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（博士課程）
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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis entitled "Preparation and Characterization of Polymer Nanocomposites Containing Boron Nitride or Cellulose Nanosheets" is composed of five chapters.

In Chapter 1 entitled "General introduction", the author introduced the background of this thesis as General Introduction.

In Chapter 2 entitled "Alcoholysis-assisted exfoliation of boron nitride nanosheets from hexagonal boron nitride", the author developed a new method to prepare boron nitride nanosheets (BNNSs) by sonication-assisted exfoliation of hexagonal boron nitride (h-BN) in primary alcohols. BNNSs are a two-dimensional crystalline form, which has a thickness of one to few atomic layers. They appear to be a potential reinforcement inorganic material for polymers because of their excellent thermal conductivity, mechanical properties, and thermal stability. Referring to a previous study on chemical peeling of BN nanotubes for BN nanoribbon production, the author attempted three different methods for BNNS preparation. Two solvents (butanol and hexanol) were used to compare the difference in morphology. The best method to prepare BNNSs was the mechanical grinding of hBN and subsequent sonication. From atomic force microscopy images, the obtained BNNSs were round-shaped nanosheet-like objects with smaller height and diameter compared with pristine h-BN. Solvent affected to the size of BNNSs. BNNSs prepared from hexanol had smaller thickness and diameter than those from butanol. A previous study demonstrated that sonication-assisted alcoholysis of B–N bonds more readily occurred in primary alcohols with longer alkyl chains. The greater reactivity was derived from the greater electron densities of hydroxyl groups for primary alcohols with longer alkyl chains due to hyperconjugation of alkyl chains. Therefore, the greater reactivity of hexanol was considered to promote the production of smaller BNNSs from h-BN. Fourier transform infrared spectroscopy showed new absorption peaks different from bulk h-BN. Hence, the production of BNNSs was originated from alcoholysis of B–N bonds of h-BN in primary alcohols during sonication processes.

In Chapter 3 entitled "Effect of boron nitride nanosheets on mechanical and other properties of poly(lactic acid) composites", BNNSs prepared from butanol were used for the preparation of polylactic acid (PLA) nanocomposites. The nanocomposite films were prepared with 1, 3, and 5 wt% BNNSs or h-BN. The mechanical properties of all nanocomposite films increased by adding of BNNSs. Young's moduli of BNNS/PLA nanocomposite films increased compared with neat PLA and h-BN/PLA composite films. Especially with 5 wt% BNNS, the Young's modulus increased to approximately 130% against neat PLA. Tensile strengths also slightly increased for all nanocomposite films. These might be due to smaller sizes of BNNSs, which can more easily disperse in PLA matrix, as shown from transmission electron microscopy images. The thermal property was analyzed by differential scanning calorimetry (DSC). The percent crystallinity was calculated. The percent crystallinity for 5 wt% BNNS was highest, which related to the Young's modulus. The crystallinity properties were observed in more detail by using polarized optical microscopy and small angle light scattering. The results showed the smaller spherulite size in BNNS nanocomposite films compared with neat PLA and h-BN composite films. Hence, it was concluded that BNNSs performed as nucleation agents to reduce the spherulite size of PLA. BNNS/PLA nanocomposites also showed faster hydrolytic degradation rate in water.

In Chapter 4 entitled "Preparation and characterization of polymer nanocomposites containing cellulose nanosheets", the author used cellulose nanosheets (CNs) to prepare PLA nanocomposite films. CNs were prepared by phosphorylase-catalyzed enzymatic reactions. The contents of CNs were 0.5, 1, and 2 wt%. The mechanical properties of 1 wt% CN showed the highest in mechanical properties. When compared with neat PLA, the tensile strength and Young's modulus were 125% and 120%, respectively. The percent crystallinity calculated from DSC was highest with 1wt% CN. The thermal stability was also analyzed by thermal gravimetric analysis. The degradation temperature was highest with 1wt% CN. Hence, it was found that CNs improved the mechanical and thermal properties of PLA.

In Chapter 5, the author summarized and concluded this thesis with future outlook. The PLA nanocomposites with BNNSs and CNs showed the attractive properties to be used for future researches and applications. Especially, they can be used for medical and food applications since they are not toxic and environmentally friendly. For BNNS nanocomposites, they can be used for short-life products since they have faster degradation rates.

This thesis would contribute to science and technology for development of polymer nanocomposites reinforced with 2D nanomaterials. The author deserves to receive a Doctor of Engineering from Tokyo Institute of Technology.