SYNTHESIS AND CATALYSIS USING GOLD AND SILVER COLLOIDS

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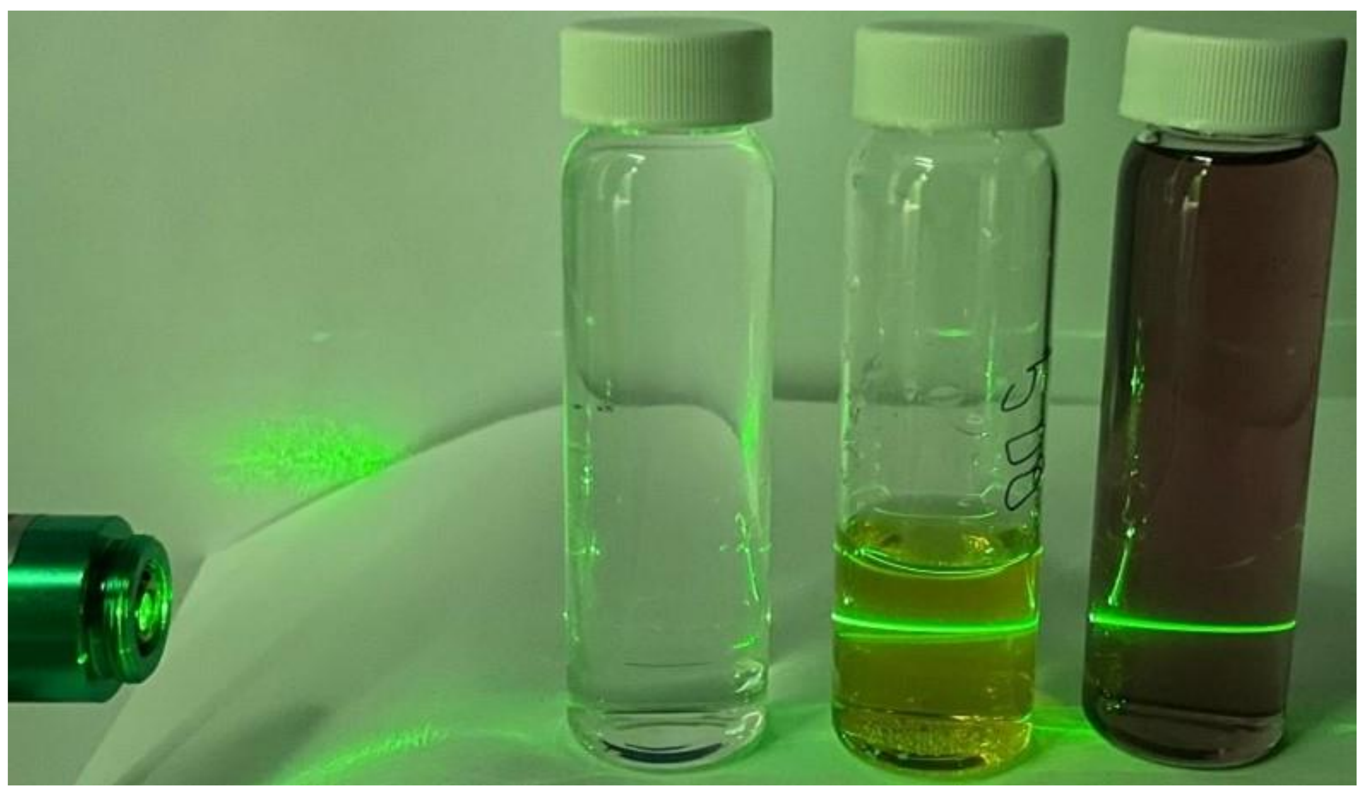
Introduction

Nanoparticles have a diameter between 1 to 100 nm. This small size results in different chemical and physical properties from bulk materials. These properties depend on the size and the shape of the particles.

In this project the synthesis of gold and silver nanoparticles was analysed by varying certain factors during the synthesis. Furthermore, the properties of the final particles were compared by use of a spectrophotometer and the Faraday Tyndall effect. The catalytic properties of these nanoparticles were tested on a range of compounds by following two different reduction reactions with and without the presence of nanoparticles.

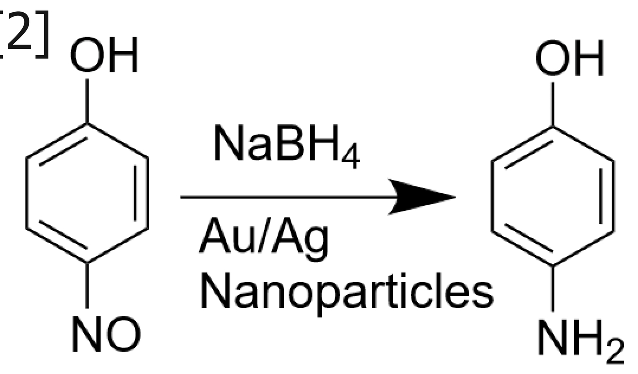


The scattering of light known as the Faraday-Tyndall effect can be observed in the synthetised colloids using a laser. [1] On the above picture are water, silver and gold colloid solutions. As expected, the light beam can be visible in the last two.

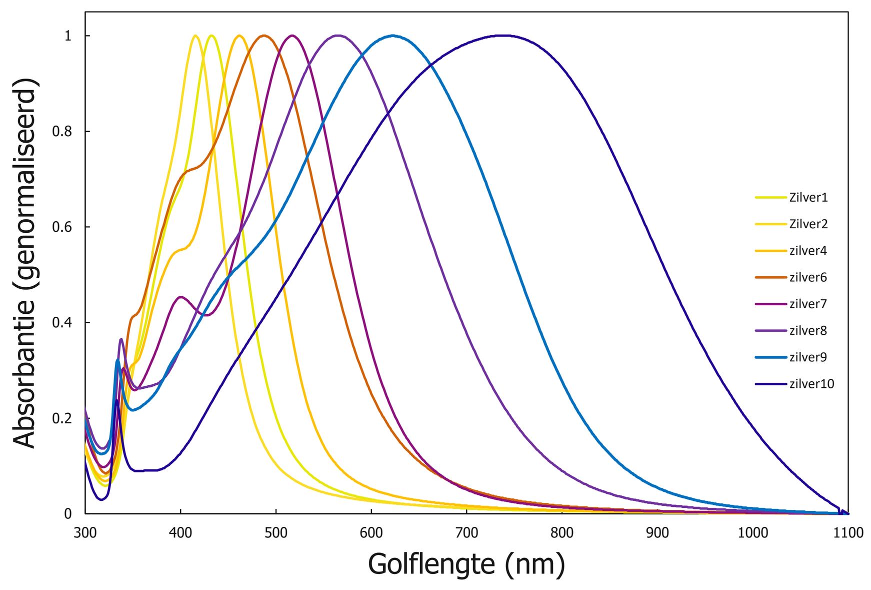
Materials and methods

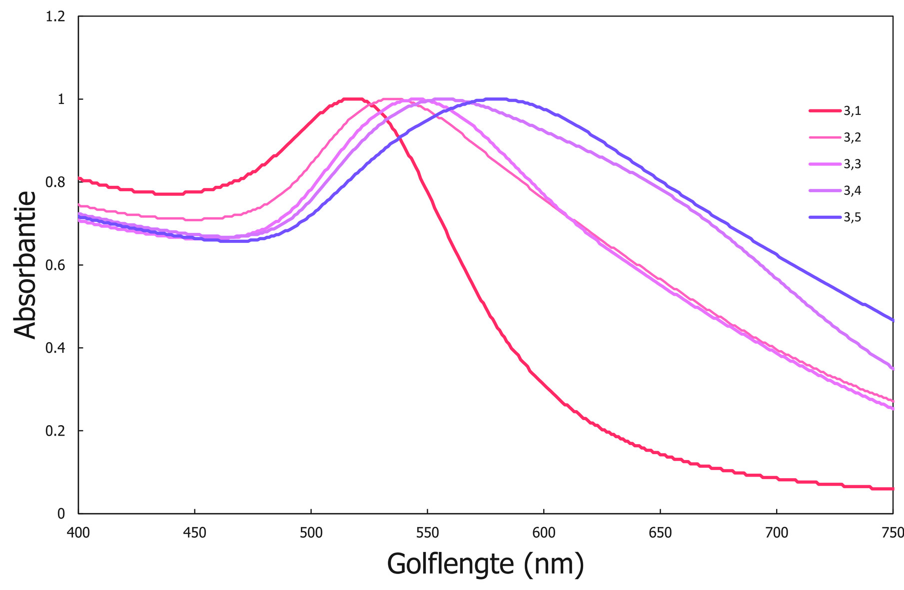
The silver and gold nanoparticles were synthetised following the same method. In this procedure both silver nitrate and tetrachloroauric (III) acid trihydrate were reduced using trisodium citrate. In a sample vail trisodium citrate and tetrachloroauric (III) acid trihydrate were added. Together with hydrogen peroxide and potassium bromide this solution was shaken by hand and sodium borohydride was added. The last step called for stirring the solutions with a magnetic stirrer for around 20 minutes until an abrupt colour change was observed.

To test the catalytic properties of the synthesized nanoparticles, the catalytic conversion of 4-nitrophenol into 4-aminophenol was followed with spectrophotometer. The p-nitrophenol was first reduced with sodium borohydride that results in a bright yellow solution whose absorbance was followed at 410 nm after addition of the nanoparticles as the catalyst. Furthermore, the entire spectra were monitored in time. [2]



