

SILVER NANOWIRES: PHOTOCATALYTIC SYNTHESIS AND CHARACTERIZATION

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One of the greatest challenges of nanotechnology is the preparation of anisotropic nanoparticles with controlled size and shape. In particular, Ag nanowires have been the focus of much attention due to not only to the fundamental interest in studying the physical properties of such 1D nanoparticles, but also due to its possible applications in the construction of electronic, optoelectronic, electrochemical, and electromechanical nanodevices. There are several reports on wet chemical procedures for the preparation of Ag nanowires, but the mechanism of formation of these nanostructures is still a matter of debate. In order to get a better insight onto the factors governing anisotropic growth of Ag nanoparticles, we have studied the formation of Ag nanowires using a novel photocatalytic reducing method and citrate as the capping agent. Citrate is known to promote the formation of anisotropic Ag nanoparticles,¹ but the results reported so far show that the morphology and size of the nanoparticles obtained are strongly dependent not only on the capping effect, but also on the kinetics of the reducing reaction.^{2,3} The present approach was selected since it allows the independent study of the influence of the reduction kinetics and the capping effect on the formation of Ag nanowires.

Silver nanowires were obtained by the photocatalytic reduction of silver nitrate, using a Sn(IV) porphyrin as the photocatalyst, and triethanolamine (TEA) as electron donor, in the presence of sodium citrate (NaCit), by a method adapted from the literature.⁴

The formation of Ag nanowires was detected after only 2 minutes of irradiation by the change in the colour of the solution to red-brown, due to the appearance of a plasmon band around 600 nm (Figure 1), and was confirmed by TEM (Figure 2). The nanowires obtained are not stable in solution, and after 4 min start to undergo a morphological transition to spherical nanoparticles, with a change of colour of the solution from red-brown to green. This morphological transition is faster in the presence of a strong capping agent (11-mercapto-undecanoic acid), a strong reducing agent (NaBH₄), and when the reaction is carried out anaerobically, indicating that the morphological transition probably involves oxidative etching and agglomeration/aggregation of nanoparticles.

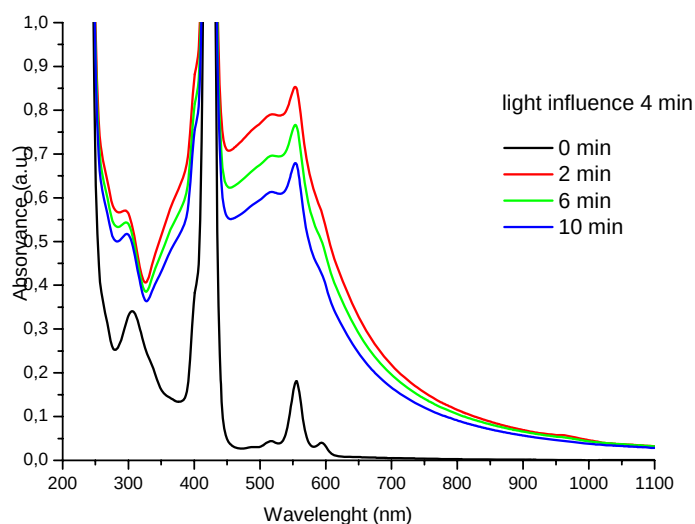


Figure 1: UV/vis spectra of the silver nanoparticles obtained by the photocatalytic method in the presence of citrate as a capping agent.

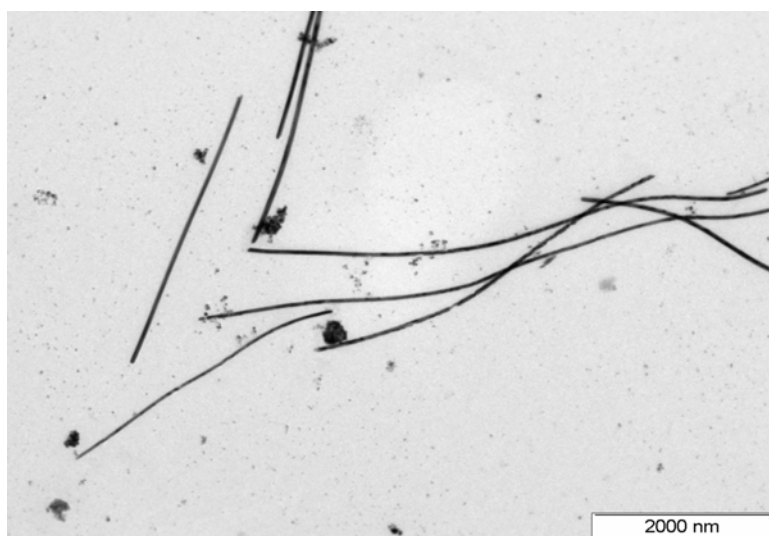


Figure 2: TEM image of the silver nanoparticles obtained after 4 minutes of irradiation.

- (1) Zhang, S. H.; Jiang, Z. Y.; Xie, Z. X.; Xu, X.; Huang, R. B.; Zheng, L. S. *J. Phys. Chem. B* **2005**, *109*, 9416-9421.
- (2) Pillai, Z. S.; Kamat, P. V. *J. Phys. Chem. B* **2004**, *108*, 945-951.
- (3) Henglein, A.; Giersig, M. *J. Phys. Chem. B* **1999**, *103*, 9533-9539.
- (4) Song, Y. J.; Yang, Y.; Medforth, C. J.; Pereira, E.; Singh, A. K.; Xu, H. F.; Jiang, Y. B.; Brinker, C. J.; van Swol, F.; Shelnutt, J. A. *J. Am. Chem. Soc.* **2004**, *126*, 635-645.

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