SYNTHESIS OF SILVER NANOPARTICLES

T. Kühlewind , A. Sindjelic , V. Juhart, A.Vass

HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFTEN MÜNCHEN

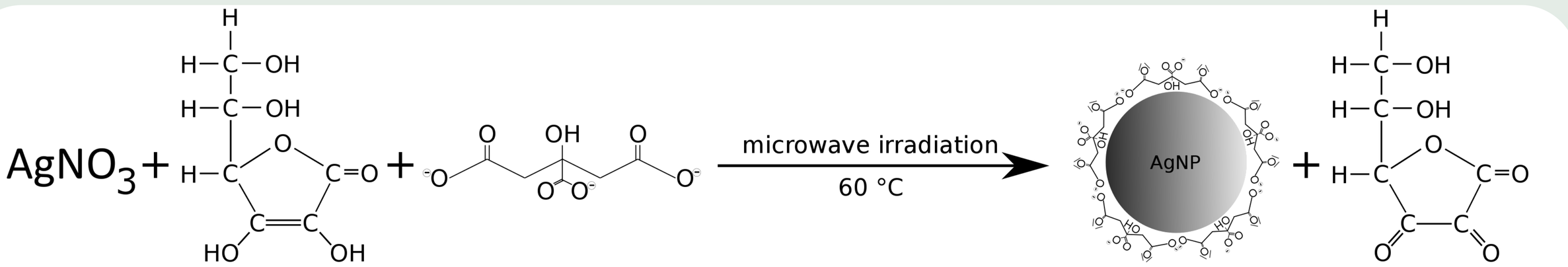
I. Introduction

Silver nanoparticles have unusual physical, chemical and biological properties compared to their macro scaled counterparts. The outcome of this is a comprehensive application range. They are for example used for **conductive silver inks**, **antimicrobial coatings, catalysts** and **surface enhanced Raman spectroscopy** (SERS).
Although silver nanoparticles are available for purchase their use is limited to high asset costs. Therefore an easy way for synthesizing these particles is required.

II. Objectives

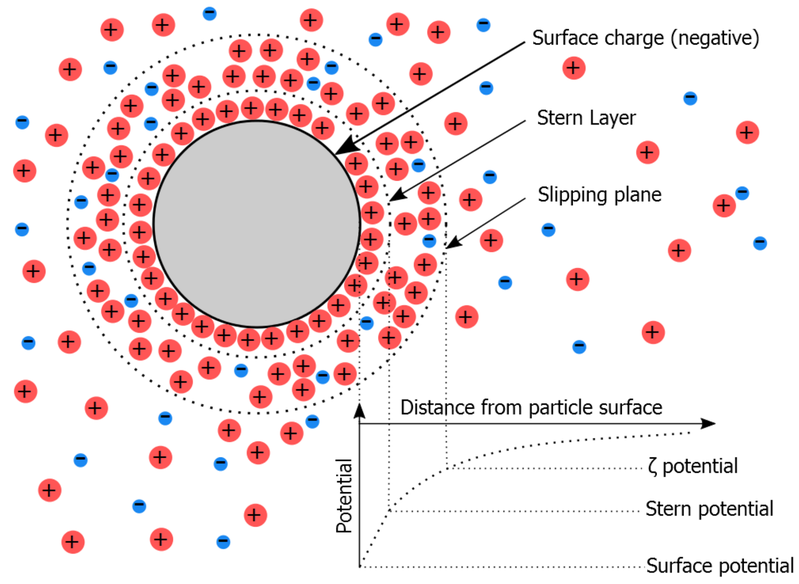
- Synthesizing **silver nanoparticles** for various applications
- Particle size control by variation of the pH-value
- Particle size measurements via dynamic light scattering (DLS)
- Generation of information about the dispersion stability by measuring ζ-potentials in dependence of the pH-value
- Simple single-batch process
- Short reaction time by heating with a microwave irradiation
- Usage and production of environmental friendly chemicals

