INFLUENCE OF NANOFIBRILLATED CELLULOSE ON THE MECHANICAL AND THERMAL PROPERTIES OF POLYLACTIC ACID

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Introduction

The objective of this work was to produce nanofibrillated cellulose by means of a twin screw extruder and its application as reinforcing material in a polylactic acid. The morphology of the fibers and the compounds was investigated by scanning electron microscopy and mechanical and thermal properties of the PLA/NFC nanocomposites were evaluated. During the drying and compounding process fibers tend to agglomerate which can be reflected as lack of improvement in mechanical properties of the composites. DSC analysis showed that NFC acts as nucleating agent for PLA matrix. Higher crystallinity of NFC composites compared to neat PLA was observed.

Experimental

Polylactic acid (3251D Nature Works®) was used as polymer matrix. Nanofibrillated cellulose was obtained by passing never dried dissolving pulp 10 and 20 times through a twin screw extruder (Brabender 20/40D). The ten times fibrillated nanocellulose was referred as NFC10 and twenty times fibrillated as NFC20. PLA/NFC nanocomposites containing 5% nanofibrillated cellulose were prepared in a Brabender dynamic kneader at 180 °C and 75 rpm.

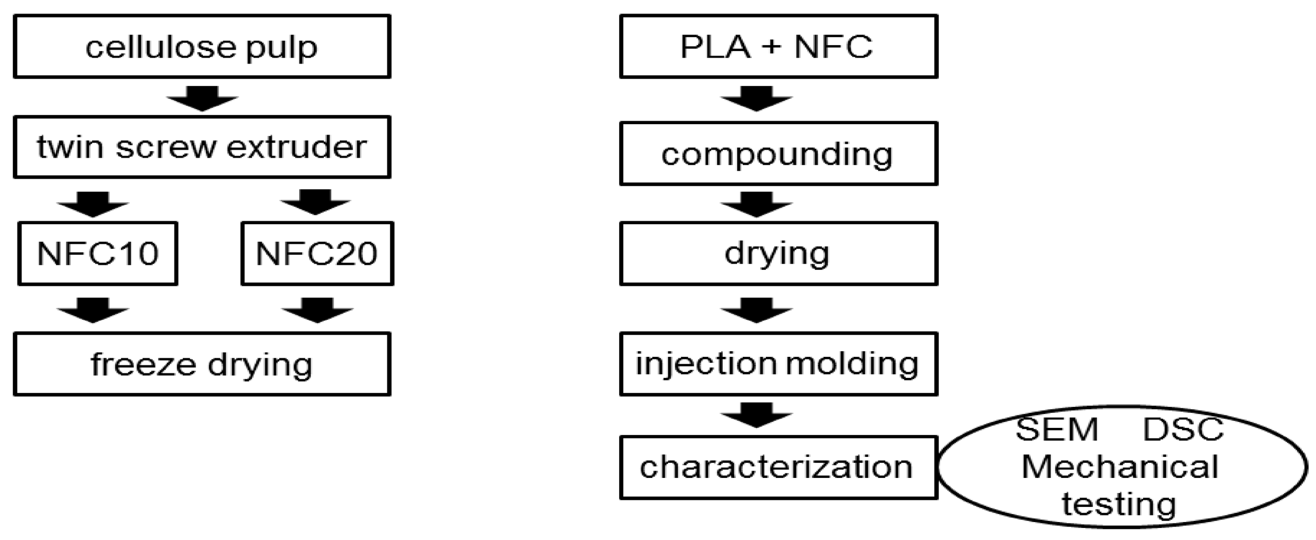

Figure 1: Process flowchart depicting steps during PLA/NFC composites preparation.

Results and Discussion

The results of mechanical testing showed a small increase of the elastic modulus for PLA/NFC nanocomposites compared to neat PLA. The addition of NFC caused reduction in impact strength in comparison to neat PLA. The reason for lack of improvement could be poor dispersion and agglomeration of the fibers during the compounding process as observed in fracture surface images showed in Figure 2. The results of the DSC measurements showed an increased degree of crystallinity for PLA/NFC20 composites compared to neat PLA which could be due to presence of NFC that accelerates the crystallization of PLA.

