CHARACTERIZATION OF WOOD AND NON-WOOD PARTICLES PROPERTIES

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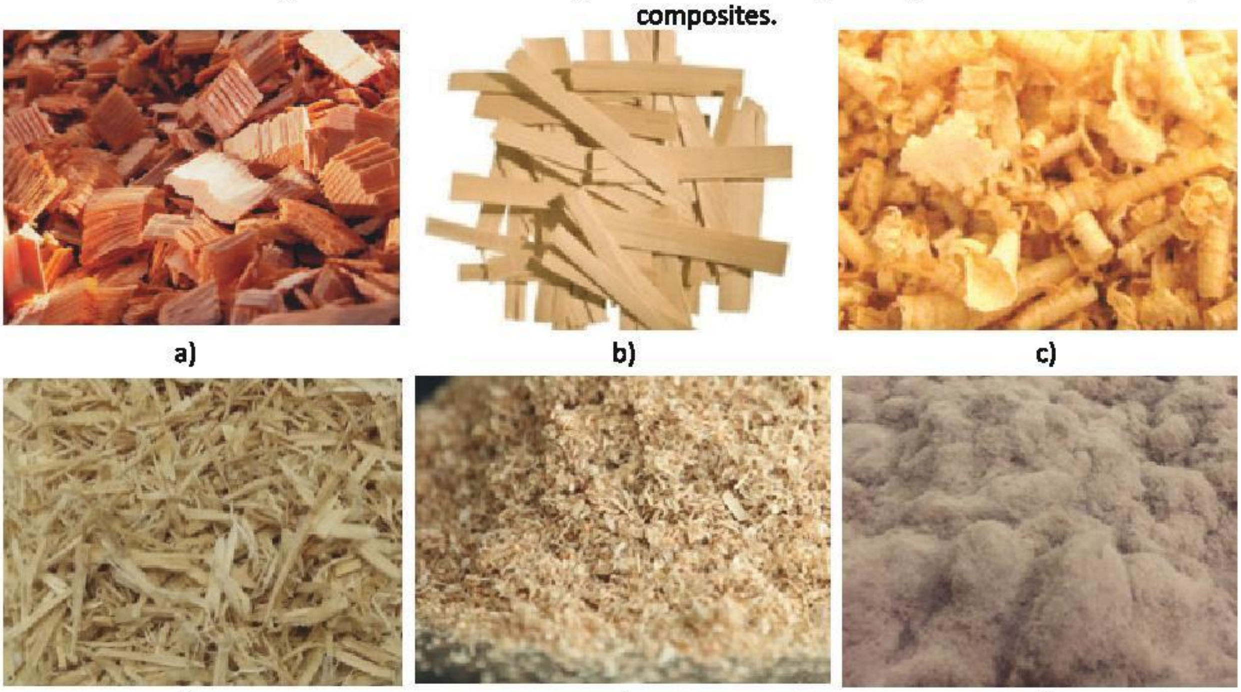
Introduction

There are many lignocellulosic resources in Malaysia and this resources can be classified as wood and non-wood. Commonly, the term "wood" is based on tree, and "non-wood" is based on non-tree plant (including shrub, palm, grass, etc). In order to use these lignocellulosic resources in particle-based composite manufacturing, the characterization of the particles is crucial. Characterization can defined as a description of the distinctive nature or features of something. In this article, the characterizations of particles are including the size (length, width and thickness), aspect ratio and geometry of wood and non-wood particles. These characteristics are substantially affecting the performance of the manufactured composites.

Commonly, particles are used in particleboard and wood plastic composite manufacturer. The term "particle" is a generic term applied to all lignocellulosic elements, either wood or non-wood, from which composites are made. The terminology can be referred to various types of particles depending on their applications. For example, the major types of particles used in particleboard manufacturing include wood shavings, flakes, wafers, chips, sawdust, strands, slivers, and wood wool (Moslemi 1974). Meanwhile the major types of particles used in wood plastic composite are commonly called fibre, particle, wood flour and sometime sawdust. Wood flour and sawdust are the same product, but in different size where the sawdust is normally having smaller size as compared to the wood flour. Figure 1 illustrates the types of particles that commonly used in composites.



a) b) c) d) e) f)

Figure 1: Types of particles used in composites (a) chips, (b) strands, (c) shavings, (d) particles, (e) sawdust, and (f) short fibres

One of the most main characters of particle is the size (including length, width and thickness). Afterwards, this size will indicate the slenderness ratio (length to thickness) and aspect ratio (length to width) of the particles. In a comparative study done by Juliana et al (2017), typical wood and non-wood particles sizes for particleboard production is 9.90 to 15.60 mm and 1.89 to 48.60 mm, respectively. Longer particle produced by non-wood might be due to the particles are in the presence of vascular bundles. Hashim et al (2009) reported that the length of vascular bundles of oil palm tree are ranging from 30 to 50 mm. Meanwhile, in wood plastic composite, short and tiny fibres (average particle size 0.24–0.35 mm) should be preferred for wood plastic composite (Ashori, 2008). Other studies stated that typical particles sizes for wood plastic composite production is 10 to 80 mesh or 0.18 to 2.0 mm, and the smaller particles were said to yield better performance (Takatani et al. 2000; Clemons 2002). The differentiation on the length and width of particles was due to the different specific gravity of the materials. As mentioned by Maloney (1993), during flaking, the ability of a knife blade to penetrate the wood and slice it depends, to a great extent, on the specific gravity and hardness of the wood.

