

A NOVEL IRRADIATING TEMPLATE APPROACH TO PREPARE SILVER NANO—RIBBONS

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ABSTRACT Silver nano—ribbons, with diameters of several tens of nanometers and lengths up to a few thousands of nanometers, were successfully prepared by employing urea as a synthetic template under γ ray irradiation. The product was characterized by XRD, ED, and TEM, respectively. The investigation showed that urea played an important role in the formation of silver nano—ribbons.

KEYWORDS γ ray irradiation, Silver nanoribbons, Urea, Template—synthesis
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1 Introduction

Much attention has been paid to the syntheses of various low dimensional nano-structures such as nanowires, nanorods and nanotubes since the discovery of carbon nanotubes^[1]. During the last few years, many methods have been developed to prepare low-dimensional nano-materials. In these methods, the template technique is one of the most important methods to fabricate low dimensional nano-material. Usually, the templates include the carbon nano-tubes^[2,3], the polycarbonate membranes with 60nm diameter pores^[4] and the porous aluminum oxide membrane with 70nm pore diameter^[5,6]. Moreover, rod-like cationic surfactant micelles have also been used as templates to fabricate rod-like nano-particles^[7]. Although the template method can provide a very good route to low-dimensional metal or compound nano-particles, it is not very convenient to obtain these templates.

It is well known that silver nanoparticles own many important properties such as optical, electrical and catalytic properties, which strongly depend on the size and shape of silver nanoparticles. So synthesis and characterization of silver nanoparticles with various sizes and shapes have been attracting extensive interest. Now, many methods have been developed^[8,10]. Among these methods, γ ray irradiation is a relatively new method, which had been extensively used to prepare nano-crystalline metal, alloys, metal oxide, composites and metal sulfide at room temperature and ambient pressure in the last few years^[11–15]. In this letter, we described a novel template-synthetic route to prepare planar silver nano-ribbons under γ ray irradiation. Silver nitrate, distilled water and isopropanol were used as raw materials. Urea was selected as the synthetic template.

2 Experimental method

All reagents used in the experiment were analytical grade and before the experiment, urea ($\text{CO}(\text{NH}_2)_2$) had been recrystallized twice to eliminate halide ions. Appropriate amount of urea was saturated in 50mL distilled water at 60°C . Then 0.01mol silver nitrate (AgNO_3) was quickly introduced. Meanwhile, to scavenge some oxidative radicals such as hydroxide radicals produced during γ ray irradiation, isopropyl alcohol was also added into the system. After the system was rapidly cooled to room temperature at the rate of $1^\circ\text{C}/\text{min}$, a needle-like crystal was obtained through filtering under low pressure. Finally, the needle-like crystal was irradiated in the field of a $2.22\times 10^{15}\text{Bq}$ ^{60}Co γ ray source for 5h with dosage of 15kGy.

The phase of the final product was identified by X ray powder diffraction (XRD) patterns employing a scanning rate of 0.05 degree/s in 2θ range from 35° to 85° , using a Japan Rigaku D/max γ_{A} X ray diffractometer equipped with graphite mono-chromatized Cu K_α radiation ($\lambda=0.154178\text{nm}$). The morphologies and sizes of the product were determined by Transmission Electron Microscopy (TEM), which were taken on a Hitachi Model H-800 Transmission electron microscope, with an accelerating voltage of 200kV.

3 Results and discussions

Fig.1 shows the XRD pattern of the final product, which had been washed with distilled water several times to remove urea, and dried at room temperature. By comparison with the JCPDS file no.4-0783, Five peaks at $2\theta=38.0^\circ, 44.8^\circ, 64.9^\circ, 77.5^\circ$ and 82.0° correspond to the five d-spacings (111), (200), (220), (311) and (222) of cubic silver, respectively. No characteristic peak of urea in Fig.1 indicated urea had been completely washed off by distilled water.

