The Influence of Synthesis Conditions on the Packing of the Spherical Particles of Silica in a Supramolecular Structure

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As a result of the conducted experiments on the synthesis and precipitation of monodisperse spherical silica particles (100-800 nm) in different conditions we have determined a direct relationship between the packing type of particles and pH, water concentration, ammonium ions, size and precipitation speed of the globules.

In fact, at high pH values we have spherical silica particles surrounded by a dense shell of gegenions that results in their electrostatic repulsion. As a result, during precipitating of particles on the surface of a supramolecular crystal, their position in the structure is conditioned by the repulsion of precipitating particles from the surface analogous to charged globules in the structure. It results in maximal filling of space. The situation is changed at low pH values and low sizes (less 400 nm) of particles which results in reducing their surface and the greater reduction of the concentration of gegenions, and as a consequence, of the force of their electrostatic repulsion. Forming here hydrogen bonds prevent the precipitation of the particles in the most favorable positions which results in reducing the filling ratio of the particles.

In the framework of the experiment conducted by us, the packing type of spheric particles in opal matrixes depends on the sol pH and silica sphere sizes. At pH 7.5–8.0 a primitive cubic packing of particles is realized. The increase of pH up to 8.5-9.0 results in the formation of hexagonal packing with a corresponding increase of particle sizes. At a higher pH values the closest packing formed which is characteristic for natural noble opal.

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