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Preparation and Properties of Nanocrystalline Cellulose and Nanozeolite-Filled Modified Oil Palm Trunk Starch Nanocomposites

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Abstract

Nano crystalline cellulose and nano zeolite field into the oil palm trunk starch modified. There was a increase in the quality of oil palm trunk starch which be used to as adhesives. Their modified starch added DSTB. Nano crystalline cellulose produced by oil palm empty fruit bunches used isolation method. Nano zeolite produced by grinding process what do by ballmill and the size was characterized by PSA. Adhesive characterized by tensile strength .

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Keywords: modified-starch, nanocrystalline cellulose, nanozeolites

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1. INTRODUCTION

The oil palm trunk is an abundant solid waste in palm oil plantations especially during the replanting season which possesses valuable starch content but has not been utilized commercially. On the other hand, the oil palm trunk starch may be used as wood adhesives but the mechanical and adhesion strengths were low due to its high water absorption. In this work the oil palm trunk starch was extracted using presipitation in water, and modified using disodiumtetraborax (DSTB) to promote crosslinking reactions within the starch main chains which in-turn improve its adhesion strength on the substrate surface. Mechanical strengths as well as durability of the starch matrix were also improved by addition of nanocellulose and nanozeolite as fillers to produce a nanocomposite adhesives for wood substrates. Weight ratios of the nanocellulose to nano zeolite were varied which were prepared using ball milling technique and their particle size distributions were measured using particle size analyser (PSA). The weight ratios of nanocellulose and nanozeolite to the composites were varied from 1%, 2%, 3%, 4%, and 5% respectively. The nanocomposites were then characterized for their physical and mechanical properties using tensile strength. The nanocellulose and nanozeolite improved the quality of the composite. Compositions and loading of the nanofillers against modified-starch matrixes were also varied and their durability and adhesion strength were compared to those of the Indonesian Standard for wood adhesives.

The oil palm trunk have used to thermoplastic board by the treatment of reactive impregnation treatment technique by using the recycle of polyolefine and then called as a polyolefine impregnation on the palm trunk which its did at around palm board surface only and didn't to be into the center of palm trunk (Wirjosentono, et al., 2001).

Oil palm trunk so have used to the raw material of the partcles board by using the adhesive from polypropilene degradated which to be fungsionalized by benzoyl peroxide, maleat anhidride, and di-vynyl benzene (Nasution, D.Y., 2011).

The starch can be obtained by extracting from oil palm trunk. Palm trunk contains starch that can be obtained by performing the extraction, which contained the highest starch yield on the shaft of oil in the 1 meter from the top of the stem with a yield of 3.3% (Ariansyah, et al., 2011).

The modified starches synthesized in the present study are found to be hydrophobic and can biodegrade in composting. Blends of a modified starch and poly(ethylene-co-vinyl alcohol) (EVOH) were prepared by melt blending. Phase diagrams of the blends exhibited a lower critical solution temperature. The nanocomposites based on a modified starch and EVOH were prepared. Natural clay (montmorillnite, MMT) and two commercial organoclays (Cloisite 30B and Cloisite 15A) were employed to investigate how the functional groups in the modified starch influence the dispersion characteristics of nanocomposites. Anionically modified starch was found to be very effective in exfoliating organoclay aggregates due to the presence of ionic interaction, as determined by Fourier transmission infrared (FTIR) spectroscopy, between the anionic group in the modified starch and positively charged N+ in the surfactant residing at the surface of an organoclay. For the nanocomposites based on a cationically modified starch and EVOH, the preparation methods had a large influence on the dispersion characteristics of the nanocomposites. The aggregates of MMT have a very high degree of dispersion characteristics in the nanocomposites prepared by solution blending but poor dispersion characteristics in the nanocomposites prepared by melt blending. FTIR spectroscopy has indicated that the ionic interaction between the cationic group in a modified starch and negatively charged surface of silicate sheets of MMT could be formed in the nanocomposites prepared by solution blending but not in the nanocomposites prepared by melt blending. We have found that an improvement in the tensile properties of nanocomposites can only be obtained if the nanocomposites have a very high degree of dispersion of the aggregates of clay, and there is strong attractive interaction between the clay and the matrix (Song, 2010).

Investigation of Effect of nano-Al2O3 on adhesion strength of epoxy adhesive and steel, journal showed that the highest adhesion strength was obtained with 2wt% nano-Al2O3 in epoxy adhesive, being almost four times higher than that of the unmodified. As the adhesion strength increased, the locus of failure changed from interfacial to the mixture of interfacial and cohesive (Zhai, 2007).

The Empty Fruit Bunches (EFB) is used to be the flour of pulp EFB esterificated as the reinforcement in the composite matrixes of polyetilene have studied about their adhesion. SEM analysis showed that the flour of esterified EFB pulp had the improvement adhesion force which reacted with polyetilene. Its effected by the change of surface from the hydrofilic to be the hydrofobic (Daulay, L. R., 2009)

Nano crystalline cellulose (NCC) isolated from empty fruit bunch (EFB) using a solvent mixture of DMAC/LiCi, were passed on activated dialysis membrane after centrifugated to release it from the solvent. The purpose of additional GMS antistatic is to lower the volume resistivity of nanocomposite PS/NCC which usually containing static electricity either due to the nature of the material or by the fabrication process itself. XRD analysis showed that the NCC formed was nanocellulose I with an average size of 72 nm diameter, because of its high surface are, the addition of NCC were able to improve the mechanical properties of the nanocomposite but did not affect the nature of the resistivity (Adriana, 2014).