Particle size is one of the main parameters that have been reported to affect the properties of the end product, namely particleboard and wood plastic composite (Moslemi, 1974; Ashori, 2008). For instance, particleboard comprises of larger and longer sized particles were found significantly stronger in bending and bonding strength as compared to the board made from smaller sized particles (Ong 1981; Jamaludin et al. 2001; Migneault et al 2008; Juliana et al. 2012). Increasing the length of particles and the slenderness ratio (length/thickness) also increases both modulus of rupture (MOR) and modulus of elasticity (MOE), but decreases the bonding strength (Miyamoto et al. 2002). In a comparative study done by Juliana et al (2017), they stated that the mechanical properties of wood plastic composites are significantly increased with increasing particle length from 0.18 mm to approximately 0.50mm, but the properties are adversely affected when the particle length increased to 0.68 mm and above.

Another character influencing the properties of composite is particle geometry, which indicates the shape and the size. Majority of wood particles appeared in form of rectangular and nearly rectangular form (Kruse et al., 2000). Meanwhile, kenaf with lower density were present in a semi-circular-end shape but most of them still retained the rectangular shapes (Juliana et al., 2012). A study reported that semi-circular end-shaped particles gave low strength, rectangular-shaped particles gave superior strength, and that flat, end-tapered and pointed, end-tapered shapes gave moderate strengths (Schneider and Conway, 1969). Overall, wood particles are more consistent in term of length and geometry. Meanwhile, non-wood particles have fluctuate length and geometry. However, some of non-wood particles has comparable characters as wood, and some other such as bamboo exhibits superior properties compared to wood.

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References

1. Ashori A (2008) Wood-plastic composites as promising green-composites for automotive industries. Bioresource Technology 99: 4661-4667
2. Clemons C (2002) Wood-plastic composites in the United States: The interfacing of two industries. Forest Products Journal 52: 10-18.
3. Jamaludin K, Abdul Jalil HA, Jalaludin H, Zaidon A, Abdul Latif M, Mohd Nor MY (2001) Properties of particleboard manufactured from commonly utilized Malaysian bamboo (Gigantochloa scortechinii). Pertanika Journal of Tropical Agriculture Science 24: 151-157
4. Juliana AH, Lee SH, Paridah MT, Zaidon A, Lum WC. (2017). Development and characterization of wood and non-wood particle based green composites. In Green Biocomposites - Manufacturing and Properties. Jawaid M, Sapuan SM, Othman Alothman, Y. (Eds.). Springer International Publishing: Switzerland , pp.181-198
5. Juliana AH, Paridah MT, Rahim S, Nor Azowa I, Anwar UMK (2012) Properties of particleboard made from kenaf (Hibiscus cannabinus L.) as function of particle geometry. Materials and Design 34: 406-411.
6. Kruse K, Dai C and Pielasch A (2000) An analysis of strand and horizontal density distributions in oriented stard board (OSB). Holz als Roh- und Werkstoff Journal 58: 270-277.
7. Li XJ, Cai ZY, Winandy JE, Basta AH (2010) Selected properties of particleboard panels manufactured from rice straws of different geometries. Bioresource Technology 101: 4662-4666.
8. Maloney TM (1993) Modern particleboard and dry process fiberboard manufacturing. Updated Ed Forest Prod Soc, Madison, Wisconsin. p. 681.
9. Migneault S, Koubaa A, Erchiqui F, Chaala A, Englund K, Krause C, Wolcott M (2008) Effect of fiber length on processing and properties of extruded wood-fiber/HDPE composites. Journal of Applied Polymer Science 110: 1085-1092.
10. Miyamoto K, Nakahara S, Suzuki S (2002) Effect of particle shape on linear expansion of particleboard. Journal of Wood Science 48: 185-190.
11. Moslemi AA. (1974) Particleboard: Volume 1: Materials. Southern Illinois University Press, USA
12. Ong CL (1981) The influence of wood density and flake dimensions on particleboard properties of five hardwood species. The Malaysian Forester 44: 508-515.
13. Schneider GJ, Conway HD. (1969) Effect of fiber geometry and partial debonding on fiber matrix bond stresses. Compos Mater; 3:116–35.
14. Stark N, Berger MJ (1997) Effect of species and particle size on properties of wood-flour-filled polypropylene composites. In: Proceedings of Functional Fillers for Thermoplastics and Thermosets, Intertech Conferences, San Diego, 8-10 December 1997, pp. 1-16.
15. Takatani M, Ito H, Ohsugi S, Kitayama T, Saegusa M, Kawai S, Okamoto T (2000) Effect of lignocellulosic materials on the properties of thermoplastic polymer/wood composites. Holzforschung 54:197-200.

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