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«Amphiphilic polymers of N-vinylpyrrolidone and their protective properties during the formation of metal nanoparticles»

Ostaeva G.Yu., Morenko I.V., Isaeva I.Yu., Eliseeva E.A., Kuskov A.N.

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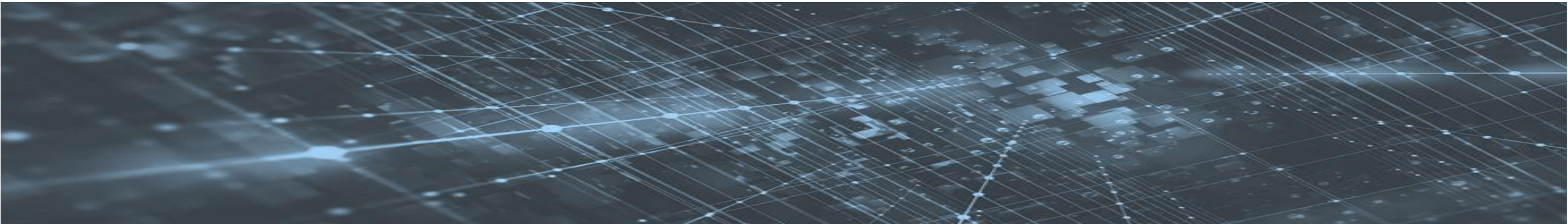
Problem statement

The convergence of nanotechnology with other fields of science and technology requires the search for new approaches to the creation of nanoscale ordered systems of inorganic particles and organic components for the development of nanomaterials designed to create effective and inexpensive catalysts, sensors, materials and reagents for biomedical applications.

Tasks

- Determination of the possibility of using amphiphilic polymers of N-vinylpyrrolidone as polymer protectors of metal nanoparticles.
- Pseudomatrix synthesis of copper and palladium sols in solutions of amphiphilic polymers of N-vinylpyrrolidone.
- Investigation of the influence of the structure of amphiphilic polymers on the formation of metal particles.
- Study of stability of the obtained sols in water and water-salt solutions.

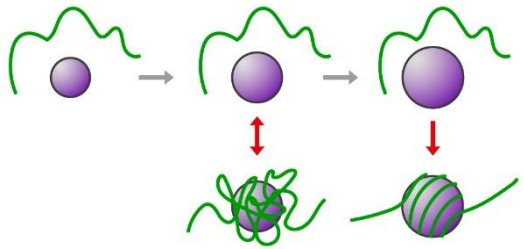


Methods

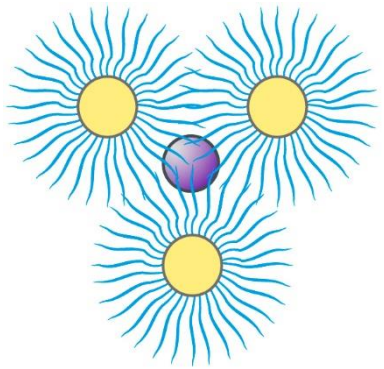
As polymer protectors, amphiphilic polymers with different molecular mass of the PVP block and the same hydrophobic block – the terminal n-octadecyl group were studied. Also polymers containing different hydrophobic blocks (residues of n-octylamine, n-dodecylamine, n-octadecylamine, di(n-octyl)amine, di(n-octadecyl)amine) with the same molecular mass of the hydrophilic block of PVP were investigated.

Reduction of metal ions with tert-butylamine-borane was performed in an aqueous solution of amphiphilic PVP and $CuSO_4$ or $PdCl_2$.

Transmission electron microscopy and electron spectroscopy were used to characterize the synthesis products.



Formation of a macromolecule-particle complex.



Stabilization of metal nanoparticles in solutions of amphiphilic polymers of N-vinylpyrrolidone.

Conclusions

The synthesized PVP amphiphilic polymers proved to be suitable polymer protectors of metal nanoparticles.

Stable copper and palladium sols were obtained.

Copper nanoparticles with a diameter of 4-12 nm or palladium particles with a diameter of 3-5 nm are formed in the presence of amphiphilic polymers. Nanoparticles are included in fairly large aggregates of micelles of amphiphilic polymers.

The stability of sols to irreversible aggregation and oxidation of metal particles increases with both the elongation of the hydrophilic block and the hydrophobic block.

The resistance to deposition and oxidation of metal nanoparticles formed in a solution of amphiphilic polymers and low-molecular electrolyte is significantly reduced.

Image of the amphiphilic polymer $PVP_{4000}OD$.

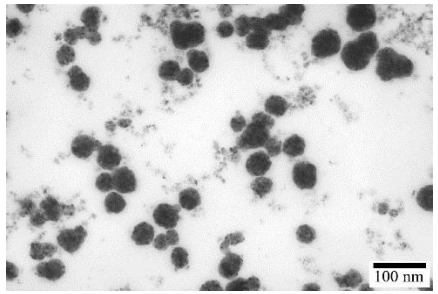


Image of copper sol obtained in $PVP_{4000}OD$ solution.

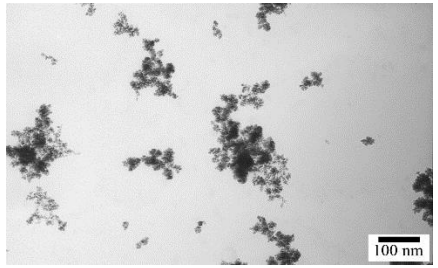


Image of palladium sol obtained in $PVP_{4000}OD$ solution.

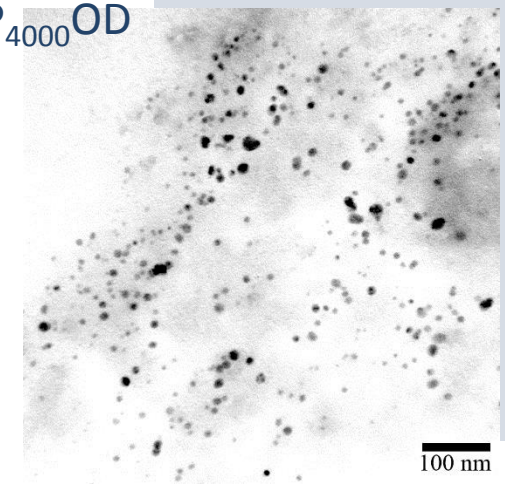


Image of copper sol obtained in $PVP_{4000}OD$ and NaCl solution.

Contacts

Ostaeva G.Yu. [1], Morenko I.V. [1], Isaeva I.Yu. [1], Eliseeva E.A. [1], Kuskov A.N. [2]

[1]Moscow Automobile and Road Construction State Technical University (MADI)

[2]Mendeleev University of Chemical Technology of Russia

E-mail: galinaostaeva@mail.ru

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