Controllable Synthesis of Cu$_2$S Nanocrystals and Their Assembly into a Superlattice

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Cu$_2$S nanoparticles are interesting area of science in nanoscience and technology since it is a p-type semiconductor with band gap of 1.2 eV.

It has verity of potential application in various areas such as

- Solar cells
- Cold cathodes
- Nanoscale switches
Cu$_2$S nanoparticles

In a typical synthesis of 8.2 nm diameter Cu$_2$S circular nanocrystals, Cu(NO$_3$)$_2$·3H$_2$O (0.24 g, 0.001 M) was dissolved in deionized water (20 ml) to form a clear blue solution. Then sodium acetate (0.82 g, 0.010M) and acetic acid (0.60 ml) were also introduced into the solution. After keeping stirring for 15 min, the solution was transferred into a Teflon-lined autoclave of 40 ml capacity and dodecanethiol (3 ml) was added finally into the solution. The autoclave was sealed and heated at 200 ºC for 6 h. After the autoclave was cooled to room temperature, the product was collected and the water in the autoclave was discarded. Then 20 ml ethanol was introduced and the product was washed and precipitated. The mixture was centrifuged for 5 min at 4800 rpm, and the precipitate was collected.

For hexagonal Cu$_2$S nanoplates, KCl (1.0 g) was introduced into the Cu(NO$_3$)$_2$ solution, without sodium acetate and acetic acid.

For elongated nanocrystals, only 0.12g Cu(NO$_3$)$_2$·3H$_2$O was dissolved in deionzed water (20ml) and neither sodium acetate nor KCl was added. After keeping stirring for 15 min, the solution was transferred into a Teflon-lined autoclave of 40 ml capacity. Then toluene (5 ml) and dodecanethiol (0.5 ml) were added into the solution. Finally, the autoclave was sealed and heated at 200 ºC for 20 h. After the autoclave was cooled to room temperature, the product was treatment as previously described.
8.2 nm

13.6/8.8

5.2/26
Summary

1. Synthesized highly uniform Cu₂S nanocrystals at oil-water interface.
2. Different morphologies were observed by changing the reagents.
3. Synthesized the 3-D superlattices by controlling the morphologies.
4. 3-D arrangement of spherical and elongated nanoparticles were explained using the dipole moment factor.
5. They can be used for the potential applications in nanodevices.