Bovine Serum Albumin-capped CuS nanoparticles prepared by a mechanochemical approach and their biological activity

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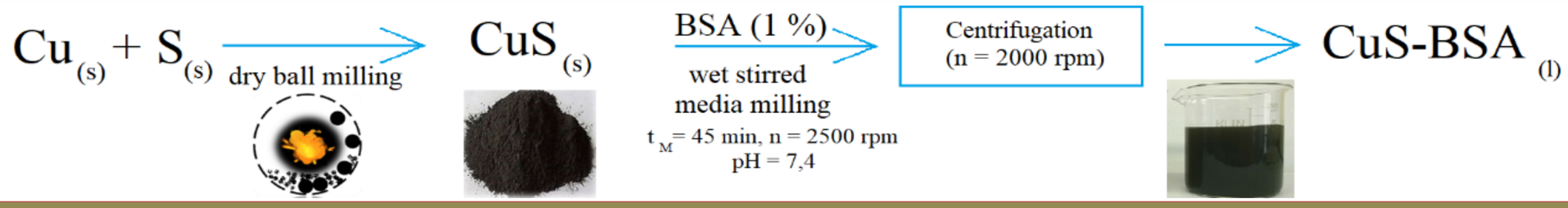
❖ INTRODUCTION

In recent years, the surface functionalization of nanoparticles has been intensively studied using biomolecules to control the synthesis and properties of nanoparticles. The programmable properties of biomolecules significantly improve the new functions of nanoparticles with the aim of achieving "intelligent" materials in biological applications [1]. Bovine Serum Albumin (BSA), protein abundantly present in mammalian plasma, is one of the most commonly used biomolecules as a nanoparticles capping agent [2]. Among different nanoparticles, copper sulfide (CuS) is a great candidate for biological applciations due to its low toxicity and excellent optical and electrical properties [3]. CuS-BSA nanoparticles are well-applicable in photothermal therapy [4]. Among many sytnhetic methods, mechanochemical synthesis stands out as a perspective alternative, well-usable for both CuS preparation [5], and also for introducing a biocompatible agent in the second step by the wet stirred media milling [6].

