# BIOCOMPATIBLE CARBOXYLATED $CuInS_2$/ZnS QUANTUM DOTS FOR BRAIN TUMOR DIAGNOSTICS

Viktoras Mažeika[1,2], Dominyka Dapkutė[1,2], Artiom Skripka[3], Riccardo Marin[3], Patrizia Canton[4], Fiorenzo Vetrone[3], Vitalijus Karabanovas[2,5]

[1] Life Sciences Center, Vilnius University, Saulėtekio av. 7, LT-10257, Vilnius, Lithuania
[2] Biomedical Physics Laboratory, National Cancer Institute, P. Baublio 3B, LT-08406, Vilnius, Lithuania
[3] Institut National de la Recherche Scientifique, Centre Énergie, Matériaux et Télécommunications, Université du Québec, 1650 Boulevard Lionel-Boulet, Varennes, Quebec, Canada
[4] Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Via Torino 155/b, I-30170, Venezia-Mestre, Italy
[5] Department of Chemistry and Bioengineering, Vilnius Gediminas Technical University, Saulėtekio av. 11, LT-10223 Vilnius, Lithuania
vitalijus.karabanovas@nvi.lt

Despite ongoing research on its therapy and diagnostics, cancer still remains one of the leading causes of death. Currently used imaging methods, mainly computed tomography (CT) and magnetic resonance imaging (MRI), allow for effective diagnostics of cancer, but the equipment is expensive and requires extensive training to be used effectively. Therefore, other diagnostic techniques are being explored for possible application. Among them, optical methods, such as fluorescence spectroscopy, have the advantage of requiring cheaper equipment which is not as difficult to use as CT and MRI. They also allow intraoperative use as a visual aid for surgeons [1].

Even though optical techniques possess some advantages over currently used cancer diagnostic methods, they have several drawbacks which cannot be ignored. Poor stability in biological media and low quantum yield of organic dyes used for imaging limit the application of these techniques. Such issues could be solved by using quantum dots (QDs). These nanoparticles possess superior optical properties and stability compared with organic dyes [2]. In addition, QDs can be modified to allow for better targeting of tumors or to combine them with therapeutic compounds, developing a theranostic (therapy + diagnostics) platform.

In this work, we investigated the potential use of carboxylated $CuInS_2$/ZnS QDs for cancer diagnostics. These QDs are free of toxic heavy metals, such as cadmium or lead, thus being better suited for biological applications. Optical and morphological properties of $CuInS_2$/ZnS QDs, as well as their stability in different media, were investigated. We also studied their accumulation in cancer cells, their effect on cell viability and overall biocompatibility. U87 glioblastoma cell line was selected for these experiments, as diagnostics and treatment of brain tumors using optical methods still remain a challenge. The main obstacle is the difficulty of transporting dye molecules through the blood-brain barrier (BBB). QDs could be used to overcome this problem, as they can be modified to allow easier passage through the BBB [3]. Results of the experiments show the potential of $CuInS_2$/ZnS QDs as agents for cancer diagnostics.

[1] F. Vasefi, N. MacKinnon, D. L. Farkas and B. Kateb, Review of the potential of optical technologies for cancer diagnosis in neurosurgery: a step toward intraoperative neurophotonics, Neurophotonics **4**, 011010 (2016).
[2] K.J. McHugh, L. Jing, A.M. Behrens et al., Biocompatible Semiconductor Quantum Dots as Cancer Imaging Agents, Advanced Materials **30**, 1706356 (2018).
[3] Y. Liu, J. Liu, J. Zhang et al., Noninvasive Brain Tumor Imaging Using Red Emissive Carbonized Polymer Dots across the Blood–Brain Barrier, ACS Omega **3**, 7888–1896 (2018).