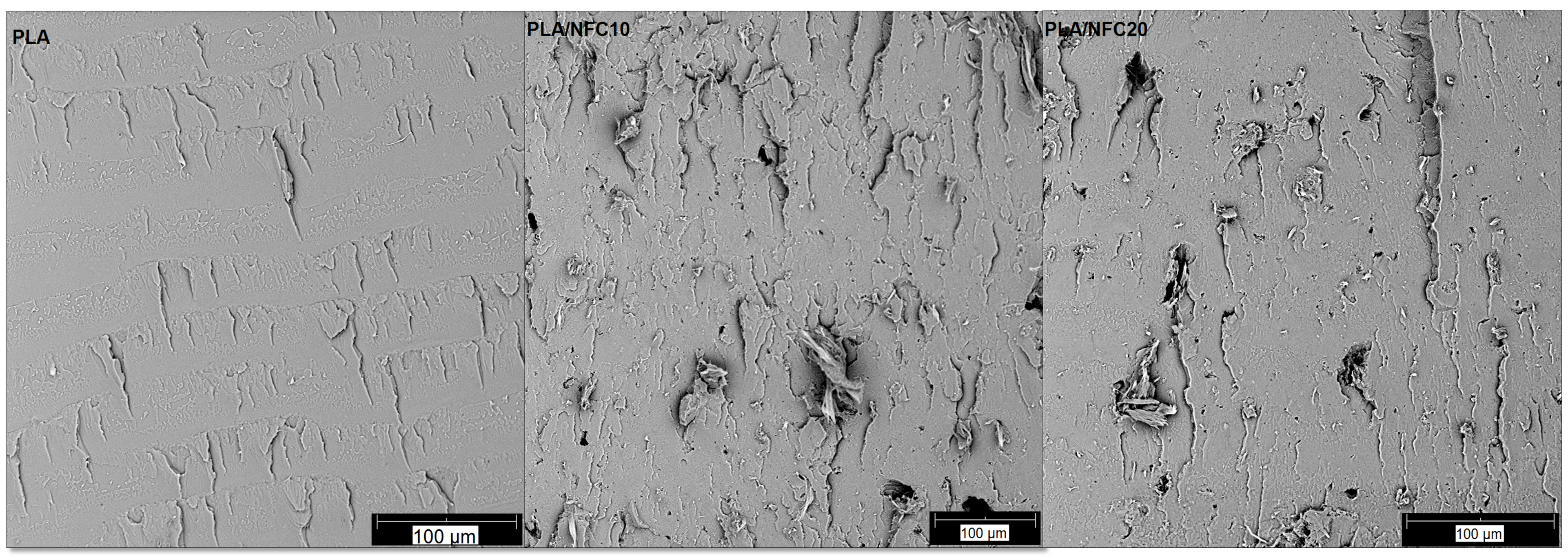

Figure 2: Scanning electron microscope image of the fracture surface of the neat PLA, PLA/NFC10 and PLA/NFC20 composites.

