Fabrication of Ramie Nonwovens and Their Characterization

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1. Introduction

Recycling synthetic fiber products is difficult because most of them are petrobased polymer materials with mixed composites structure. Current disposal methods for these synthetic fiber products are garbage dumps or burning, both causing environmental concerns. Consequently, the synthetic fiber products have become environmental concern and resources exhaustion problems. A possible solution for this problem is to make biodegradable polymer like PLA(polylactic acid) or using natural fibers[1].

Specially, the development of ramie nonwoven fabrics means high functional nonwoven fabrics developments that have antibiosis, biocompatibility, hygroscopicity, biodegradation and with function of original nonwoven fabrics[2,3]. Therefore, the use of ramie nonwoven fabrics to replace synthetic fiber nonwoven fabrics will improve functionality of industrial textile. However, research is needed to evaluate end-use performance of ramie nonwoven fabrics as it is replaced synthetic fiber nonwoven fabrics.

Therefore, the purpose of this study is to establish of ramie nonwoven process through carding method and calendaring method and investigate of basis properties, morphological structure and mechanical properties.

2. Experimental

2.1 Sample preparation

Ramie fiber used in this study was from waste of ramie spun process. LMP staple fiber and PLA staple fiber were also used in this study as binder fiber. The ramie fiber mixed with the binder fiber in a ratio of 60:40 and 40:60, respectively.

The ramie/binder blend was fed into a lab-scale carding machine to obtain fiber web. During carding, the fiber blend was further opened and individual fibers were combed to be relatively parallel. To enhance web uniformity, the fiber blend was carded three times. A lab-scale calending machine was used for thermal bonding the ramie/binder web. The processing procedures are illustrated in Figure 1 and Table 1 summarizes the sample preparation process and basic properties.

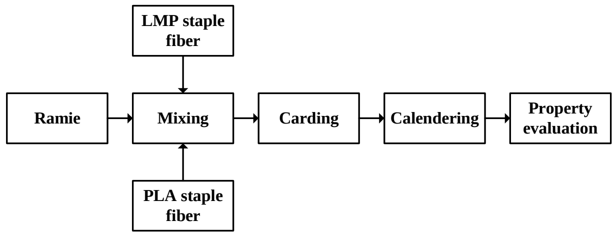


Figure 1. Ramie nonwoven fabrics processing flow chart

Table 1. Sample preparation conditions and basic properties

Sample ID	Portion ratio (wt%)		Calender Roller temp.(℃)		Basis weight (g/m^2)	Thickness (mm)
	Ramie	LMP	Top	Bottom		
WL15	90	10	100	100	49.01±3.22	0.12±0.01
WL110					69.92±6.68	0.15±0.03
WL25	60	40			48.63±3.02	0.09±0.01
WL210					72.72±5.11	0.17±0.01
WP15	90	10	140	145	47.00±2.50	0.15±0.01
WP110					80.10±1.75	0.20±0.01
WP25	60	40			69.47±4.09	0.15±0.01
WP210					92.23±7.76	0.27±0.02

2.2 Measurement and Observation

The observation of morphological structure on samples was carried out SEM(JSM-7000F,JEOL). Evaluation of tensile properties for the ramie nonwoven fabrics was performed in accordance with th ASTM D 4632 and tested using as Instron tester model 4467.

3. Results and discussion

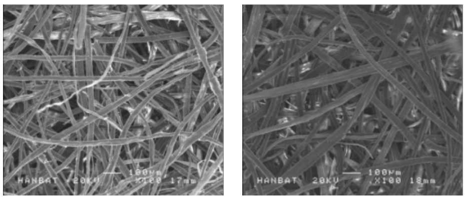
3.1 Morphological structure

Morphological structures of ramie/LMP samples are shown in Figure 1. Ramie fibers are adhered to sheath of LMP fiber at a point of intersection. And fiber morphological transforms through calender roller pressure are not observed in all of samples. As basis weight increased, pore size decreased. Also increasing adhesion phenomena between ramie and LMP were observed with LMP portion increased.

