Cryogenic approach for production of biomedical nanocomposites: antibacterial drug dioxidine with silver nanoparticles

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A prospective approach to enhance a bioavailability of solid-phase drugs is particles size reduction down to nanoscale. In the nano state, another mechanism of penetration is possible - endocytosis, as well as different polymorph phases with enhanced saturation solubility and dissolution rate exist. Doping of drug nanoparticles with oligomers and nanoparticles of metals and their oxides makes it possible to enhance the antibacterial and anticancer activity of drugs, and can also be used for targeted delivery, for example magnetic drug delivery.

A new cryogenic technique has been used for obtaining nanoparticles. The process involves sublimation of initial drug powder and metal sheet, organization of two directed molecular beams intersecting on the surface, cooled with liquid nitrogen, where the condensation occurs. The method does not require additional precursors, in particular for the stabilization of nanoparticles.

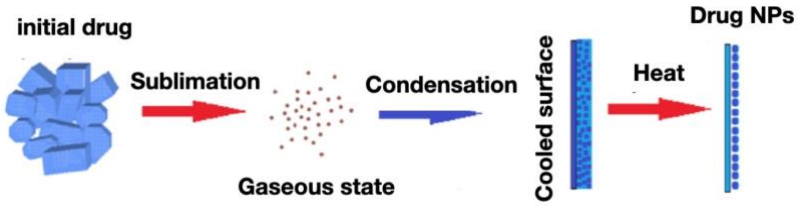

Fig. 1. Scheme of the experiment on cryogenic production of nanoparticles

In the framework of this study a series of experiments was carried out to obtain dioxidine nanoparticles with silver. The mass fraction of silver varied in the experiments. According to AEIR spectroscopy data, no new covalent bonds are formed in the dioxidine molecule during nanomodification. Upon results of the TEM, obtained samples are dioxidine composites with silver particles incorporated inside. The average dioxidine particle size is 100 nm, while the average size of incorporated silver particles is 3 nm. X-ray powder diffraction reveals dioxidine to form a metastable triclinic crystal lattice, unlike the original sample represented by an orthorhombic lattice. Also, at a low concentration of silver, reflexes corresponding to the joint crystalline form of silver and dioxidine clusters are observed on the diffractogram. The analysis of the dissolution kinetics showed a more than 4-fold increase in the dissolution rate, as well as an increase in saturation solubility (up to 20%). Studies of antibacterial activity by the disk-diffusion method have been carried out. The obtained sample demonstrates increased bioactivity up to 2 times in relation to the main pathogens compared with the sum of the bioactivity of silver and dioxidine separately. We assume the synergism of the action of silver and dioxidine: despite the complex mechanism of action of both substances, it is known that both dioxidine and silver disrupt DNA transcription.

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