酸化銅ナノ粒子合成におけるプラズマ電気分解と従来型電気分解の比較

Comparation between plasma electrolysis and conventional electrolysis on the synthesis of copper oxide nanoparticles

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Introduction

Recently, many researchers reported that a wide range of materials, such as noble metal nanoparticles (Au and Ag) [1] and metallic oxide materials [2-4], were successfully synthesized by atmospheric-pressure plasma electrolysis due to its unique ability of producing highly reactive species. In our last work, we have successfully synthesized cuprous oxide (Cu_2O) nanoparticles by using plasma electrolysis and proposed the synthesis mechanism. In this work, we tried conventional electrolysis to compare with plasma electrolysis and distinguished their similarity and difference.

Experimental Procedures

The schematic diagram of the experimental devices is shown in Fig. 1. Helium plasma in contact with electrolyte was used as the cathode, and a copper plate was used as the counter electrode. The distance between the two electrodes was 2 cm and the gap between the electrolyte surface and the tip of the tube for feeding helium was 3 mm. The NaCl solution with different concentrations was used as electrolyte. During the discharge, the current was fixed at 20 mA and the whole treatment time was 20 min. The devices used for conventional electrolysis was similar except the plasma cathode was replaced by a Pt wire.

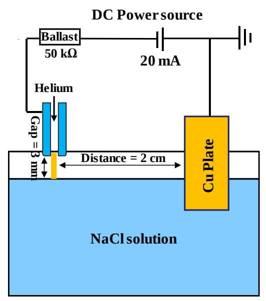

Figure 1. Schematic diagram of experimental devices

Results and discussion

In our previous work, we investigated the effect of pH value of electrolyte, and found it played a critical role on the formation of Cu_2O. When plasma worked as the cathode, it could generate a lot of OH^- ions which increased the pH during discharge. Meanwhile, the anodic dissolution reactions which happened at the copper anode could produce a large amount of $CuCl_2^-$ ions which could react with OH^- ion to generate Cu_2O. Therefore, in this plasma electrolysis processes, plasma played as the source of OH^- ions and liquid convection. Because the anodic dissolution could also occur in conventional electrolysis, we compared conventional electrolysis with the plasma electrolysis.

The XRD results are as shown in Fig. 2. Firstly, in the cases of plasma electrolysis, when the concentration of NaCl solution was higher than 0.25 M, the products were mixture of Cu_2O and $Cu_2(OH)_3Cl$. In the case of 0.1 M, no peaks corresponding to Cu_2O could be found. In the case of conventional electrolysis, we could also clearly observe the formation of Cu_2O in the cases of 1.0 and 0.5 M and very weak peaks of Cu_2O in the case of 0.25 M. It was similar to plasma electrolysis in the case of 0.1 M; we couldn't observe the peaks corresponding to Cu_2O. This result indicated that Cu_2O could be synthesized by conventional electrolysis, too. By comparing the pH distribution during experiment, we believed the synthesis mechanism was similar.

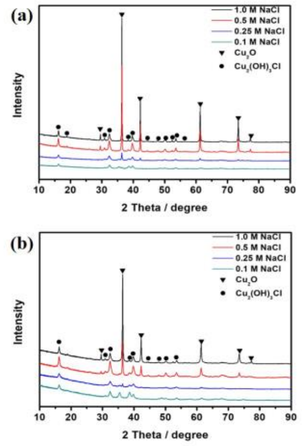

Figure 2. XRD results of (a) plasma electrolysis and (b) conventional electrolysis.

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