Synthesis and characterization of nanomaterials: colloids

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Introduction

Nanocolloids are nanosized particles with a diameter between 1 to 1000 nm. The synthesis of gold, silver and copper nanoparticles is a very visual process. The solution will change from being colorless to being red when gold or copper colloids are formed and yellow when silver colloids are formed.

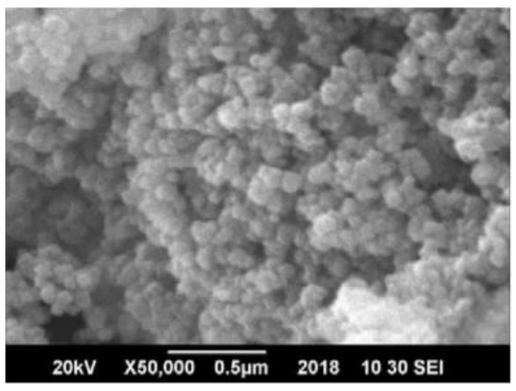

Figure 1 Example of Cu and Cu_2O nanoparticles in a SEM image. (1)

During this research project the goal was to synthesize gold and silver nanocolloids using the Turkevich method and by using the Leidenfrost effect. A brief experiment was done to try to synthesize copper colloids by using the Leidenfrost effect.

Materials and methods

Gold and silver nanoparticles were synthesized by reducing $HAuCl_4$ (for gold) and $AgNO_3$ (for silver) with trisodium citrate that acts as the reducing agent. First, the gold or silver solution was heated to its boiling point. When the boiling point was reached, the citrate solution was added using an addition funnel while stirring. The Leidenfrost effect was also used to create nanoparticles of gold, silver and copper. This is achieved by dripping the different solutions in a hot metal bowl. The metal bowl is heated by a Bunsen burner. To synthesize copper colloids, a copper sulfate solution was added to a droplet of starch solution in the bowl and then a few drops of ascorbic acid were added.

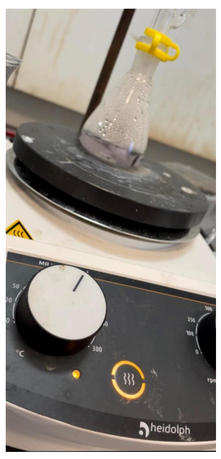

Figure 2 Citrate reduction method

Figure 3 Leidenfrost effect

Results and discussion

When using the Turkevich method for gold and silver colloids, a visible change in color takes place after a few minutes after adding the citrate solution. When using the Leidenfrost effect the change of color takes place in less than a minute after adding the citrate solution or the ascorbic acid for copper colloids. The color transition for gold and copper is from colorless to blood red. For silver, it turns from colorless to yellow-brown.

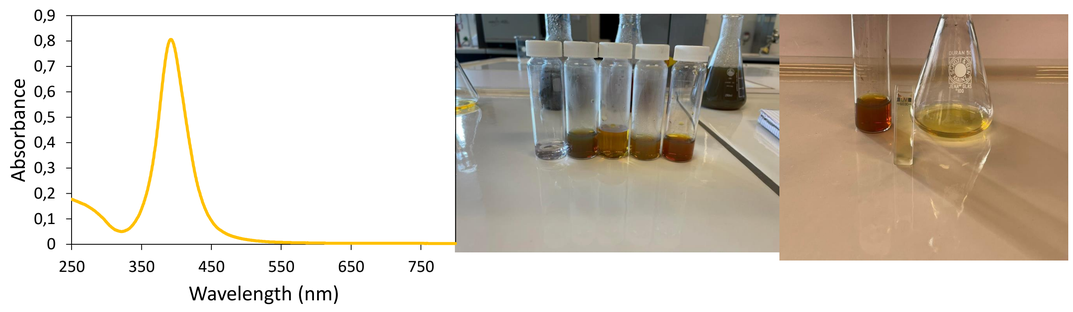

Figure 4 UV-Vis spectrum (left) of the synthesized silver colloids (middle & right)

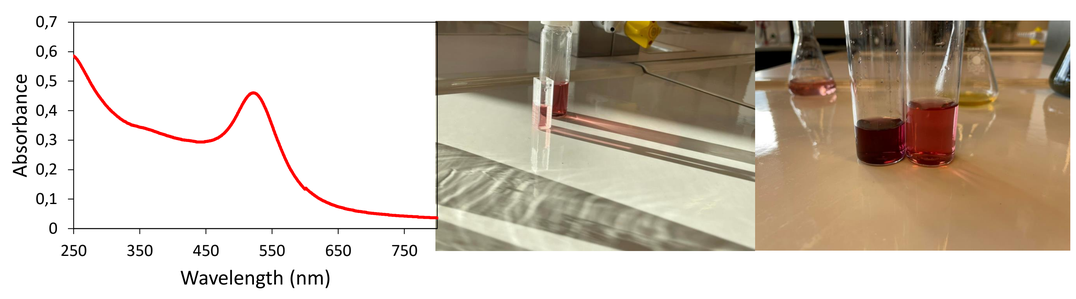

Figure 5 UV-Vis spectrum (left) of the synthesized gold colloids (middle & right)

By using the tyndall effect, based on scattering, it was checked whether or not there were colloids present and it wasn't just a colored solution.

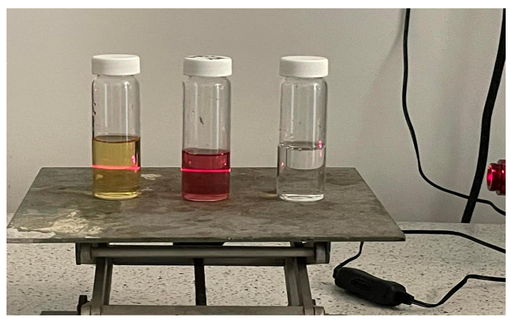

Figure 6 Tyndall effect in a solution with silver colloids (left), gold colloids (middle) and water (right)

Conclusion

Using the Leidenfrost effect, we were able to synthesize gold, silver and copper colloids. For the gold and silver colloids, the classical Turkevich method also proved to be successful. With regard to the synthesis of copper colloids with the Leidenfrost effect, more experiments were needed to be done to optimize this method. In this study it was only discussed very briefly and it did not go so smoothly. However it was established that it is certainly an option to synthesize copper colloids in this way.

Reference

(1) Khan A, Rashid A, Younas R, Chong R. A chemical reduction approach to the synthesis of copper nanoparticles. Int Nano Lett. 2016;6:21-26.

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