III. Chemical Reaction

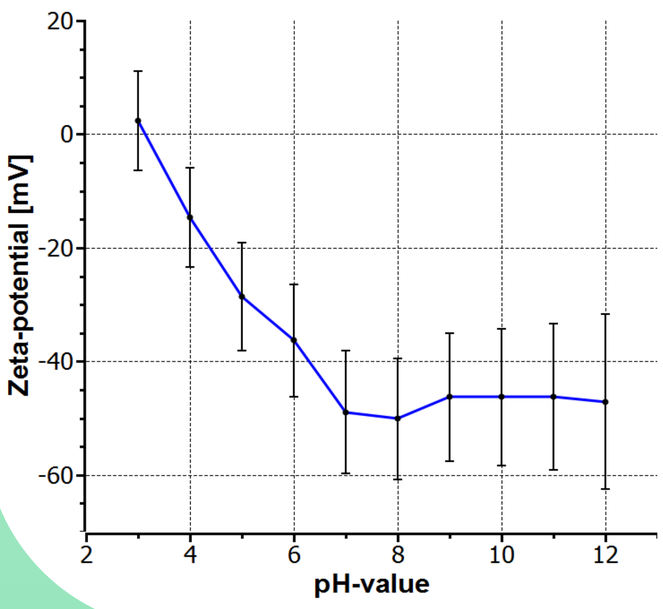


Silver Nitrate (Precursor) | Ascorbic Acid (Reducing Agent) | Citrate (Stabilizing Agent) | **Silver Nanoparticle** stabilized by Citrate | Oxidated Ascorbic Acid

IV. Dispersion Stability



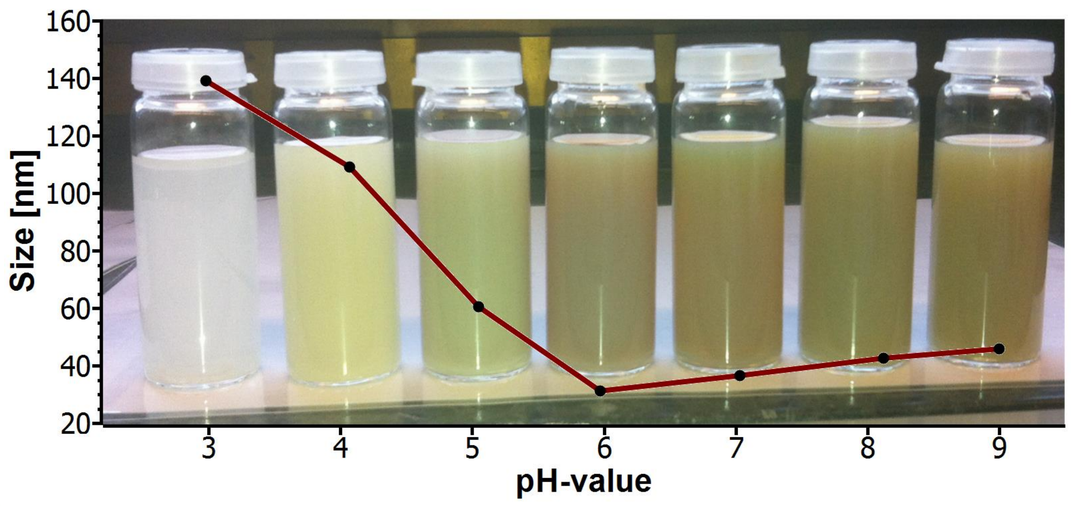
The **ζ-potential** is a measure of the particle loading, which characterizes the dispersion stability. The particle loading is completely shielded by ions in a stationary layer (Helmholtz-layer) and a diffuse layer (Stern-layer). Under movement within an electrical field, a part of the diffusive layer is sheared off. The difference from the potential of the slipping plane and the potential of the solution is the measured ζ-potential.



From pH-values of 7 to 12 the particles are stabilized by a repulsion with a potential smaller than -40 mV. With decreasing the pH-value protons are adsorbing in the stationary layer, shielding the negative particle charge. The particles are not stabilized through electrostatic repulsion and therefore tend to agglomerate.

V. Particle Size

With the pH-value the kinetic of the reaction can be controlled. Decreasing the pH-value leads to a decrease of the reaction velocity, resulting in a lower supersaturation. This produces less seeds, the particle size increases.



V. Conclusions

- Silver nanoparticles particles can easily be synthesized in a single batch microwave process within 2 minutes
- Particle size can be controlled by adjustment of the pH-value of the initial solution
- Colloidale dispersions are very stable in alkaline environment with a potential under -40 mV
- Ascorbic acid, trisodium citrate and silver nitrate are without risks for health and environment

Laboratory of Physical Chemistry, BEC, FK 06
University of Applied Sciences Munich