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Preparation of sulfur nanoparticles in the reaction of sodium thiosulfate with mono- and dibasic acids in the region of low concentrations and study of their antifungal activity

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Abstract

The process of formation and coarsening of sulfur nanoparticles in aqueous medium precipitated from sodium thiosulfate solution was considered. Sulfur nanoparticles precipitated at room temperature and atmospheric pressure by mixing solutions of sodium thiosulfate with acids at different concentration ratios were characterized using a laser particle size analyzer, X-ray diffraction and electron probe microscopy. It was found that in all cases first primary sulfur particles with an average size of 20-25 nm are formed, which in the aqueous medium eventually coalesce to clusters with dimensions of 100-1000 nm and further to 5-10 μm. It was found that the sizes of primary particles strongly depend on the acid concentration and on the molar ratio between sodium thiosulfate and acid. The established regularities of processes of coarsening of sulfur particles isolated from sodium thiosulfate are consistent with analogous data obtained by using solutions of calcium, barium, sodium and potassium polysulphides as sources of nanoparticles. At the same time, when sulfur nanoparticles were separated from a solution of sodium thiosulfate with the use of dibasic acids, a nonlinear dependence of the change in the size of sulfur particles in the low concentration region was found, related to the $[H^+]$ concentration in the reaction medium. Mechanisms for the formation of a nanoparticle are given where the ratio [acid / sodium thiosulfate] < 1 and indicate the possibility of regulating the particle sizes by varying the molar ratios in this region. Comparing the antifungal activity of preparations consisting of microparticles and sulfur nanoparticles it was found that the preparation containing sulfur nanoparticles exceeds by tens of times the preparation consisting of sulfur of micron sizes and opens the prospect of creating medical preparations based on sulfur nanoparticles. The obtained results are consistent with the existing general concept concerning the use of nanoparticles in modern technologies, according to which the use of nanoparticles radically changes many properties of substances, including biological ones.

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