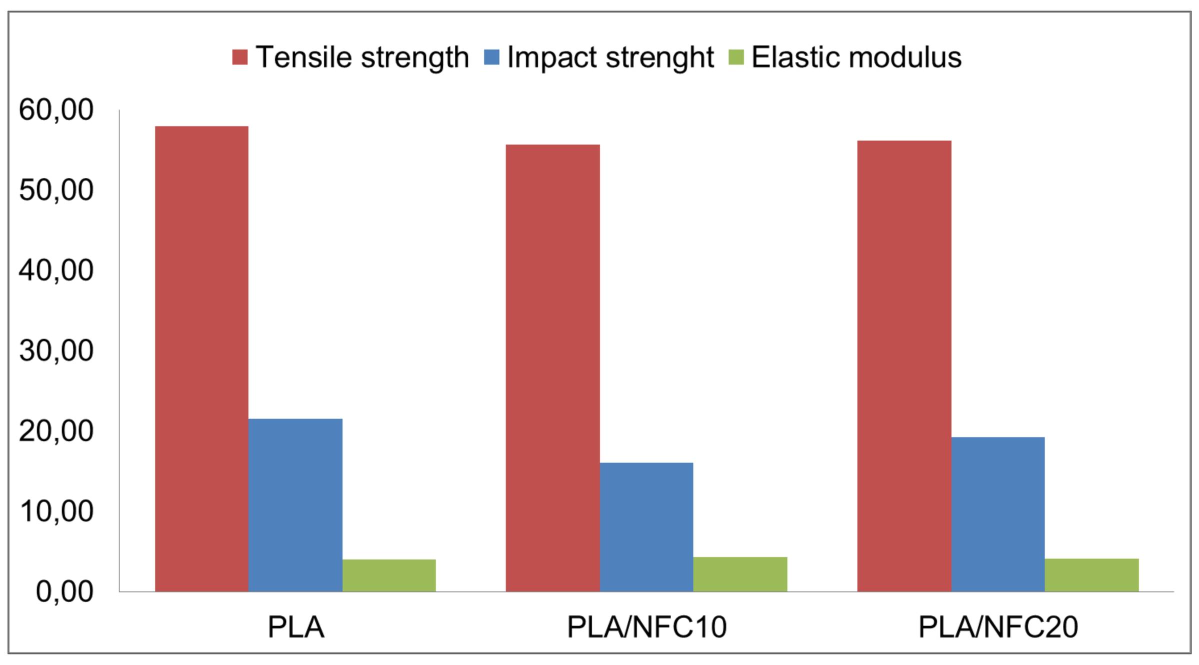

Figure 3: Mechanical properties of neat PLA, PLA/NFC10 and PLA/NFC20 composites.

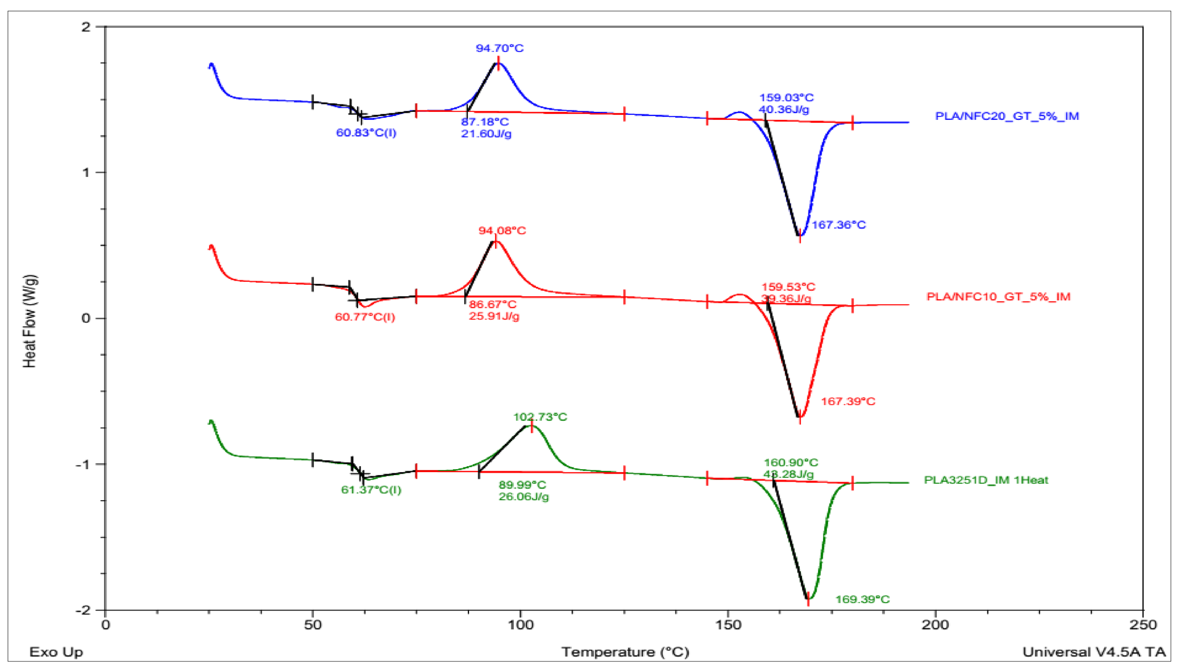

Figure 4. DSC curves of the neat PLA, PLA/NFC10 and PLA/NFC20 composites.

Table 1:Thermal properties of the neat PLA, PLA/NFC10 and PLA/NFC20 composites.

Sample	T_g (°C)	T_c (°C)	T_m (°C)	X_c (%)
PLA	61,37	102,73	169,39	16,01
PLA/NFC10	60,77	94,08	167,39	13,17
PLA/NFC20	60,83	94,70	167,36	18,37

Conclusions

Polylactic acid composites with a 5 wt% nanofibrillated cellulose were successfully prepared via compounding and injection molding. The composites exhibited a well dispersed morphology, but week polymer-fiber adhesion and a some agglomeration occurred. The incorporation of nanofibrillated cellulose in PLA induced a drop in impact strength of the PLA. Improved crystallinity shows that nanofibrillated cellulose fibers can act as nucleating agent for PLA crystallization.

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