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The story of how mitoxantrone chose his friends: Surface interaction and semiconductor quantum dots luminescence quenching for mitoxantrone detection

As the rapid growth of the cancer research field, the development of new analytical methods for the sensitive detection of anticancer drugs possesses an important significance. Mitoxantrone (MTX), as one of anthracycline drugs, is usually used for the treatment of solid tumors such as metastatic breast cancer, acute myeloid leukemia, and non-Hodgkin's lymphoma. The most effective method for the determination of MTX in biological objects is HPLC with tandem mass spectrometry, however, this makes analysis more expensive. In recent decades, other methods for detecting MTX have been developed, based on different principles: chemiluminescent; electrochemical; and enzyme-linked immunosorbent assays; Raman scattering techniques and luminescence quenching. Compared to the methods described above, luminescence spectroscopy is considered a promising strategy as it is simple, easy to use and does not require complex pre-processing. Luminescence spectroscopy to detect MTX can be a good alternative to HPLC.

Developing of a simple and fast method for the detection of MTX can greatly simplify routine laboratory testing. This can be done using an approach based on quenching the luminescence of quantum dots (QDs). To do this, it is necessary to select QDs with significant quenching of their luminescence in the presence of MTX. A detailed study of the process of their interaction will optimize the analysis. Two types of semiconductors luminescent QDs were studied as detector systems, sensitive to MTX presence: (i) series of size-selected fractions of non-cadmium AgInS/ZnS QDs with a wide emission spectrum and long lifetime and (ii) alloyed CdZnSeS and CdZnSeS/ZnS QDs with a narrow emission spectrum and short lifetime. This made it possible to evaluate the effect of the QDs composition on the efficiency of luminescence quenching by MTX. The shelling of initial semiconductor cores (AgInS or CdZnSeS) with ZnS improves the luminescent core passivation and quantum yield. Thioglycolic acid molecules were chosen as surface ligands because they can form a thin monolayer hydrophilic coating.

For both types of QDs the dependence of the luminescence intensity and lifetime from MTX concentration was studied. Presumably, the quenching process occurs predominantly by a static mechanism. MTX limits of detection 3 and 5 nM were achieved for AgInS/ZnS and CdZnSeS/ZnS QDs, respectively. Thus, the application luminescent QDs as a direct detector system greatly accelerates and simplifies the detection of the anthracycline cytostatic agent MTX.

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