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Cationic Gemini Surfactants as Efficient Capping Agents of Silver And Gold Nanoparticles

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Abstract

Over the past several decades, silver and gold nanoparticles continue to attract scientific interest due to their unique physical and chemical properties that are different from bulk metal materials. Their high surface area-to-volume ratio, special electronic effects, unique surface, magnetic, and plasmonic properties, and surprisingly high level of biological activity makes them suitable for a variety of applications. Gold nanoparticles showed a strong potential of becoming a basis for novel systems with distinct optical, physicochemical, and biocompatible properties and applications preferentially in biomedical and biotechnological areas. Silver nanoparticles are well-known for their potent antimicrobial and bactericidal effect. They show a broad-spectrum antibacterial, antivirotic and fungicidal effect even against multi-resistant pathogens. A feature which is important for the applications in medicine and pharmacy, is the outstanding antimicrobial activity and antiflogistic properties of silver nanoparticles and their good biocompatibility.

The key issues related to metal nanoparticles are the low application concentration and poor particle stability in aqueous solutions over longer period of time, which results in the limitation of their potential applications. A promising solution to this issue turned out to be a stabilisation of silver and gold nanoparticles by a special group of double chain surfactant molecules, so-called gemini surfactants. Compared to the single-chain conventional surfactants, cationic gemini surfactants show lower critical micelle concentration, better adsorb at the interfaces, and form a broad range of specific aggregate structures [1].

Our previous investigations of synthesis and stabilisation of silver nanoparticles revealed that single-chain cationic surfactants based on nitrogen or phosphorus atom [2] in their hydrophilic part can successfully stabilise silver nanodispersions [3,4]. However, some limitations in the efficiency of stabilisation of nanoparticles by single-chain surfactants occurred, mostly due to the weaker charge of the hydrophilic part of single-chain surfactant molecules or due to the insufficient hydrophobicity of their alkyl chain.

The aim of the presented study is to show the application of more efficient gemini surfactants in the synthesis of silver and gold nanoparticles and the determination of their physical parameters and biological activity. Variation of gemini molecular parameters such as the spacer length or the presence of soft biodegradable groups in hydrophobic spacer resulted in some surprising properties and high biological activity levels of gemini surfactant-capped nanoparticles.

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