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Cs-Corrected High Resolution Transmission Electron Microscopy (HRTEM) of Silver Nanowires

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Nanowires, as one dimensional nanostructured materials, have become the focus of intensive research due to their great potential for use as building blocks in the fabrication of electronic, optoelectronic, and sensor devices with nanoscale dimensions. Among others, the possible applications of nanowires are expected to be in electromagnetic, and energy storage devices. Silver has many important applications due to its high electrical and thermal conductivity and its unique optical properties that depend on size and shape. Therefore, the study of Ag nanowires has aroused much interest [1-4].

In this work we are presenting the observation and analysis of these silver nanowires by HRTEM using a FEI Cs-corrected TECNAI 20 microscope. It is indicated that the nanowires highly faceted at nanometric scales. Because the delocalization function when the Cs is zero is almost zero, the position of the atoms is well localized are the facets can been very well measured.

We synthesized the nanowires by the polyol method (Fig. 1). In this method, ethyleneglycol (EG) is used as both reducing reagent and solvent [1]. Poly(vinylpyrrolidone) (PVP) plays a role of structure-directing agent or capping agent. Nanowires were also synthesized by a modified polyol method using glycerin (G) instead of EG and poly(diallyldimethyl ammonium chloride) (PDDAM) replacing PVP.

The experimental setup used for this study consisted of a three neck flask with condenser system heated in oil bath. 10 ml of EG or G with 5 ml of an EG or G solution of 0.375 M PVP or PDDAM were refluxed at 160 °C for 2 h, then 5 ml of an EG or G solution of 0.25 M silver nitrate were added drop wise in not less than five minutes. The color of the solution changes significantly in the experiment. When the first drops of silver nitrate are added, the mixture turns yellow immediately. With the addition continuing, the solution becomes opaque gradually. After all the silver nitrate solution is added, the solution turned turbid with a grey color in about 15 min, indicating the appearance of Ag nanowires; the reaction continued at 160 °C for 30 min. When the reaction has finished, centrifugation is needed to remove nanoparticles and other impurities from the nanowires. Then the grey precipitate remained and needed no further purification.

The obtained nanowires show a pentagonal cross-section, and when they are observed with the Cs-corrected microscope, they presented very well faceted surfaces (Fig. 2).

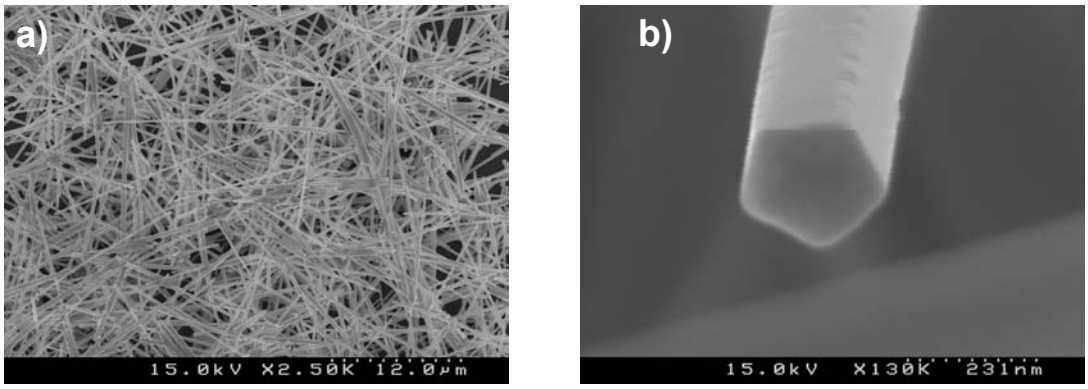

Figure 1. a) SEM image of nanowires **b)** SEM images of one nanowire. Note the five-fold symmetry of the nanowire.

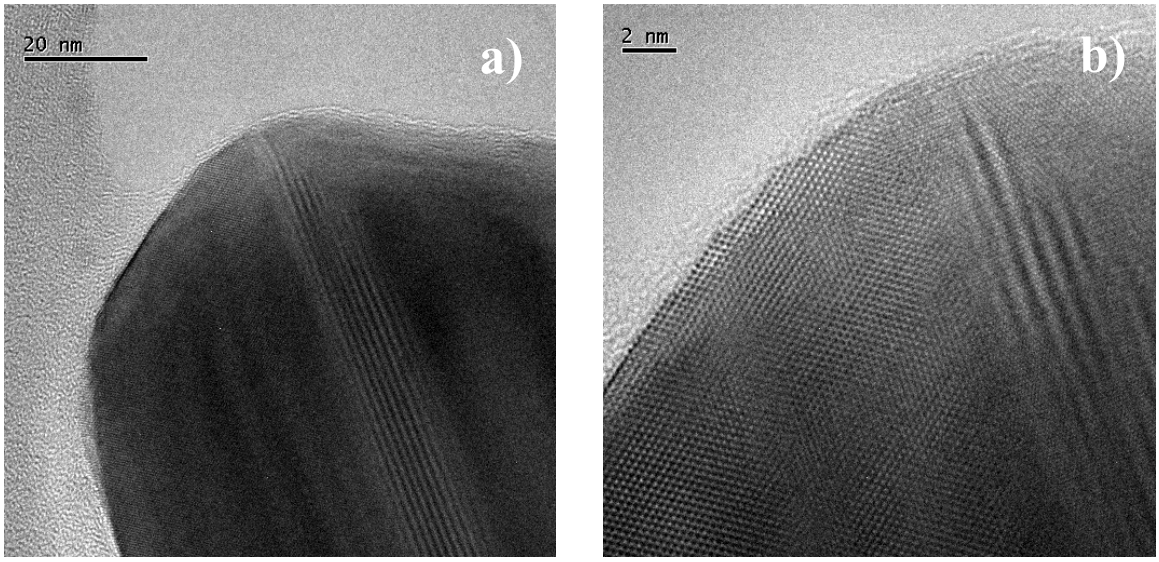

Figure 2. Cs-corrected HRTEM images of silver nanowires. The faceted edge is clearly observed in **b)**.

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