大気圧プラズマ電気分解による酸化銅ナノ粒子合成における電解液量の影響

Effect of electrolyte volume on the synthesis of copper oxide nanoparticles by atmospheric-pressure plasma electrolysis

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Introduction

Atmospheric-pressure plasma electrolysis is a novel technique which is different from conventional electrolysis. A metal electrode in conventional electrolysis is replaced with a plasma interacting with electrolyte. By using this method, the synthesis of the wide range of materials, such as noble metal nanoparticles [1] and metallic oxide materials [2-4], are possible due to the unique ability of producing highly reactive species.

In this work, we used atmospheric-pressure plasma electrolyte to synthesize copper oxide (CuO or Cu_2O) nanoparticles and found that the volume of electrolyte would affect the final products.

Experimental Procedures

As shown in Fig. 1, a copper plate partially immersed into the electrolyte was used as the anode. In the opposite side, helium gas was flowing toward the electrolyte surface through a brass tube (inner diameter 0.5 mm) at a flow rate of 200 sccm. A DC power source was used to apply a high voltage between the two electrodes to generate a helium plasma which was used as the cathode. Sodium chloride (NaCl) solutions with various concentrations were used as the electrolyte. The distance between the two electrodes was maintained at 2 cm and the distance between the tip of the tube and the electrolyte surface was kept at 3 mm. During the discharge, the current was fixed at 20 mA and the whole treatment time was 20 min. After the discharge, the products were collected by centrifuging the treated solution and then dried in air.

Results and discussion

In this work, we compared two different volumes of the NaCl solution (50 mL and 5 mL) with two concentrations (250 mM and 100 mM). To complete these experiments, two types of reaction vessels were used: a 100 mL beaker and a 10 mL cuboid cell as shown in Figs. 2a and 2b.

The XRD results are shown in Fig. 2c. It is obvious that quite different materials were synthesized by using the two electrolyte volumes. In the case of the 50 mL, 100 mM NaCl solution, we found the peaks corresponding to CuO and no peaks corresponding to Cu_2O. When the concentration of the NaCl solution was increased to 250 mM, the peaks corresponding to Cu_2O appeared. On the other hand, there are intense Cu_2O peaks in both the 5 mL NaCl solutions, while peaks corresponding to Cu_2O are

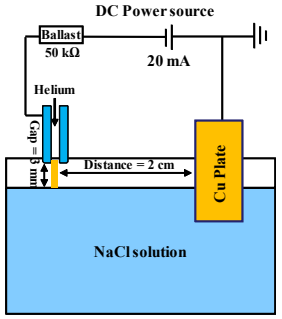

Figure 1. Schematic diagram of experimental devices

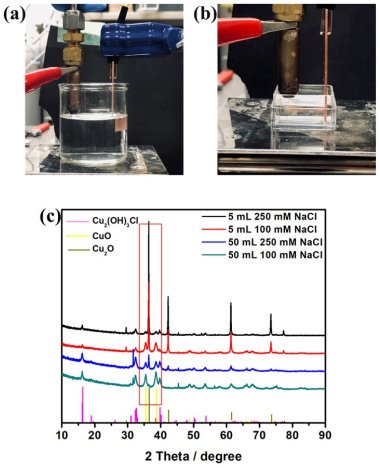

Figure 2. Photos of the experiment devices using (a) beaker and (b) cuboid cell as reaction vessel; (c) XRD results of using different electrolyte volume and concentration.

seen only in the 50 mL, 250 mM NaCl solution. This result indicates that the small electrolyte volume can help the formation of Cu_2O nanoparticles. It could be attributed to the convection in the solution.

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