

The pH effect on gas-born Ag nanoparticles capturing into the PVP solutions

N. Sakono, K. Omori, A. Shimizu, and M. Kita

¹Department of Applied Chemistry and Chemical Engineering, National Institute of Technology,
Toyama College of Toyama, Toyama, 939-8630, Japan

Keywords: gas-born nanoparticle, capture, PVP, pH

Presenting author email: nsakono@nc-toyama.ac.jp

Metal nanoparticles are widely interested in chemical, physical, and optical properties. Various methods for nanoparticle production have been reported such as chemical reduction, laser ablation, and gas vaporization. In particular, the gas vaporization method, which enables to synthesize nanoparticles from bulk metal in the gas phase by heating, has attracted much interest because of easy operation and low cost.

Our previous report demonstrated that gas-born nanoparticles are able to be transferred into solution successfully (Hashimoto et al., 2011). The production of Ag nanoparticles by heating was carried out in the furnace equipped with N₂ gas-flow path, and then gas-born particles were transferred to the capture solution via the gas-flow path. When pure water was used as the capture solution, the gas-born nanoparticles were aggregated in the water solution. This result shows that the gas-born nanoparticles were unstable and low dispersibility in water. When the polyvinylpyrrolidone (PVP)-dissolved water was employed as capture solution, the aggregation of gas-born nanoparticles was not observed. In addition, stable dispersion of nanoparticles in the capture solution was demonstrated by UV measurement. The XPS analysis revealed that the Ag nanoparticles transferred into capture solution interact with PVP molecules via their oxygen atoms.

However, the capturing efficiency of gas-born Ag nanoparticles into capture solution were obscure. The aim of this study is to investigate the efficiency of the solution pH for capturing the gas-born Ag nanoparticles. Dependence of proton concentration in capture solution on capture efficiency was investigated by pH adjustment.

Ag gains loaded in a quartz tube was vaporized at around 1100 °C in a furnace with an N₂ gas flow at a rate of 2.0 L/min regulated using gas-flow meter under atmospheric condition. The produced Ag nanoparticles were blown through an electrically conductive tube into a Polyvinyl pyrrolidone (PVP, average molecular weight (M_w) = 10,000) solution, concentration of which was adjusted at 0.125 gL⁻¹. Two kinds of PVP solutions were prepared which were adjusted at pH = 9.00, and 11.98, respectively. After 3-hours blown, the obtained solutions were analysed using a UV-vis spectrophotometer, and Transmission electron microscope (TEM).

Figure 1 shows the UV-vis spectrum for obtained PVP solutions. Both spectrum has the same peak position at about 410 nm. This peak position derived from the surface plasmon resonance (SPR) for Ag nanoparticles. This suggest that both solutions were captured the produced Ag nanoparticles. The intensity at 410 nm of the PVP solutions which pH is 9.00 is higher

than that PVP solutions which pH is 11.98. In addition, the TEM image shows that the diameter of the captured nanoparticles was changed between the PVP solution which pH adjusted 9.00, and 11.98. The mode diameter of the captured nanoparticles into PVP solution which the pH adjusted at 9.00 was about 8 nm. In contrast, the mode diameter of the captured nanoparticles into PVP solution which the pH adjusted at 11.98 was about 2 nm. This results suggest that the gas-born Ag nanoparticles transferred to capture solutions were aggregated at high pH conditions and were unable to disperse in PVP solution, suggesting that the pH influences complexation between PVP and nanoparticles. Therefore, above result implies that capture efficiency is strongly influenced by the property of capture solution not only dispersing agent.

We will discuss the proton effect in detail, and also discuss the efficiency of acid PVP solutions.

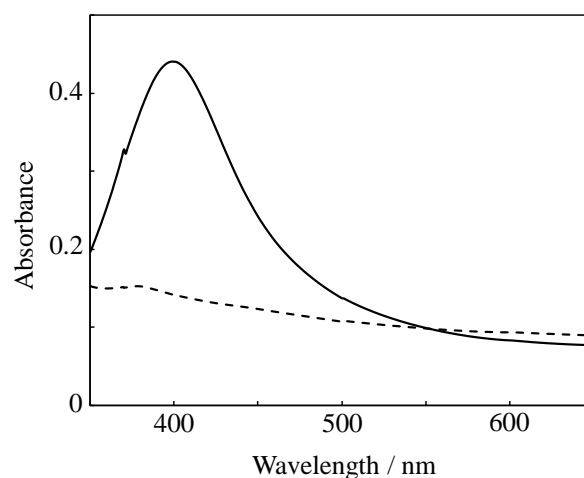


Figure 1. UV-vis spectrum. (solid line) the PVP solution which pH was adjusted 9.00, (dashed line) the PVP solution which pH was adjusted 11.98.

N. Hashimoto, N. Nishida, H. Murayama, and H. Tanaka. (2011) *Chem. Lett.* **40**, 144-146.