Improving PLA Properties Using Nanotechnology

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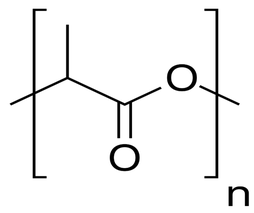
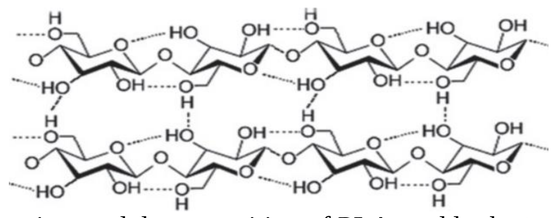
◎ Introduction

- **PLA**, one of the natural synthetic biodegradable plastics, can be obtained by fermenting and refining various microorganisms to obtain lactic acid and polymerizing it, and is attracting attention as an alternative material that is harmless to the human body and easy to recycle.
- Existing biodegradable plastics cannot overcome various problems. Due to these shortcomings, food can be scattered if it is used as a **food packaging material** where speculative and moisture permeability are important.
- The **nanocomposite** may achieve excellent physical properties improvement as compared with the existing composite by dispersing particles up to a nano size and fusing with a polymer.

◎ Purpose

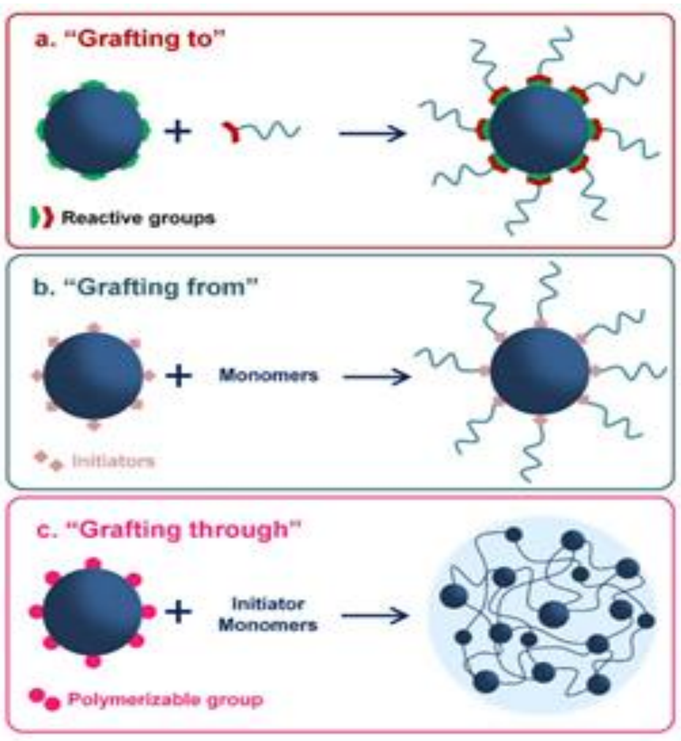




1) Understand the principles of production, processing, and decomposition of PLA, and look at ways to reinforce it. It also identifies the relationship between these measures and the reinforcement of physical properties.
2) Since nanocellulose is hydrophilic, it is difficult to make a composite by mixing with hydrophobic PLA. In order to increase the miscibility of PLA, nanocellulose is modified to be hydrophobic and used, and various related methods are investigated.
3) In order to be used in food packaging materials, the most appropriate method is evaluated using various characteristics including speculative and moisture permeability.

◎ Results and Discussion

- A polymer grafting hydrophobic chamber that uses fatty acid chloride directly in dried cellulose



- Degree of Substitution(DS)

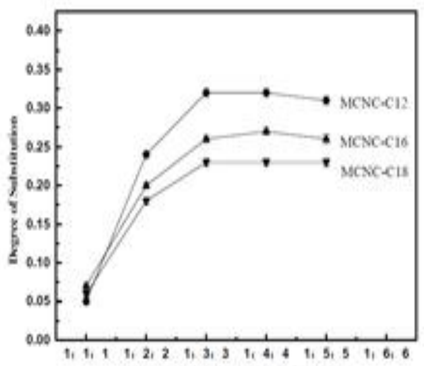


Figure 1. Effect of the ratio of co-reaction reagent on substitution degree of MCNC.

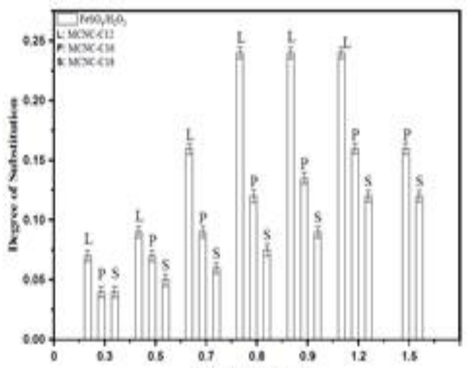


Figure 2. Effect of initiator type and dosage on substitution degree of MCNC.

