Review

Recent Advances in the Colloidal Stability of Nanoparticles†

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Abstract: This paper focuses on the colloidal stability of nanoparticles (NPs), a critical factor in their efficacy and safety in various applications. Nanoparticles, defined as particles with dimensions between 1 and 100 nanometers, exhibit unique physical, chemical, and biological properties due to their increased surface area and quantum effects. These properties have been harnessed in diverse fields, including medicine for therapies, diagnostics, and drug delivery. The colloidal stability of NPs, which determines their behavior in solution, is influenced by their surface chemistry and interactions, such as adsorption of molecules and directed self-assembly. This paper delves into the colloidal stability of various types of nanoparticles, including polymeric, inorganic, and carbon-based nanoparticles. We explore the stability mechanisms of different nanoparticles like zinc oxide, silver, iron oxide, gold, and diamond nanoparticles in various environments such as in high ionic strength mediums. For instance, SDS-modified zinc oxide nanoparticles show improved stability and reduced aggregation compared to unmodified counterparts. Similarly, gold nanoparticles stabilized with specific ligands demonstrate enhanced colloidal stability. The paper also identifies several research gaps, including the need for long-term stability studies, understanding environmental impacts, interactions between different NP types, and the influence of solvents and pH on NP stability. The paper underscores the importance of surface modifications and coatings in improving colloidal stability. The colloidal stability of nanoparticles is paramount for their effective application across various domains. Future research directions include developing nanoparticles with precise stability profiles, sustainable synthesis methods, advanced characterization techniques, and exploring their environmental and health implications. The potential for nanoparticles in medicine, renewable energy, and advanced materials is vast, contingent upon our understanding and manipulation of their colloidal stability.

Keywords: nanoparticles; colloidal stability; zinc oxide; silver; gold; diamond; iron oxide

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