The tensile test results obtained in the presence of nano particles increase in natural zeolite, the composition of 2%wt with calcination process give 8 Mpa and 6%wt without calcination give 7.7 Mpa, while without the nanozeolite give 6.6 Mpa tensile strength (Bukit, 2011).

The production of casava starch-based adhesive studied investigate possible improvement methods of the properties of the adhesives produced by studying the effects of borax and temperature on the viscosity, density and pH of adhesive and the use of two different modifiers (HCL and NaOH) in the production of the adhesive; thus provide a range of conditions for producing starch-based adhesives for diverse applications depending on the required properties and industrial applications (Gunorubon, 2012).

2. EXPERIMENTALS

The first, raw material like the oil palm trunk starch produced by oil palm tree 22th years old and was do extraction and presipitation processes. NCC produced by oil palm empty fruit bunches used isolation process. NZ produced by grinding using ballmill.

The second, the oil palm trunk starch, DSTB, NCC, NZ, NaOH/HCl has prepared and then blending in the variety mass on hotplate at temperture 338K. DSTB used 5%weight for each sample.

The third, characterization by tensile strength and PSA.

3.RESULTS AND DISCUSSIONS

The adhesives were as the final productor yield after was be packaged like figure 1:

Figure 1: adhesive as the final product

There was in the figure 1 showed from left to right there were adhesive added DSTB+2%NZ, added DSTB+2%NCC, and without them, respectively.

The minimum strain value is 4th sample and stress value is 1st sample and showed on the table 1:

Table 1 tensile strength for adhesive

No	Sample	Strain	Stress	Mo
1	No DSTB (A)	1072.2900	97.16923	0.182492
2	With DSTB (Ab)	1102.3550	92.28203	0.169220
3	Ab+1%NCC	1078.0330	87.95288	0.167577
4	Ab+2%NCC	955.7640	95.41088	0.241536
5	Ab+3%NCC	1074.7520	87.16509	0.177085
6	Ab+4%NCC	1066.6060	85.92613	0.201391
7	Ab+5%NCC	1024.9630	82.08150	0.163934
8	Ab+1%NZ	1004.1460	78.50742	0.198348
9	Ab+2%NZ	1028.5000	82.29756	0.187070
10	Ab+3%NZ	1119.2460	85.34626	0.162506
11	Ab+4%NZ	1140.4530	87.47597	0.162099
12	Ab+5%NZ	992.2957	88.71492	0.210408

The characterization of adhesive (yield) using tensile strength did until twice replications showed on the table 2 in the following:

Table 2: tensile strength for adhesive for two times replications

No.	Sample	Tensile Strength (MPa)	MoE (MPa)	Elongation breaks (%)
1a	No DSTB	59.367	68.809	22.5
1b	No DSTB	53.944	36.859	19.0
2a	With DSTB	54.591	43.990	26.4
2b	With DSTB	59.164	40.702	28.5
3a	1% NCC	79.601	25.891	29.0
3b	1% NCC	48.611	59.815	23.0
4a	2% NCC	49.307	30.561	20.8
4b	**2% NCC**	**109.235**	**69.385**	**23.3**
5a	3% NCC	45.018	56.498	28.2
5b	3% NCC	51.940	65.124	22.1
6a	4% NCC	48.844	35.064	27.0
6b	4% NCC	49.931	34.360	23.6
7a	5% NCC	47.107	42.671	26.2
7b	5% NCC	45.547	65.438	24.0
8a	1% NZ	41.690	33.688	21.1
8b	1% NZ	51.550	56.135	32.0
9a	**2% NZ**	**80.732**	**36.442**	**32.2**
9b	2% NZ	44.591	16.802	20.6
10a	3% NZ	50.891	30.369	29.2
10b	3% NZ	49.463	15.948	24.1
11a	4% NZ	51.854	52.167	28.2
11b	4% NZ	51.166	45.148	28.8
12a	5% NZ	54.476	30.597	22.9
12b	5% NZ	50.865	29.672	21.9

The optimal elongation break was adhesive added 2% NZ field namely 32.2 %.
Tensile strength was adhesive added 2% NCC field namely 109.235 MPa.

4.CONCLUSION

2

Physica and mechanical characteristics of the nanocrystalline-cellulose and natural nanozeolite-filled modified oil palm trunk starch nanocomposites are reported.

2

Durability of the nanozeolite is the better than nanocrystalline cellulose-filled modified oil palm trunk starch nanocomposite to heat. Durability and adhesion strength of the nanocomposites were compared to those of the Indonesian Standard for wood adhesives which there have been gave us a new information for adhesive. Nanozeolite added 2% and nanocrystalline cellulose added 2% into nanocomposite were the optimal yield.

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