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AGGLOMERATION OF NANOPARTICLES WITH IONIC BONDING

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Abstract
This work allows us to discuss situations how the form and radius of the ion of particles affect the magnitude of surface charges.

Keywords: Agglomeration of nanoparticles, surface, band gap, ionic bond.

Introduction

Agglomeration of particles is an important parameter that not only determines the size distribution, but also affects the characteristics of the dispersion. Agglomeration depends on the physicochemical characteristics of the dispersion medium, the preparation of the dispersion, the concentration and polydispersity of the nanoparticles, as well as the concentration of other substances in the dispersion, the physicochemical characteristics of the nanoparticles themselves and the type of interaction between the particles [1-2, 3]. Among all the forces acting between the particles, there are three main forces of different nature acting within the dispersion and controlling the interparticle interaction. These are the forces of electrostatic interaction (attraction and repulsion), the Van der Waals forces of attraction and the forces of spatial stabilization due to macromolecules adsorbed on the surface. Due to the forces acting between colloidal particles, they can form stable, metastable dispersions or undergo agglomeration processes. Due to the constant Van der Waals forces of attraction, lyophobic dispersion colloids, which include most known nanomaterials, agglomerate until the dispersion is stabilized, where interparticle repulsive forces will be present [2, 3-4]. Nanoparticles in the dry state can be in 2 forms: aggregated (with strong bonds between the original particles) and agglomerated (with a low value of Van der Waals forces). After the preparation of the dispersion, the nanoparticles in the solution can remain separately or agglomerate (Fig. 1) or remain in the form of aggregates surrounded by a double electric layer. Figure 1 shows the different states of nanoparticles in the dry state and in dispersion. It is necessary to note the difference between the concepts of agglomeration and aggregation: aggregates are formed by covalent bonds between nanoparticles and are therefore stronger than agglomerates, which are formed due to van der Waals forces, hydrophobic interactions or hydrogen bonds [3].

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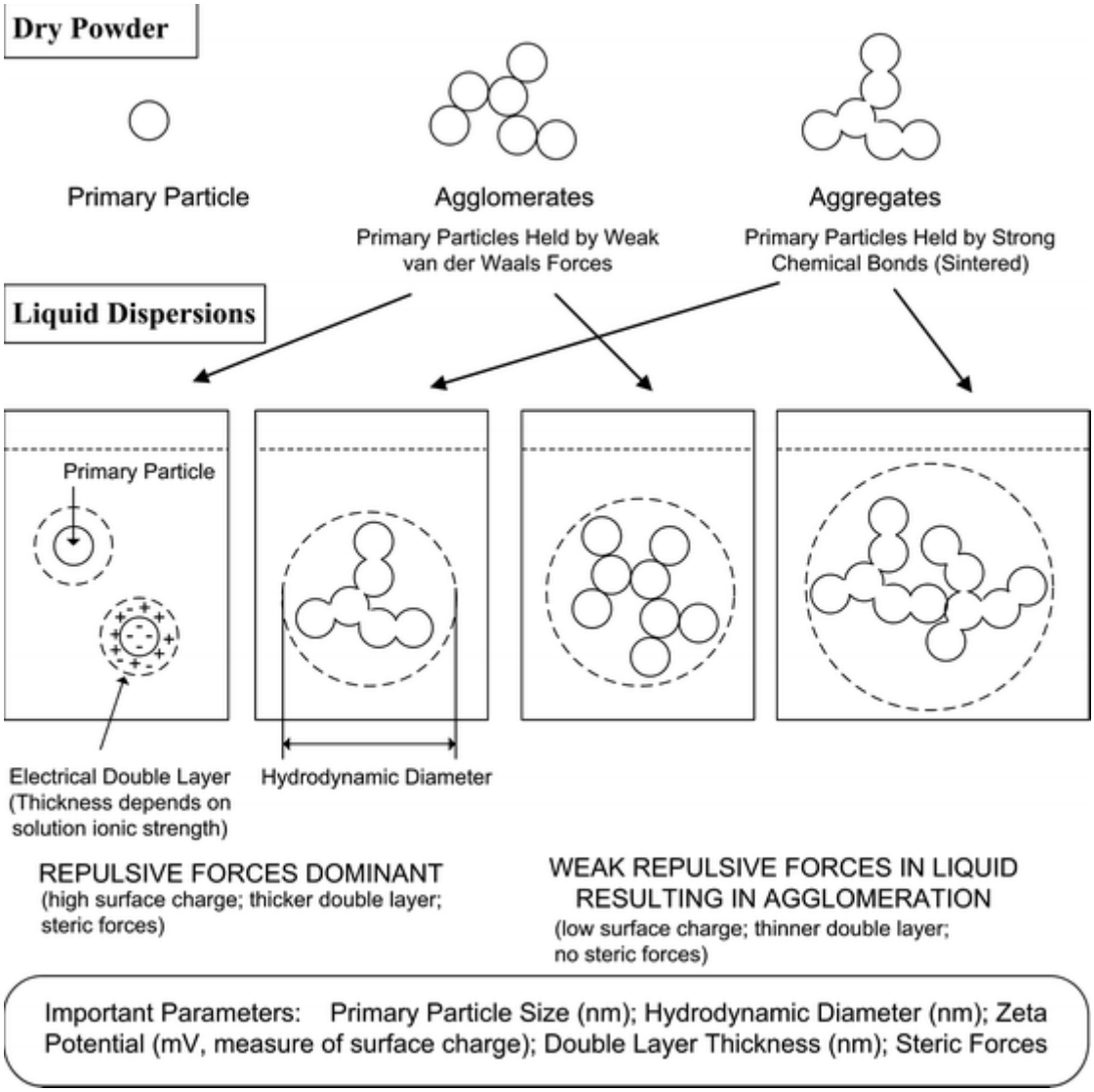

Figure 1 – Different states and configurations of particles in dry state and in dispersion

Usually, when agglomerated samples of nanoparticles are placed in a liquid medium, their separation is possible by overcoming weaker attractive forces in several ways, while aggregated particles cannot be separated.

Conclusions

The experiment shows that under certain conditions, particle agglomeration occurs. This is a harmful phenomenon for nanotechnology and must be combated. The question arises - how? To combat agglomeration, it is necessary to understand the nature of this phenomenon. From the most probable models, it can be assumed that the agglomeration of ionic crystallites is associated with the Coulomb attraction of charges located on the surface of nanoparticles in the form of localized states (Tamm levels). The theory of surface states for ionic crystals is well described by Davison and Lieven (Surfaces Tammovskaya ... Ch. 3, paragraph 10) In the simplest version of the theory, the Modelung model is used, that the width of the forbidden band is related to the Modelung energy (Coulomb binding energy) in Kittel (Introduction to Solid State Physics). The main result of the Modelung theory as applied to the surface is the following: the width of the

forbidden band is related to the value of the Modelung energy (in the bulk it is larger). In the bulk of the crystal, the Modulung energy is greater than on the surface, since on the surface the ions have non-closed bonds, as a result of which the electron gap and the Modulung energy on the surface are less than in the bulk of the crystal (approximately 2 times). Moreover, the Modelung energy on the surface depends on the shape of the surface: in the case of convex inhomogeneities, the Modelung energy is less (and so is the gap); in the case of concave surfaces, the Modelung energy is greater (and the gap energy is greater). These ideas allow us to discuss situations in which the shape and radius of ion particles affect the magnitude of surface charges, as well as their sign. Undoubtedly, the phenomenon of agglomeration of ionic crystallites should be associated with Tamm levels, but for a curved surface this phenomenon is more complex.

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