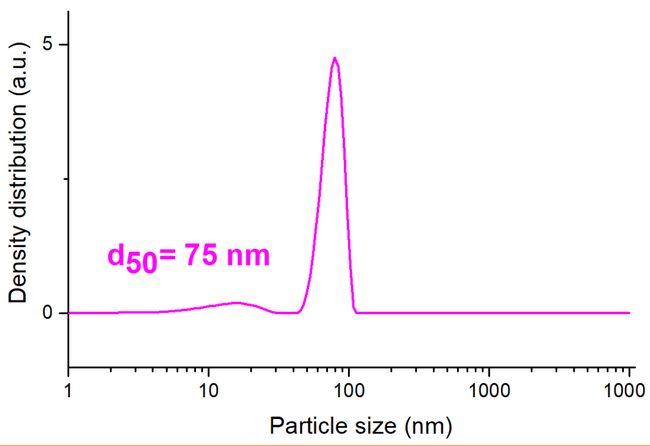
❖ EXPERIMENTAL PROCEDURES

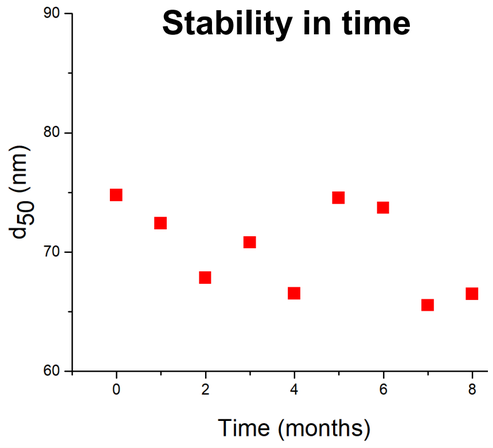


❖ RESULTS

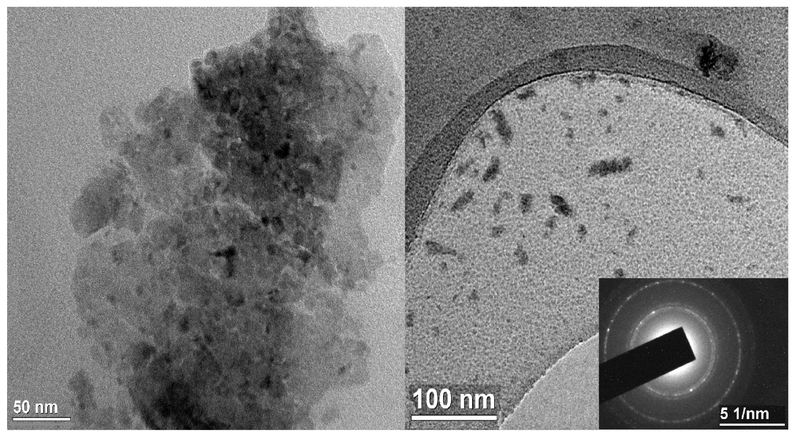
❖ PRODUCT CHARACTERIZATION

PHOTON CROSS-CORRELATION SPECTROSCOPY

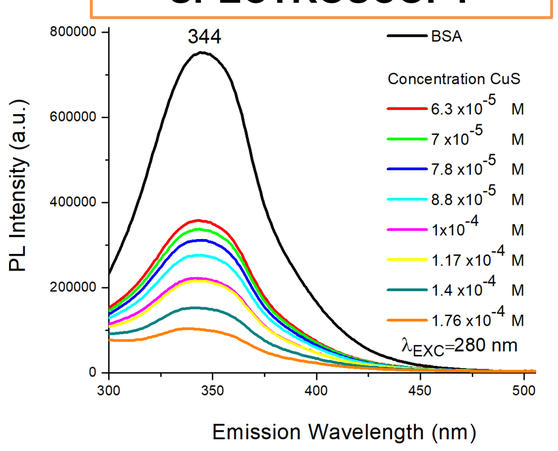




TRANSMISSION ELECTRON MICROSCOPY

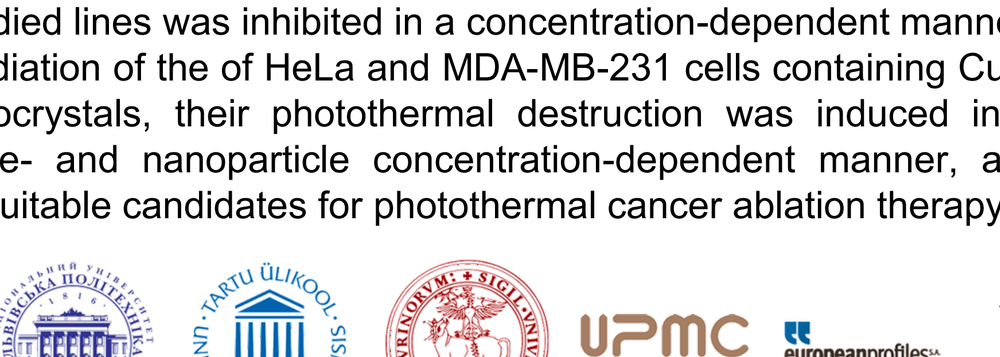


PHOTOLUMINESCENCE SPECTROSCOPY



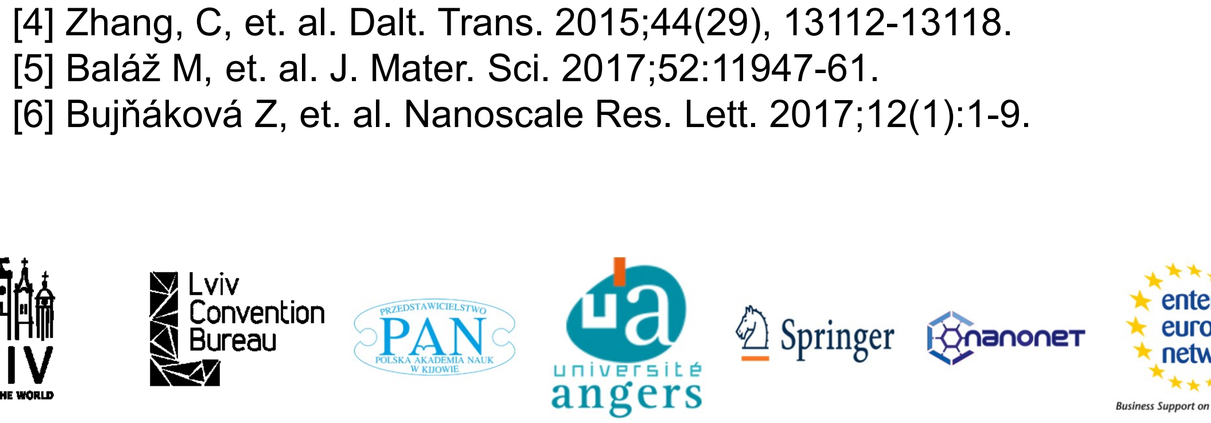
❖ BIOLOGICAL ACTIVITY

INHIBITION OF METABOLIC ACTIVITY



cell line	A-549	MDA-MB-231	MCF-7	Caco-2	HCT-116	HeLa
IC_{50}	37.7	20.9	17.7	46.6	31.9	16.4

PHOTOTHERMAL ABLATION



❖ CONCLUSION

- ✓ The stable CuS-BSA nanosuspension with unimodal particle size distribution with an average hydrodynamic diameter of 75 nm was prepared.
- ✓ Good optical properties and nanocrystalline character of the sample were confirmed by photoluminescence spectroscopy and transmission electron microscopy, respectively.
- ✓ The cell viability and anticancer activity is dependent on the concentration of CuS-BSA nanocrystals. The metabolic activity of all tumor studied lines was inhibited in a concentration-dependent manner.
- ✓ Upon irradiation of the of HeLa and MDA-MB-231 cells containing CuS-BSA nanocrystals, their photothermal destruction was induced in a laser dose- and nanoparticle concentration-dependent manner, and they are suitable candidates for photothermal cancer ablation therapy.

❖ ACKNOWLEDGEMENTS

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❖ REFERENCES

[1] Oh J-H, et. al. Anal. Bioanal. Chem. 2015;407:8627-45.
[2] Carter DC, Ho JX. Adv. Protein Chem. 1994;45:153-203.
[3] Goel, S, et. al. Small, 2014;10(4):631-645.
[4] Zhang, C, et. al. Dalt. Trans. 2015;44(29), 13112-13118.
[5] Baláž M, et. al. J. Mater. Sci. 2017;52:11947-61.
[6] Bujňáková Z, et. al. Nanoscale Res. Lett. 2017;12(1):1-9.