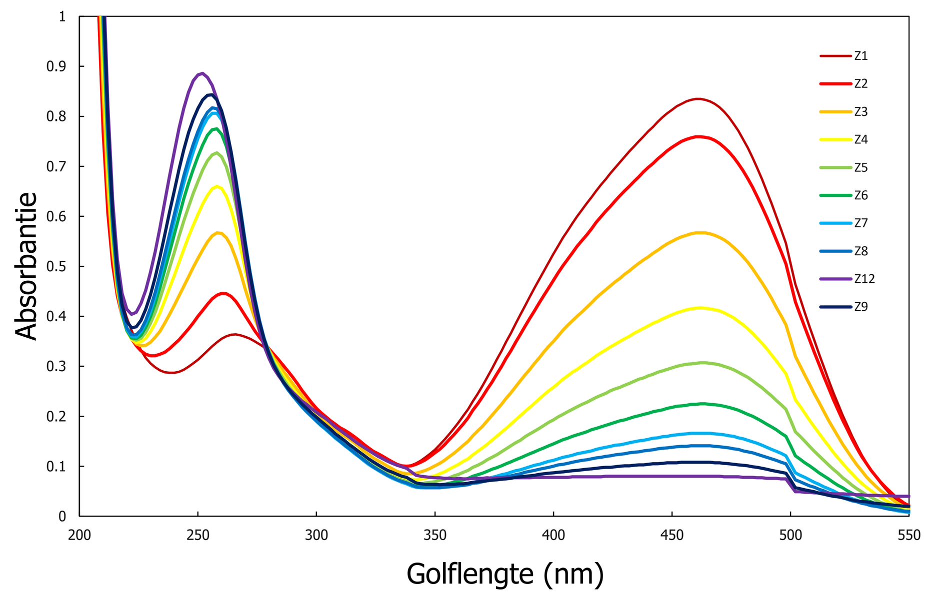
Results and discussion

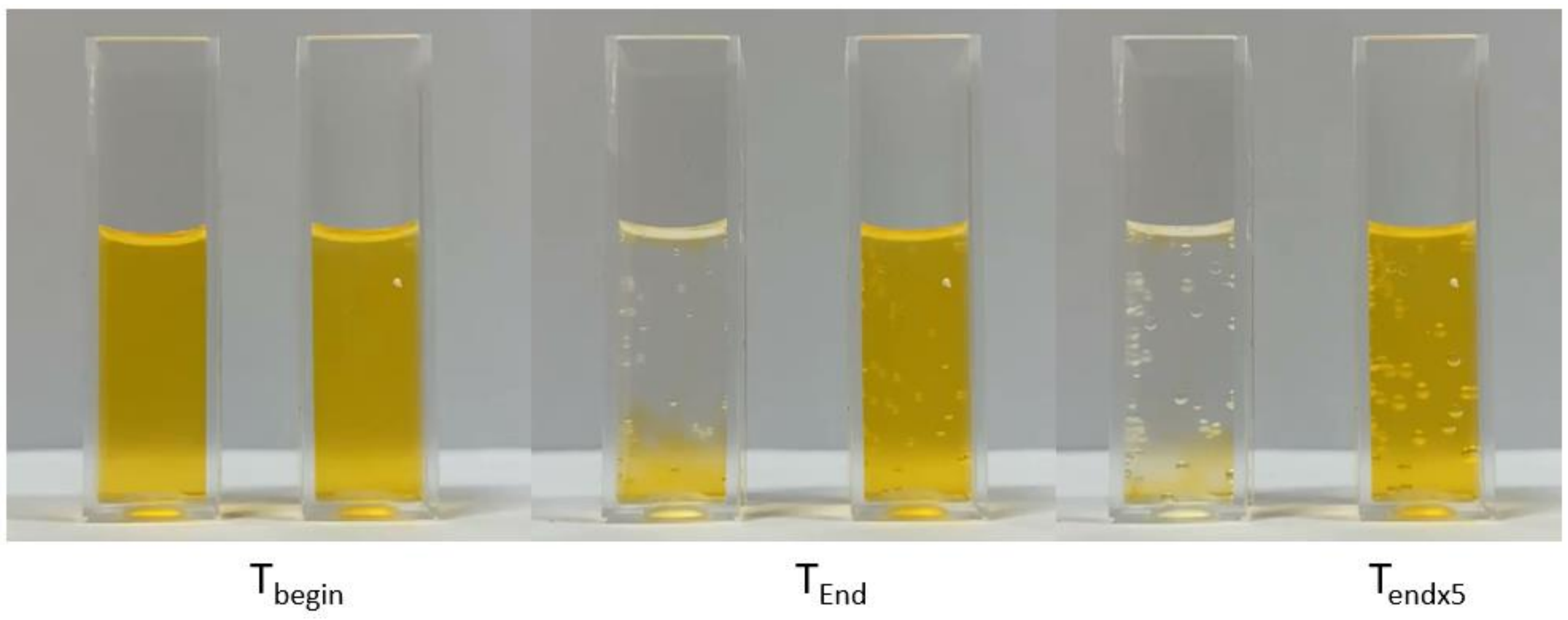




The upper two graphs represent the spectra of synthetised silver (left) and gold (right) nanoparticles with varied concentrations of KBr.

The graph on the bottom right shows the spectra of reduced 4-nitrophenol that changes during the nanoparticle-catalysed reaction using gold nanoparticles.





Reduction of methyl orange with (left) and without (right) added gold nanoparticles

Conclusion

The colours of the resulting silver nanoparticles ranged from a dark blue to yellow, depending on the amount of potassium bromide that was added. As for the gold nanoparticles, the synthesis resulted in a light pink to a dark red solution. An increase in reaction speed of up to a factor of 5 was reported using the gold nanoparticles to reduce the 4-nitrophenol. A factor of 2 was achieved for the catalytic reduction of methyl orange using the gold nanoparticles. The rates for silver were relatively lower.

References

- [1] Mortier, T. (2021) *Nanotechnologie* (pp. 127–147). Acco learn.
- [2] Strachan, J., Barnett, C., Maschmeyer, T., Masters, A. F., Motion, A., & Yuen, A. K. L. (2020). Nanoparticles for Undergraduates: Creation, Characterization, and Catalysis. Journal of Chemical Education, 97(11), 4166–4172. https://doi.org/10.1021/acs.jchemed.0c00499

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