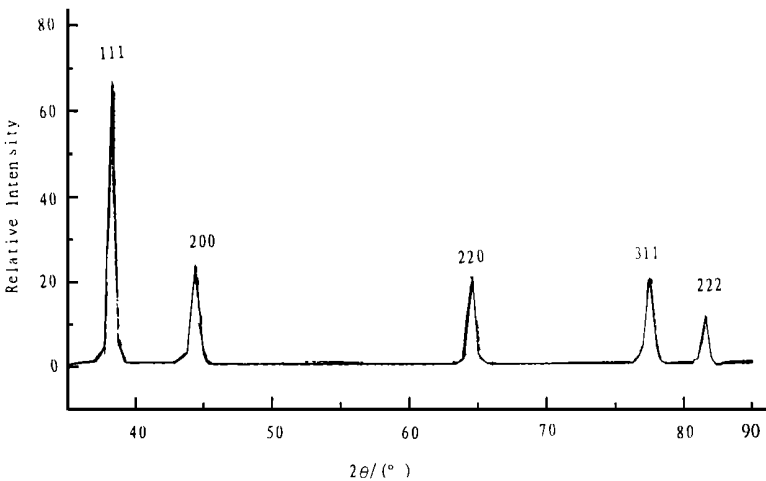


Fig.1 XRD pattern of the sample which had been washed with distilled water several times to remove urea, and dried at room temperature

Fig.2 is the TEM images of the final product shown in Fig.1. In Fig.2 (a), many

silver nano-ribbons tangled together can be clearly observed. Fig.2 (b) shows a long silver nano-ribbon. Its size is about $70\text{nm} \times 6000\text{nm}$. The electron diffraction (ED) pattern of this area is shown in Fig.2 (c), in which the diffraction dots can be clearly seen. Through calculation, It is confirmed to be the plane (111) of silver.

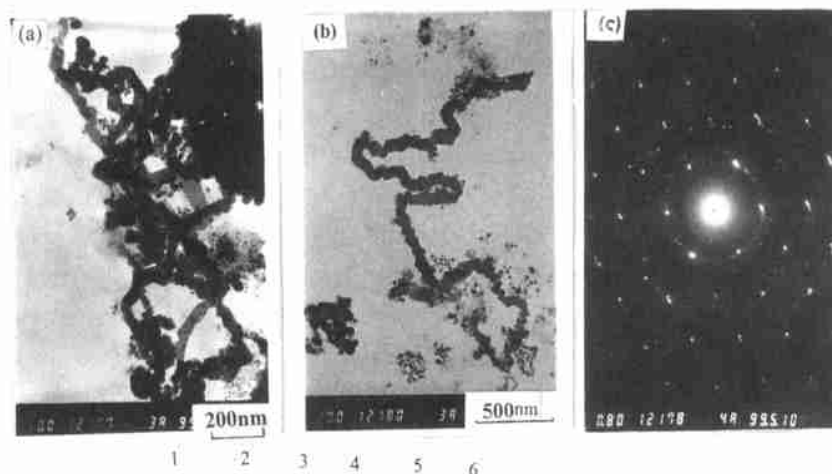


Fig.2 TEM images of the sample shown in Fig.1.

- (a) Silver nano-ribbons tangled together, (b) A silver nano-ribbon with the size of $6000\text{nm} \times 70\text{nm}$,
(c) The electron diffraction (ED) pattern of the sample shown in Fig.2 (b)

In this experiment, urea played an important role in the formation of silver nano-ribbons because only spherical silver particles were obtained without the presence of urea in the system. In addition, the rate of dropping temperature is another factor that influences on the formation of silver nano-ribbons. When the temperature was slowly decreased to room temperature, no silver nano-ribbon was obtained.

4 Conclusion

Silver nano-ribbons have been successfully prepared via using urea as the synthetic template under γ irradiation. The studies show that urea played an important role in the formation of silver nano-ribbons. In this method, the obtainment of the template is very convenient; the procedure is quite simple and the reaction condition is also mild. So it is very useful for the fabrication of ordered nano-structural metals and compounds.

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一种采用辐照模板法制备银纳米带的新方法

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摘要 在 γ 射线辐照条件下,运用尿素作为模板,成功地合成了直径几十 nm,长数千 nm 的银纳米带。所得产物分别用 X 射线粉末衍射、电子衍射和透射电子显微镜进行表征。

关键词 γ 射线,辐照,银纳米带,尿素,模板合成

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