Seed Mediated Grown Gold Nanorods Study

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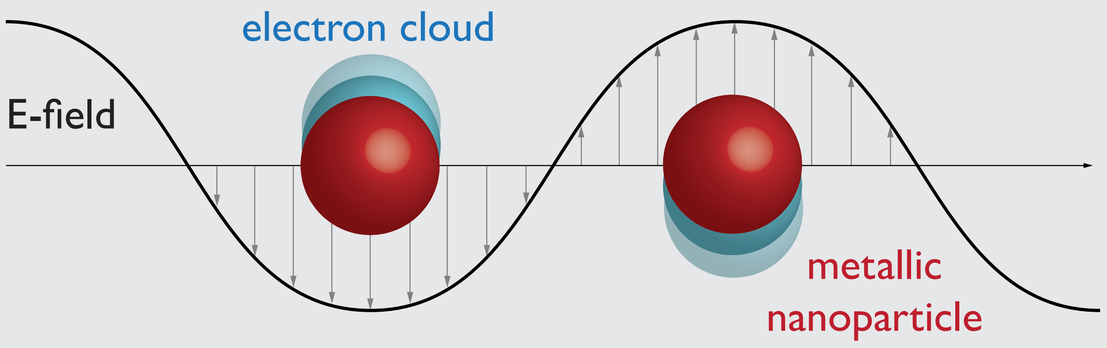
Introduction

Synthesis of gold nanorods (GNRs) by seed mediated growth method allows controlling size and shape of prepared asymmetric nanoparticles (NPs). Both of these parameters have a crucial impact on a phenomenon called localized surface plasmon resonance (LSPR). Such knowledge can be used for interpreting reaction kinetics of growing GNRs in situ. Obtained results are discussed in terms of processes which can occur during synthesis.

Localized surface plasmon resonance

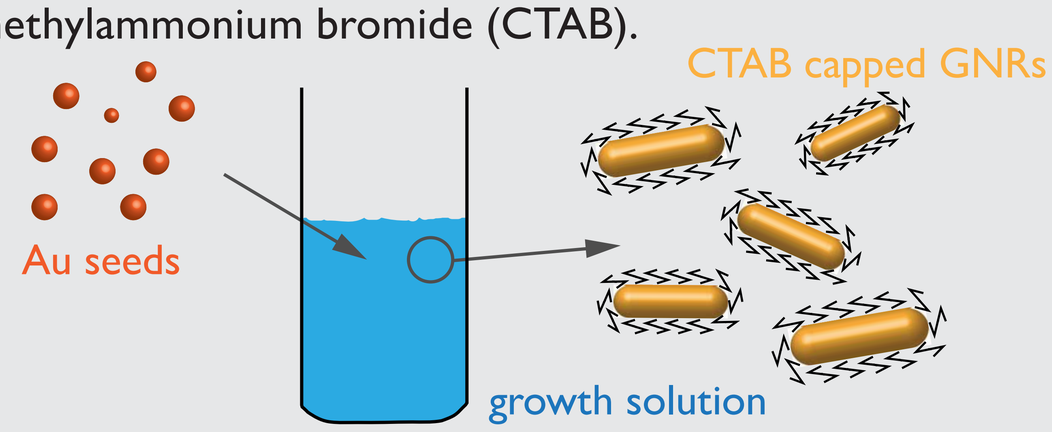
LSPR causes characteristic color of solutions containing gold nanoparticles. Incident electromagnetic field (i.e. visible light for gold NPs) gives rise to charge density oscillations on metallic nanoparticles. In case of GNRs the resonance is split into two modes: transversal and longitudinal. Therefore, two absorption peaks are present.



Schematic illustration of localized surface plasmon resonance.

Gold nanorods synthesis

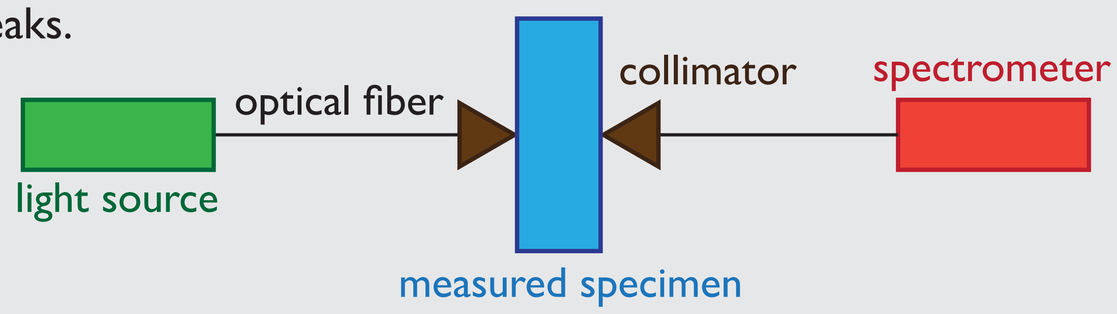
GNRs were prepared by well-known seed mediated growth method. Final colloidal solution includes GNRs stabilized by cetyltrimethylammonium bromide (CTAB).



