【博士学位論文要約】

The emerging infectious diseases and the development of drug resistance of the microbial organisms are major risks to health. It is necessary to develop new disinfectants free of resistance instead of the conventional chemical antimicrobial agents. In recent years, silver nanoparticles (nAg) have been considered as one of the strongest antimicrobial agents free of resistance. They attack microorganisms simultaneously in broad directions including cell membrane structures and functions, and inhibit the expression of proteins associated with ATP production. However, nAg is unstable in solution and will be easily aggregated with average particle size larger than 40 nm. Because their particles' charge/zeta potential approaches to zero (slightly negative), the attractive force dominates repulsive force and the suspension will begin to bulk and eventually turn into agglomerates. In order to keep stability and antimicrobial properties of nAg, stabilizer/carriers are necessary for nAg. In this research, chitin and chitosan were used as stabilizer for nAg because of their excellent biocompatibility, biodegradability, nontoxicity and antimicrobial capability. The aim of this research is to develop new antiviral and antibacterial materials based on combining great properties of nAg and chitin/chitosan and their applications for medical and environmental purposes.

Composites of nAg/chitin and nAg/chitosan were synthesized first and then the composites were characterized by transmission electron microscope (TEM) and scanning electron microscope (SEM) to understand the nanoscale structures of the composites. The composites were evaluated with their antiviral (H1N1 influenza virus), antibacterial (*E. coli*) and antifungal (*Aspergillus niger*) activities. The results showed that nAg was dispersed and became stably embedded onto the chitin/chitosan matrices. Chitin with small particle sizes and nanoscale-fiber-liked surface structures adsorbs much more nAgs compared with those of chitin with larger particle sizes and smooth film-liked surface structure. The composites of nAg/chitin and nAg/chitosan exhibited strong antiviral and antibacterial properties. The composite of nAg/chitin could reduce viral titers by approximate 99.9% at concentration of nAg of 6 μg in 1 mg chitin. In addition, composites contained nAg with small sizes showed strong antimicrobial activity, compared with those of composites contained nAg with large particles size.

The composites of nAg/chitin/chitosan could be applied for various applications in medicine or environment, such as water filter, air filter, deodorant or wound dressing. In this study, a developed composite sheet of nAg/chitin was applied to cover the contact part of the screening system, which was used for rapid distinguishing of infectious patients from healthy people within 15 sec. The system was designed simultaneously

measuring three vital signs of facial temperature, heart and respiratory rates. The system showed high accuracy for distinguishing influenza patients from healthy people. However, this system is contact type, so there is a possibility of secondary cross infection. To prevent secondary infections, an antibacterial material sheet is necessary to cover the contact part of the system. The developed composite sheet of nAg/chitin showed high antiviral activity, it could reduce viral titers by approximate 99% when used concentration of nAg of 8.5μg in 1 cm^2 chitin sheet. This indicates that it could be applied for the infection screening system to prevent the secondary infection between patients who touched on the system.

The results show that chitin and chitosan, especially chitin, containing nanoscale-fiber-liked surface structures can be used as an excellent stabilizer/carrier for nAg. The nAg/chitin/chitosan composites have a great potential in a variety of biomedical applications as new antiviral and antibacterial materials. Furthermore, using nAg/chitin sheet to cover the contact part of the screening system could reduce the risk of secondary infection.