CHAPTER V
CONCLUSION

5.1 Conclusion

Polyelctrolyte multilayer thin films of some polyelectrolytes and silver nanoparticles were prepared. Silver nanoparticles were prepared by photo-reduction of silver nitrate in dilute solution of polyelectrolytes, i.e, poly(methacrylic acid) (PMA), poly(4-styrenesulfonic acid-co-maleic acid) (CoPSS) and alginic acid (alginate), under the sunlight. Apart from being a reducing agent, these polyelectrolytes also acted as a capping agent. After few minutes of exposure, the reduction of silver ions by PMA, CoPSS and alginate led to the changes of the color of the solution to pink, yellow and orange, which finally turned into red, olive green and olive green, respectively. The mixed solutions between silver nitrate and polyelectrolyte were measured with UV-Vis spectrophotometer, which showed surface plasmon band of silver particles. The reducing of alginate capped Ag reacted faster than CoPSS capped Ag and PMA capped Ag, and went to stable state faster than CoPSS capped Ag and PMA capped Ag, respectively. Alginate capped Ag and CoPSS capped Ag were more suitable for layer-by-layer assembly than PMA capped Ag because PMA capped Ag solution had excess silver ions. Ammonia solution was used for removing excess silver ions. Transmission electron microscopy showed silver particle solution in nano-size. The nanoparticles were very similar in sphere-like shape for all type of polyelectrolyte. The polyelectrolyte capped Ag solutions were stored in the dark until being used for layer-by-layer assembly.

Polyelectrolyte multilayer thin films from poly(diallyldimethylammonium chloride) and polyelectrolyte capped Ag were successfully coated on silk and nylon fibers by layer-by-layer technique. The deposition of nanoparticles on fibers was controlled by the number of deposition cycles. The coated of nylon and silk fibers, the PMA capped Ag nanoparticles were deposited led to the appearance of a red color onto the fiber. The color on fibers came from color of silver nanoparticles and silver crystallize of AgCl but ammonia solution can remove silver crystallize of AgCl after the deposition on fibers. After rinsing with ammonia solution, the fiber showed yellow color from silver nanoparticles. In order to monitor the layer-by-layer deposition of silver nanoparticles were used the K/S value provided by a reflectometer spectrophotometer. The increase in K/S value of the silk and nylon as a function of the number of deposited PDAD/PMAcapAg bi layers. The K/S value of nylon fiber increased slower when compared with the K/S value of silk fiber. This slowed down the deposition on nylon fiber because the nylon fibers have a lower charge density than silk fibers. The deposition of silver nanoparticle on fibers were confirmed by scanning electron microscopy analysis. The coated PDAD/PMAcapAg on fibers showed antimicrobial properties toward *staphylococcus areus* bacteria. The silk fibers showed antimicrobial properties in 41% bacteria inhibition with 10-layer coating and 80% bacteria inhibition with 20-layer coating deposited of silver nanoparticles. The nylon fibers showed a lower antimicrobial properties in 0% bacteria inhibition with 10-layer coating and 53% bacteria inhibition with 20-layer coating deposited of silver nanoparticles.

Follow by deposition of CoPSS capped Ag and PDAD, alginate capped Ag and PDAD on silk fiber were controlled by the number of deposition cycles. The sequential dipping of silk fibers in PDAD and CoPSS capped Ag or alginate capped Ag solution led to the appearance of yellow color onto silk fibers. The increase in K/S value of silk fibers as a function of the number of deposited. The silk fibers coated with PDAD/CoPSS capped Ag and silk fibers coated with PDAD/alginate capped Ag had the same trend of K/S value with silk fibers coated with PDAD/PMA capped Ag. Which, SEM pictures can be confirmed silver nanoparticles deposited on silk fiber. For antimicrobial properties of silk coated 20 layer with PDAD/CoPSS capped Ag and PDAD/alginate capped Ag showed a lower percent inhibition than silk coated 10 layer with PDAD/CoPSS capped Ag and PDAD/alginated capped Ag because, for inoculation, the fiber was shaken in bacteria and nutrient 1 h which was not for the bateria to grow in nutrient broth. Silk coated with 10 layers had higher surface area of silver nanoparticles than silk coated with 20 layers. This means silk coated with 10 layers had a lot of silver nanoparticles to expose to bacteria.

5.2 Suggestions

1. For polyelectrolyte capped silver nanoparticle solution, would be minimized. High yield solution should be used because the effects from the excess silver ion. The yield of silver nanoparticles solution was easily to observe from the color of solution. The low yield solution is brown and the high yield solution is yellow.
2. Wash fastness should be investigated in order to study the durability of silver nanoparticles on textile substrate.
3. The fiber samples were difficult to characterize. PEM should be deposited on fabric substrate because sample is widely characterized in variety methods but the limited construction of PEM on fabric is difficult to remove the excess of polyelectrolyte completely.