Understanding Colloidal Nanoparticle Growth

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Abstract

Colloidal nanoparticles have attracted much attention due to their unique properties and promising applications. Synthetic procedures are known and have been investigated since Faraday's ground-breaking experiments about gold colloids more than 150 years ago.[1] However, a profound understanding of the underlying nanoparticle formation processes is still missing.[2]

Recently, we introduced novel setups and techniques which enable the determination of the size evolution and concentration of colloidal nanoparticles throughout the growth process. These technical developments have been the key to determine the growth mechanisms of several metal colloid syntheses. [3]-[6]

The comparison of the different mechanisms reveals fundamental principles of nanoparticle growth that are in contrast to present nucleation and growth theories. For the investigated systems it was shown that growth is only governed by colloidal stability whereas a process of nucleation has no significant effect on the final particle size distribution. Instead, a novel model is presented that provides a comprehensive understanding of the fundamental principles of colloidal nanoparticle growth.

Exemplified for gold, silver and palladium nanoparticles, it will be demonstrated that the gained mechanistic knowledge allows improving and developing strategies for size controlled syntheses of nanoparticles without additional stabilizing agents.

In summary, three major issues in colloidal science are addressed: (i) experimental techniques and methods to investigate nanoparticle formation processes in-situ and time resolved; (ii) fundamental principles of nanoparticle growth deduced from mechanistic information of several nanoparticle syntheses;(iii) precise size control of colloidal metal nanoparticles.

References

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