STUDY OF THE MELTING TEMPERATURE OF SILVER NANOPARTICLES

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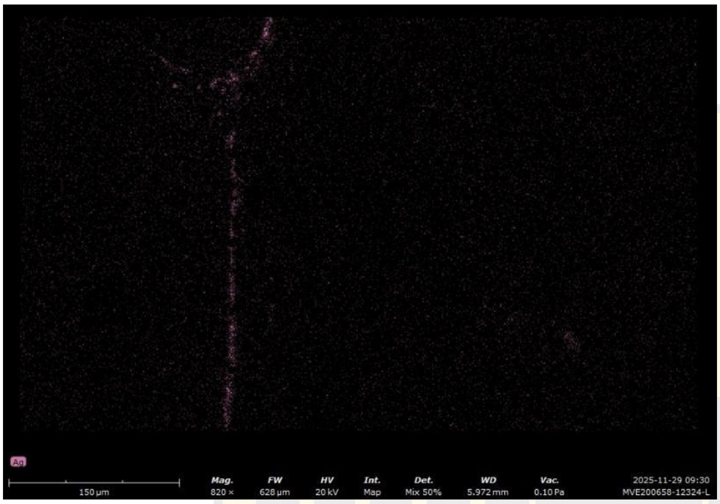
ABSTRACT

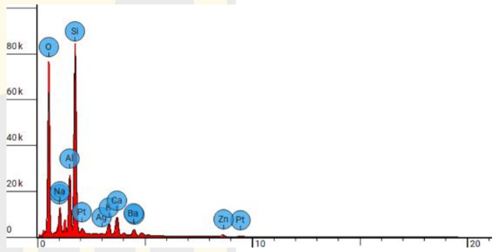
Analysis of the dependence of the melting temperature of silver nanoparticles on the nanoscale and the study of their antibacterial properties

Introduction: The study of the melting point of silver nanoparticles has important scientific significance in the development of printing electronics, conductive coatings, and low-temperature technologies, as well as in the creation of antibacterial coatings. With the transition to nanoscale, the thermal properties of materials change dramatically, and the melting temperature strongly depends on particle size, the degree of aggregation, and external energy sources. Molecular dynamics simulations showed that Ag nanoparticles with a size of 3 nm melt at 815 K. In another study, the melting temperature of Ag nanoparticles of various sizes was studied using molecular dynamic methods.The melting point for a nanoparticle with a size of 5 nm is 662.9 °C, 20 nm. It was 885.9 °C.[2] When very small Ag particles with a diameter less than 2.8 nm combine to form large cubic nanoparticles, they have been found to melt at an unusually high temperature. [3] Another study reported that silver nanoparticles melt at a melting point of 5 nm 663oCand 20 nm 886 oC.[4] The antibacterial properties of silver nanoparticles depend on the particle size. It is known that with a decrease in particle size, their biological activity increases. The greatest bactericidal effect of silver metal nanoparticles is achieved with nanoparticles with a diameter < 20 nm. [5]

When preparing a nanosuspensionof Ag nanoparticles with an average of 10-30 nm, synthesized by electrolysis, by spraying and drying on the surface of a ceramic tile, and then firing at a temperature of 700°C, the surface of the coating was observed by the Scanning Electron Microscope (SEM) device,which reflected the spatial distribution of silver on the surface. (1- Results) Ag was observed scattered across the entire surface, which indicates a regular and continuous distribution of silver nanoparticles along the coating. Silver particles cover almost the entire surface, large agglomerates do not predominate, i.e., Ag does not accumulate in the form of macroscopic droplets. The temperature of 700 °C activated the diffusion of Ag atoms along the surface and grain boundaries. A fine and active phase of Ag remained on the surface. This indicates the formation of a partially synthesized structure with high reactivity. Before firing, the average size of the silver nanoparticle in the nanosubstance was 10-30 nanometers. At 700°C, complete dissolution and adhesion were observed, and when studying the antibacterial properties of 1) staphylococcus aureus KOE106, 2) staphylococcus hemolytic, KOE105 3) lactose negative Escherichia coliKOE104, it was found that they were completely eliminated.In conclusion, the studied literature and the results of the study indicate that the melting temperature of Ag nanoparticles depends on the size and aggregation state.



	Element Number	Element Symbol	Element Name	Atomic Conc. [%]	Weight Conc. [%]
	8	O	Oxygen	68.56	52.10
	11	Na	Sodium	4.03	4.40
	13	Al	Aluminum	5.70	7.30
	14	Si	Silicon	17.01	22.70
	19	K	Potassium	1.29	2.40
	20	Ca	Calcium	1.94	3.70
	22	Ti	Titanium	0.26	0.60
	30	Zn	Zinc	0.48	1.50
	47	Ag	Silver	0.06	0.30
	56	Ba	Barium	0.41	2.70
	78	Pt	Platinum	0.25	2.30



Although a decrease in melting temperature was observed as the size decreased, it was found that in some cases, the clustering of nanoparticles leads to an increase in melting temperature. Ag nanoparticles, synthesized by electrolysis and having an initial size of 10-30 nanoscale, were partially sintered when dissolved at a temperature of 700°C, but the active Ag phase remained on the surface. SEM analysis showed a uniform and continuous distribution of silver on the coating surface. This structural state ensured effective release of Ag^+ ions and high antibacterial activity of the coating against bacteria. The obtained results indicate the prospects for the development of low-temperature technologies and effective antibacterial coatings based on Ag nanoparticles.

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