Effect of quenching on gold ultrathin films for Localized Surface Plasmon Resonance sensor

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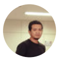

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Effect of quenching on gold ultrathin films for Localized Surface Plasmon Resonance sensor

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1. Introduction

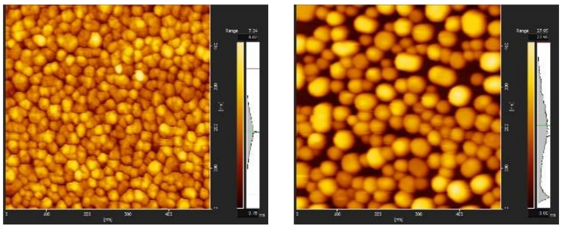
Nowadays, nanometallic thin films based on noble metal materials are drawing attentions and fascinating in sensing applications such as Localized Surface Plasmon Resonance (LSPR) sensors due to their plasmonic properties[1]. The fabrication of a gold ultrathin film for LSPR sensor has led to an investigation of the process of gold nanoparticles (AuNPs) formation on glass substrates (SiO_2) when annealed at high temperature[2]. However, there have been very few reports about the fabrication methods of gold thin films on glass substrate for LSPR sensors by vacuum evaporation followed with short annealing time and quenching treatments. Therefore, this work aimed to investigate the effect of proposed quenching treatment on gold ultrathin film fabrication processes for LSPR sensor.

2. Experimental Procedure

Gold ultrathin films were thermally evaporated on thick glass substrates (0.17 ~ 0.25 mm) used 99.99% pure gold in high vacuum. The initial define thickness of gold thin layer was 1.09 nm. These films were annealed at 550 °C for 10, 30, 50 min using furnace oven and then quenching (cooling rate about 35 °C/s) to room temperature.
The surface morphology of gold ultrathin films was observed by an atomic force microscope (AFM). The optical gold ultrathin film characteristics were recorded by an UV-Visible spectrophotometer at wavelength between 350 to 1000 nm.

3. Results and Discussion

Fig. 1 shows the AFM images of the sample before and after annealing at 550 °C for 10 minutes followed quenching. Compared with the as deposited, we found that the annealing temperature and time was acceptable for revamping the initial structure gold thin layer. Furthermore, the AuNPs became less connected to each other and the shape became mostly in a spherical shape. In physics view, quenching will affect to the recrystallization process of AuNPs with the shock of rapid temperature changes, and as expected, the final shape of AuNPs with quenching different with normal cooling. Fig. 2 shows the optical characteristic of samples before and after treatments. Evidently, the LSPR spectra characteristics of all the samples became narrow and blue-shift compare with before treatments. Moreover, the LSPR spectra of all the samples is also responsive to the annealing time and quenching treatment.



(a) (b)

Fig. 1. AFM images of a gold ultrathin film (500 x 500 nm^2 scan areas). (a) As deposited; (b) After annealing at 550 °C for 10 min and quenching.

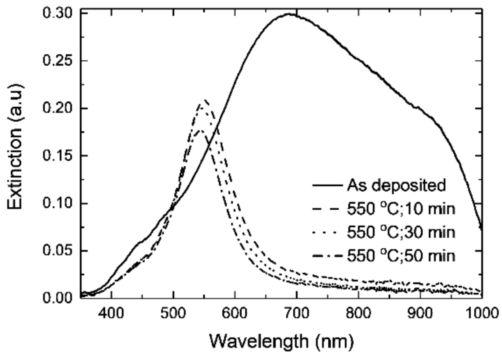


Fig. 2. LSPR spectra of gold ultrathin films before and after annealing-quenching treatments.

4. Conclusion

In summary, the modification direction of gold ultrathin films in the surface morphology and LSPR spectra using short annealing time and quenching treatments was investigated. This work was the feasibility study of proposed quenching method for fabrication processes of gold ultrathin films. These results open up strongly high supportive to apply for fabrication processes of other metallic ultrathin film in order to LSPR sensor applications.

Acknowledgement

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References

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