Picture illustrating seed mediated growth method. *Gold seeds (~ 2nm NPs) are added to the appropriate growth solution. This step leads to the formation of CTAB capped GNRs.*

Reaction kinetics measurement

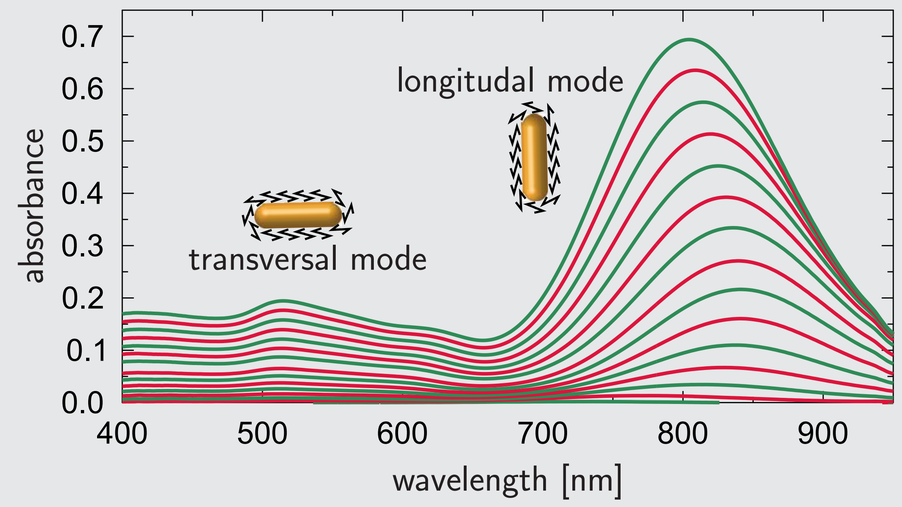
Absorption spectroscopy was used for reaction kinetics measurement. Absorption spectra were acquired during the GNRs formation. Emphasis was placed on observing changes of absorption peaks.



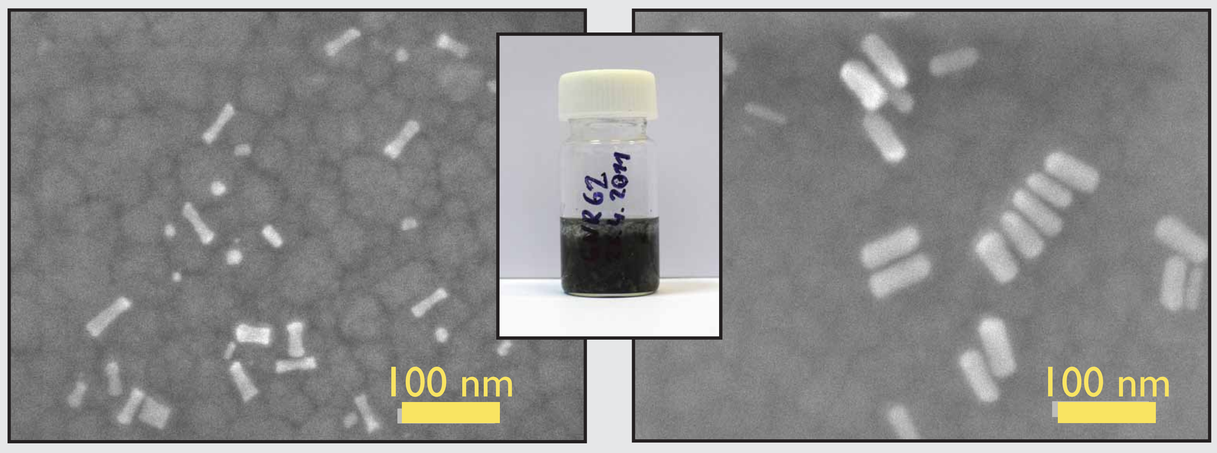
Schematic illustration of reaction kinetics measurement.

Results

Presented results come from experiments, which contained silver nitrate in their growth solution. Silver nitrate allows formation of GNRs with higher aspect ratios. [1]



Top: Absorption spectra evolution of the first 15 min of the GNRs formation. Bottom: Time-resolved position of the longitudal mode (LM) and corresponding value of absorbance.



Left: SEM image from the 8th minute. Center: Photo of the final GNRs solution. Right: SEM image of the final GNRs solution.

Applications

GNRs are predestined for various applications. Applications in bioscience are amongst on of the most promising. GNRs have been utilized in vivo for imaging and therapy of tumor cells. [2]

Conclusion

GNRs exhibit size and shape dependent optical properties, thus precise control over the synthesis is desirable. It has been shown how addition of silver nitrate changes growth kinetics. First, dumbbell-like NPs are formed. Second, dumbbell-like NPs grow up into final GNRs. Measured characteristics might be utilized for tailoring GNRs with desired optical properties. LSPR behavior is in agreement with tuning tip curvature of GNRs [3].

References

[1] B. Nikoobakht and M. A. El-Sayed: Preparation and Growth Mechanism of Gold Nanorods (NRs) Using Seed-Mediated Growth Method, Chemistry of Materials, 2003, 15, pp 1957-1962
[2] T. Niidome et al.: PEG-modified gold nanorods with a stealth character for in vivo applications, Journal of Controlled Release, 2006, 114, pp 343–347
[3] M. Grzelczak et al.: Influence of Iodide Ions on the Growth of Gold Nanorods: Tuning Tip Curvature and Surface Plasmon Resonance, Advanced Functional Materials, 2008, 18, pp 3780–3786