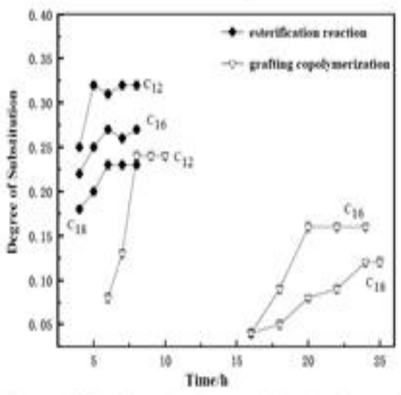


Figure 3. Effect of reaction time on substitution degree of MCNC.

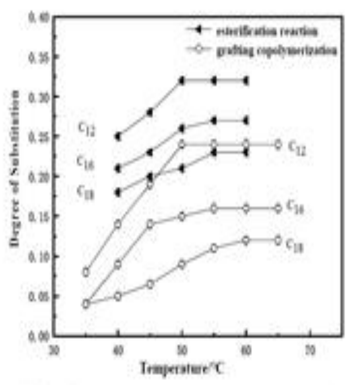
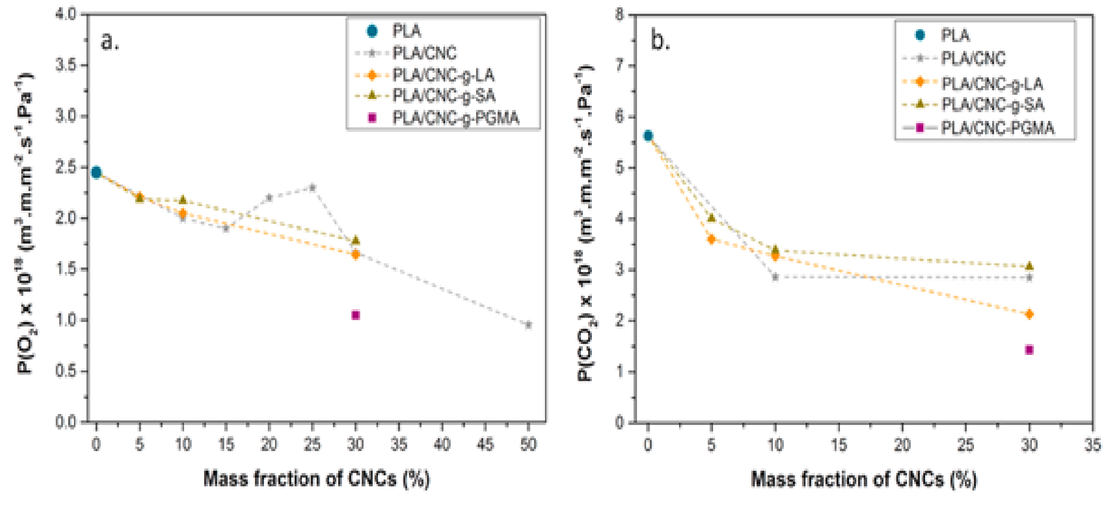
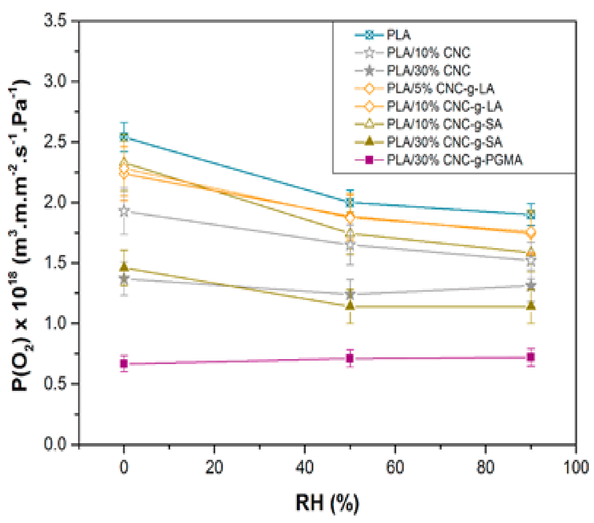


Figure 4. Effect of reaction temperature on substitution degree of MCNC.

- CNC-g-PGMA has shown the best improvement, but considering the barrier performance, non-toxicity, and simple grafting process, the use of lauric acid seems to be the best choice.





- Hydrophile-Lipophile Balance(HLB)

$$HLB = \frac{Hydrophilic\ group\ quality}{Surfactant\ quality} \times \frac{100}{5}$$

$$= \frac{The\ quality\ of\ the\ hydrophilic\ group}{Lipophilic\ bas\ quality + Hydrophilic\ group\ quality} \times \frac{100}{5}$$

$$= \frac{A - DS}{(B-1) \times DS + A} \times \frac{100}{5}$$

Modified CNC	HLB Value of Grafted Copolymer
CNC-g-LA (C12)	15.73
CNC-g-PA (C16)	16.17
CNC-g-SA (C18)	16.69

◎ Conclusions

1) It is basic to improve the performance of PLA as a food packaging material, and the application field can be expanded as various types of reinforcing materials can be used.
2) It can be combined with achievements from various fields such as nano-process, nano-device, and nano-measurement, which are the foundations of nanotechnology, to make great progress throughout the nano-field.