Sol-gel synthesis of zinc oxide nanoparticles with controlled dimensions in the environment of humic substances

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Zinc oxide nanoparticles (ZnO-NP) demonstrate a range of biomedical applications. The sol-gel method is the most appliable synthesis for the nanoparticle obtaining. The purpose of this work was to obtain ZnO nanoparticles with controlled sizes in a medium of humic substances (HS) for use as the wound healing compositions. Addition of the humic substances (HS) coating to the ZnO-NPs may improve the colloidal stability of the nanoparticles by creating a charged surface layer, which increases electrostatic repulsive forces and steric repulsion between nanoparticles [1]. In addition, HS are natural compounds, which demonstrated no toxicity over the entire range of natural concentrations. The HS salts are soluble in water.

To achieve this goal, sodium humate from coal (CHP) was used as HS. Zinc acetate was used as a zinc precursor. The synthesis conditions were chosen as described in [1]. Synthesis was carried out in the range of HS concentrations from 0.1 to 10 g/l. The concentration of zinc acetate was 0.025 M. The synthesis was carried out by mixing the reagents at pH 12 and subsequent stirring at T = 20^{o}C for 2 h. The result of reaction was the precipitation of an insoluble product. The precipitate was centrifuged, washed with water, and dried in a vacuum oven at T = 60^{o}C. The resulting product was characterized by XRD, UV-vis spectroscopy, and TEM. TEM images are shown in Fig. 1.

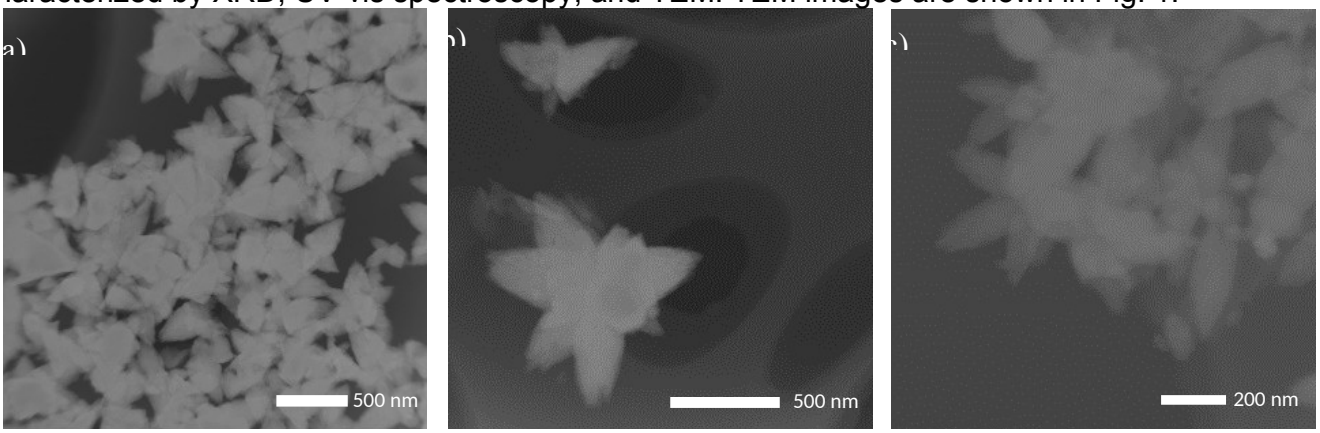

Figure 1. TEM images of ZnO nanoparticles obtained in GW solutions with concentrations (g|L): 0.1 (a); 1.0 (b); 10 (c).

According to TEM data, the size of ZnO particles was in the range of 400–500 nm. The aggregation of nanoparticles might occur as a result of the centrifugation and the absence of the HS macroligands. In accordance with the XRD data, an increase of the HS concentration contributed to the formation of smaller nanoparticles. Experiments without washing from humic ligands are planned.

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