Physical characterization of copper-based nanoparticles properties and their effect on serum proteins

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Abstract

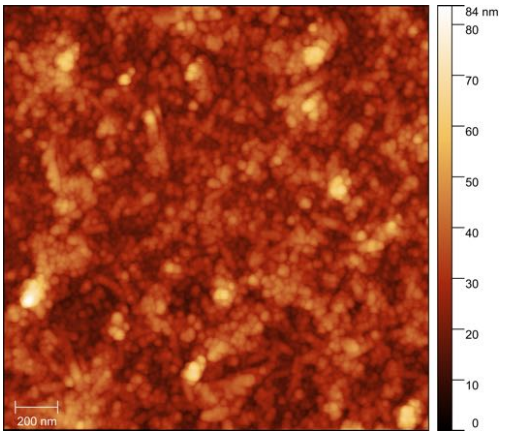
Metal and metal oxides nanoparticles (NPs) have attracted much attention in the nanoscience over the past decade due to their chemical and physical properties i.e. catalytic and antimicrobial activity [1,2]. Copper-based nanoparticles are released into the environment as a result of the processing of copper ores, industrial applications and, as a result, the combustion of fossil fuels [3]. This may lead to increased exposure of living organisms including human beings to Cu nanomaterials. Copper cations play a crucial role in several cellular functions i.e. it is involved in antioxidant defense and neurotransmitter synthesis. On the other hand, current evidence indicates that excessive levels of copper cause the generation of free radicals and occur in neurodegenerative diseases, such as Alzheimer Disease.

The main aim of our studies was to synthesize and characterize the copper as well as the copper oxide nanoparticles including the investigation of their interaction with bovine serum albumin (BSA) and human cystatin C (HCC). Serum albumins play an important role in transportation of drugs and nutrients through the body and human cystatin C is a protein possibly associated with Alzheimer disease thus it is very important to investigate the interaction between these proteins and copper-based nanoparticles.

Cu and CuO NPs of average size less than 50 nm have been synthesized by chemical reduction method according to procedures described by Sulce et al. [1] and Ahamed et al. [2]. Furthermore Cu NPs have been functionalized with ligands such as cysteine, proline and OH- to maintain their stability. UV-Vis spectroscopy, X-Ray diffraction (XRD), transmission electron microscopy (TEM) and atomic force microscopy (AFM) have been used to characterize the NPs. Circular dichroism (CD) studies and ThT fluorescence assay on plate reader have been utilized for the measurements of the interaction of NPs with BSA (CD) and aggregation HCC in the presence of NPs.

This research has been founded by grants 2017/27/B/ST4/00485 and 2021/41/B/ST4/03807 from National Science Centre (Poland).

Image



AFM picture of copper oxide (II) nanoparticles.

References

1. A. Sulce et al. (2016) Reactive oxygen species (ROS) formation ability and stability of small copper (Cu) nanoparticles (NPs), RSC Adv., 6, 76980-76988, DOI:10.1039/C6RA16599K
2. M. Ahamed et al. (2014) Synthesis, characterization, and antimicrobial activity of copper oxide nanoparticles, J. Nanomater., 2014, 1-4, DOI:10.1155/2014/637858
3. A. Talbi et al. (2018) Assessment of annual air pollution levels with PM1, PM2.5, PM10 and associated heavy metals in Algiers, Algeria, Environmental Pollution, 232, 252-263, DOI:10.1016/j.envpol.2017.09.041.
4. B. Tizon et al. (2010) Cystatin C Protects Neuronal Cells from Amyloid-β- induced Toxicity, Journal of Alzheimer's Disease, 19, 885-894, DOI: 10.3233/JAD-2010-1291
5. A. Szymańska et al. (2019) First studies on the interactions of the C- terminal cystatin C fragment 85–94 with Cu(II) ions, Journal of Coordination Chemistry, 72, 1-11, DOI: 10.1080/00958972.2019.1605065

Photograph



Biography

Karolina Rucinska is a PhD student in Biomedical Physics Department, Faculty of Physics, Adam Mickiewicz University in Poznan. In this work, she synthesized and characterized copper-based nanoparticles, which may have impact on serum protein possibly associated with Alzheimer Disease. She is interested in nanoscience and neurodegenerative diseases.

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Notes/Comments: