# 광환원으로 얻은 금나노 입자가 들어간 PVA 박막의 제작 및 광학적 특성연구

# Fabrication and optical characterization of gold nano particles in PVA film by photoreduction

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Nano-sized noble metal particles have received great attention for their unique electrical and optical properties, such as surface plasmon resonance (SPR) and quantum size effects (QSE), which depend on the particle size(1). Nano gold particles could be obtained by photoreduction method of chloroauric acid ($\mathrm{HAuCl}^{4}_{-}$)from hydrogen tetrachloroaurate (III) ($\mathrm{HAuCl_4 \cdot xH_2O}$) since composites of gold nano-particles in dielectric matrix can be easily obtained leading to a large NLO susceptibility, $\chi^{(3)}$. In this work, we investigated the changes of SPR peak as the preparation parameters are varied such as the irradiation time, the film thickness, and the molecular weight of PVA polymer.

Two different molecular weight (MW) PVA are selected, that is, MW 72,000 and MW 9,000. Two aqueous solutions, PVA(9.0 wt.%) and $\mathrm{HAuCl_4 \cdot xH_2O}$ (0.9 wt.%), are mixed with ethylene glycol in the volume ratio of 2: 1: 0.05. The faint-yellow solution was obtained, which that color is known to be from the Au-Cl bond in $\mathrm{HAuCl_4 \cdot xH_2O}$(2). The Au/PVA film was fabricated by spin coating on a glass substrate, and the film was baked at 80°C for 30 min.

Upon irradiation of UV light, the photoreduction takes place to reduce gold, resulting in a nano-composite film. It is observed that the color of the Au/PVA film disappear and SPR peak of nano gold particle appear during the UV irradiation, which indicates that the chemical bonds in the Au-Cl bond breaks down through the photoreduction process and gold nano-particles are formed inside the polymer matrix(2). The optical absorption spectra confirms the presence of the SPR, which is attributed to the gold nano-particles (Figure. 1 (a) and (b)).

In Figure 1 (b) and (c), the change of the optical absorption spectra of the Au/PVA film is shown for PVA as a function of the elapsed time. After 9 days peak around 540 - 620nm corresponding to the gold nano-particle SPR resonance starts to emerge and increases as time goes on. We suppose that a slow aggregation of noble gold atoms aggregate in time inside the PVA polymer matrix.

Figure 2 shows changes of the SPR peak absorption of Au/PVA films for different molecular weights: circles for MW 72,000, triangles for MW 9,000. It indicates that the photoreduction process takes place at a slower rate in a lower MW PVA, while the photoreduction saturates more quickly in a higher MW.

As seen in figure 3, the changes of SPR peak are investigated with varying the film thickness. We find that there occurs the increase of the peak height, a red shift and a broadening of SPR, which indicates that the number and the size of nano-particles increase as the film thickness gets thicker, since the plasmon bandwidth and peak position of SPR peak depend on the particle size.

Furthermore, energy dispersive spectroscopy was employed to quantitatively identify the amount of photoreduction in the Au/PVA films.

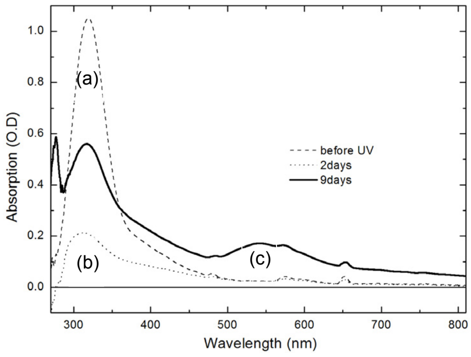

Figure 1. Change of the optical absorption spectra of the Au/PVA film is shown for PVA as a function of the elapsed time.

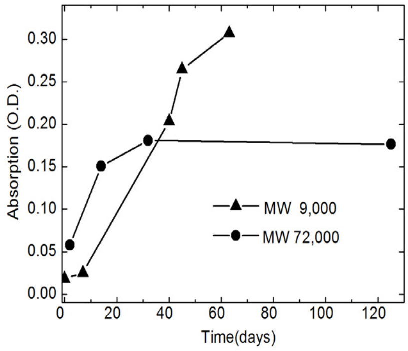

Figure 2. Changes of the SPR peak absorption of Au/PVA films for different molecular weights.

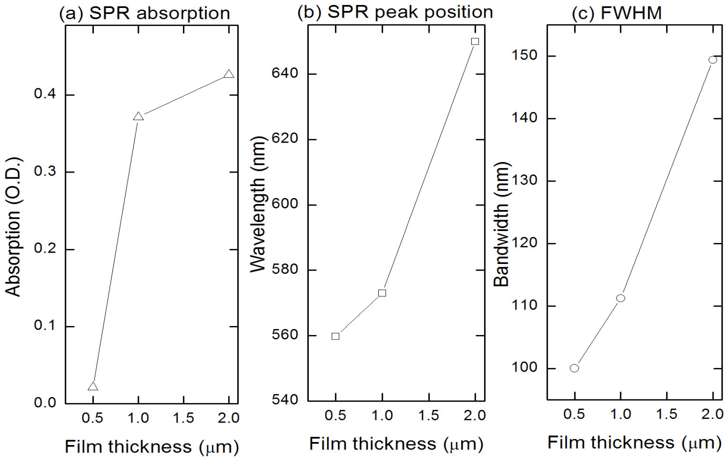

Figure 3. (a),(b), &(c) shows the SPR peak heights, the spectral position of the peaks, and the bandwidth of the peaks for 3 samples.

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