that chestnut could improve adhesion behavior of soy adhesive better than mimosa. Also, using of tannins in soy adhesive composition increased internal bonding and bending properties in manufactured particleboards.

**Key words:** soy flour adhesive, tannin, thermo-mechanical analysis, internal bonding, particleboard.

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## Fire performance, mechanical strength and dimensional stability of wood flour–polyethylene composites under the influence of different fire retardants

### Abstract

Flammability is one of the most important parameters that often limit the application range of wood plastic composites. Therefore, the improvements of retardancy performance of these products have a considerable impact. The aim of this work was to evaluate the influence of expandable graphite (EG) and its combination with aluminum trihydroxide (ATH), inorganic phosphate (IP) and melamine borate (MB) on the flammability of wood flour–polyethylene composites. Composites were prepared by the melt compounding method and cone calorimetry as well as limited oxygen index (LOI) tests was employed to study their flammability properties. Also, the effect of different fire retardants on the mechanical strength and water uptake of samples were investigated. Cone calorimetry characterization indicated that with incorporation of fire retardants, heat release rate and burning rate decrease and char residual as well as the time to ignition increase. These findings were ascribed to the formation of char layer by fire retardants. The combination of EG and other fire retardants yielded better improvements in flame retardancy in comparison to the sample that has just EG as flame retardant. The LOI test was used to determine the lowest concentration of oxygen at which a material will maintain combustion in a flowing mixture of oxygen and nitrogen. The results showed that inclusion of fire retardants improve the LOI of sample. Furthermore, the presence of fire retardants decreased the tensile and flexural resistance (strength and modules) and impact strength of samples, and increased the water absorption as well as thickness swelling. Generally, among the different treatments examined, the EG–ATH retardancy system showed the highest potential in flame retardancy of composites.

**Key words:** cone calorimetry, flammability, limited oxygen index, mechanical properties, retardancy.

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