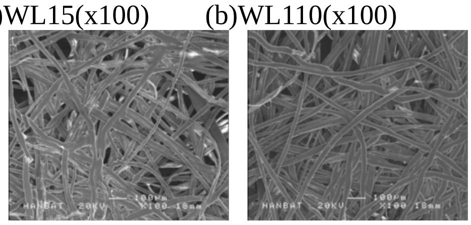
Figure 2 shows morphological structure of ramie/PLA samples. As mentioned above, pore size is decreased by increasing basis weight of samples. And morphological transforms of PLA fibers are occurred by calendar roller pressure. Most of PLA fibers lose fiber form and adhered to ramie fiber by sheet form.

3.2 Tensile properties

The results of stress-strain curves of nonwoven fabrics are shown in Figure 3. The tensile strength of ramie/LMP and ramie/PLA increased with increase in portion of binder fibers. Also, breaking at elongation of samples increased with increasing of binder fibers. It was shown that as portion binder fibers increased, adhesion point increased between ramie and binder. And as basis weight of samples increased, tensile properties increased. However, ramie/PLA tensile strength decreased despite increasing of basis weight. It was shown that WP110, WP25 and WP210 samples have higher basis weight than WL samples despite same input web weight because thermal shrinkage of PLA fibers in calendaring process.

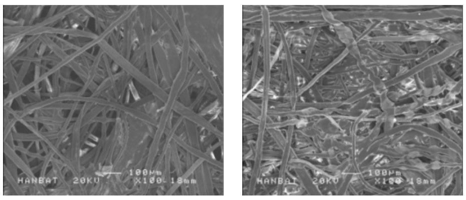


(a)WL15(x100) (b)WL110(x100)

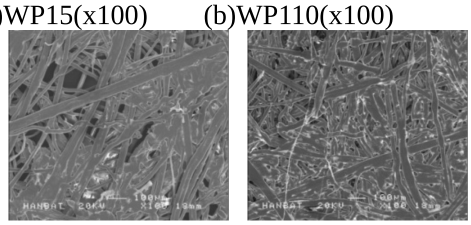


(c)WL25(x100) (d)WL210(x100)

Figure 1. SEM images of ramie/LMP samples

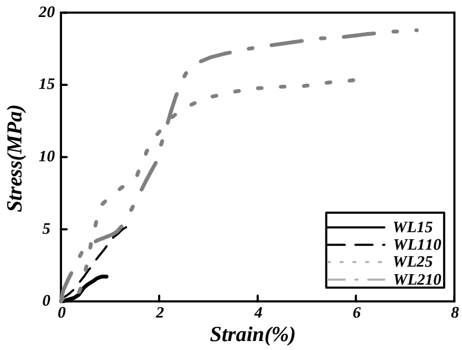


(a)WP15(x100) (b)WP110(x100)

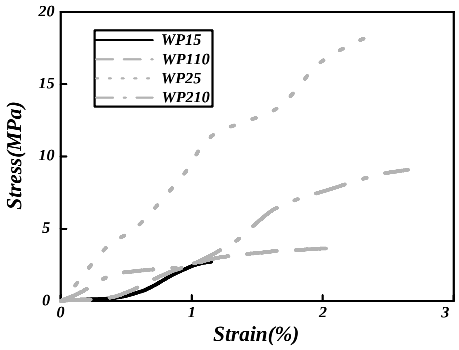


(c)WP25(x100) (d)WP210(x100)

Figure 2. SEM images of ramie/PLA samples



(a) Ramie/LMP



(b) Ramie/PLA

Figure 2. S-S curves of samples

4. Conclusions

The ramie nonwoven fabrics are produced by carding and calendaring methods. The ramie nonwoven fabrics show different morphological structure and pore size with character of binder fibers.

Increasing of binder fiber portion caused that tensile strength and breaking elongation of ramie nonwoven fabrics are increased. Basis weight of ramie/PLA nonwoven fabrics are not constant despite input web weight constant because of thermal properties of binder fibers. Increasing of basis weight of WP samples by thermal shrinkage caused that it has higher thickness than WL samples. Consequently, thermal properties of binder fibers decide mechanical properties the ramie nonwoven fabrics.

5. REFERENCES

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[3] S. Nam, and A. N. Netravali, *Fibers and Polymers*, 7(4), 372-379(2006).