Abs. 135, 204th Meeting, © 2003 The Electrochemical Society, Inc.

Microwave Assisted Synthesis of Silver Nanorod

Fu-Ken Liu[1*], Yu-Cheng Chang[2], Fu-Hsiang Ko[1], Tieh-Chi Chu[2]
[1]National Nano Device Lab., 1001-1 Ta Hsueh Road Hsinchu, Taiwan
[2]Department of Nuclear Science, National Tsing Hua University, Hsinchu, Taiwan
E-mail address: fuken@ndl.gov.tw

Nanomaterials of noble metals have received much attention due to their potential application in microelectronics[1] and their unique optical and catalytic properties.[2] It is well known that silver is superior to other nanostructured metal particles for many reasons such as electrical conductivity, antimicrobial effect, optical properties, and oxidative catalysis.[3] The preparation and characterization of silver nanoparticles are discussed in a great number of publications.

Since 1986, microwave irradiation as an efficient heating method has been found to have a number of applications in chemistry. The microwave synthesis, which is generally quite fast, simple, and very energy efficient, has been developed. It is well known that the interaction of dielectric materials, liquids or solids, with microwave leads to what is generally known as dielectric heating. Electric dipoles present in such materials respond to the applied electric field. In liquids, this constant reorientation leads to friction between molecules, which subsequently generate heat.[4] Until recently, it was found that microwave reaction in solution could produce nanoparticles.[5] To our knowledge, the precisely temperature control program is a build-in function of a commercial microwave instrument. It may be a convenient approach to study the relationship between the thermal effect and the morphology of nanoparticles.

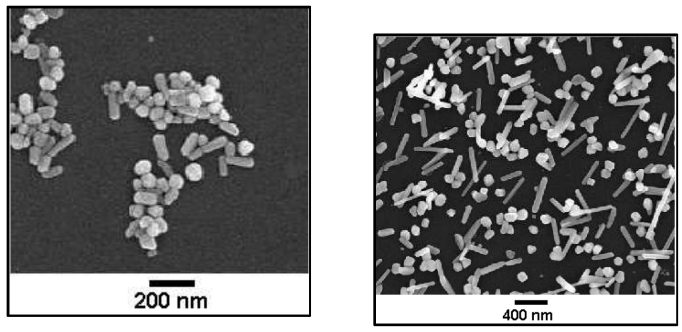
With the lower synthesis temperature (80°C), Figure 1a reveals sphere aggregations were synthesized. When the synthesis temperature increase to 100°C, Figure 1b reveals that silver nanorods start to appear. Rod-like particles were produced with high yield (60 %). The mean value for the width, the length and the aspect ratio are 56.6 nm, 432.3 nm, and 8.0 respectively. As the reaction temperature rises to 140°C, Figure 1c reveals rod-shaped nanoparticles reduce in the population. Rod-like particles were produced with low yield (35%). The mean value for the width, the length and the aspect ratio are 43.2 nm, 105.3 nm, and 2.5 respectively. Again, particles appear to have smaller in size when the reaction temperature rises to 180°C. The images show that the temperature parameter plays an important role in the synthesis of silver nanorods.

With faster raising temperature programs, Figure 2 reveals that wire-like silver particles were synthesized. With the rise temperature from room temperature (about 20℃) to 100℃ in a duration of 1 min. Figure 2a reveals that silver nanowires with aspect ratio more than 150 and the length more than 4 μm have been synthesized. In contrast, with slower rising temperature of microwave-heating as shown in Figure 2c, the aspect ratio of silver nanowires is smaller than Figure 2a-b. After purification by centrifugation to remove sphere particles that extracted from Figure 2a, the corresponding particle length showed in Figure 2d demonstration that highly anisotropic, needle-liked nanorods were synthesized.

This study demonstrates the usefulness of microwave rapid heating in the synthesis of silver nanorods and promises a great tool for the examination of thermal stability, which phenomenon is difficult assessment by the conventional hot plate heat station.

Acknowledgement

This work was supported by the National Science Council, Taiwan for financial support under grants number NSC 91-2722-2317-200.



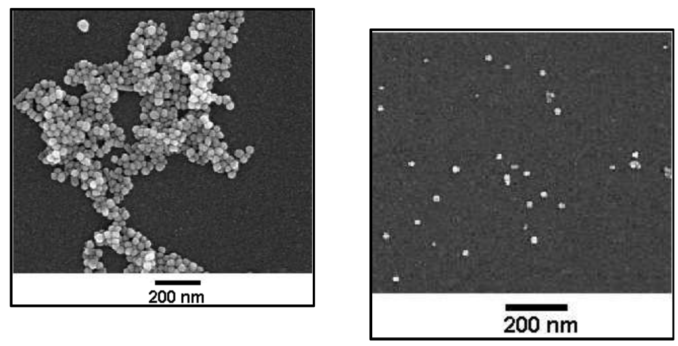
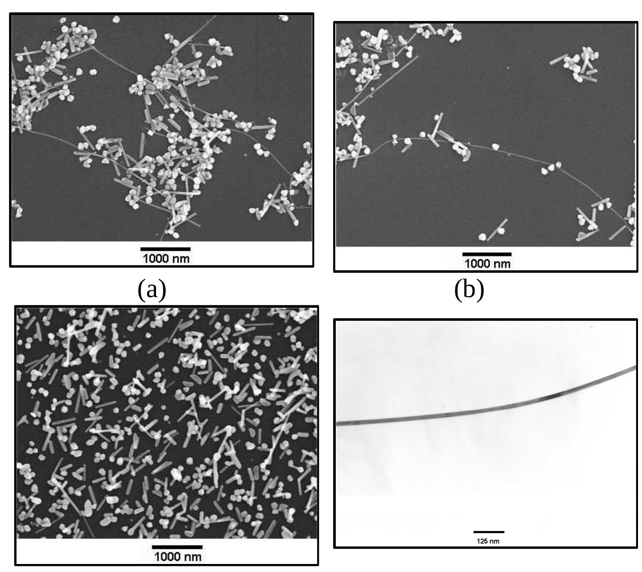


Figure 1. Electron micrographs at various reaction temperatures. (a) 80°C; (b) 100°C; (c) 140°C; (d) 180°C.



(c) (d)

Figure 2. Electron micrographs at various increasing rate of reaction temperatures.
SEM images with (a) 80°C / min; (b) 16°C / min; (c) 8°C / min of the increasing temperature; (d) TEM image of the increasing temperature with 80°C / min.

References

1. M. Antonietti and C. Goltner, Angew. Chem. Int. Ed. Engl., **36** 910 (1997).
2. L.T. Chang and C.C. Yen, J. Appl. Polym. Sci., **55** 371 (1995).
3. Y. Shiraishi and N. Toshima, Colloid Surf. A, **169** 59 (2000).
4. K.J. Rao, B. Vaidhyanathan, M. Gaguli and P.A. Ramakrishnan, Chem. Mater., **11** 882 (1999).
5. W.X. Tu and H.F. Liu, J. Mater. Chem., **10** 2207 (2000).