11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Biocompatible Water Soluble Quantum Dots as Human Lymphocytes Cells Labels – Applications for Flow Cytometry

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Abstract – We have synthesized water soluble CdTe/CdS quantum dots using two types of stabilizing agents (mercaptoacetic acid and mercaptopropionic acid) and applied them as fluorescent labels of lymphocyte cells. We have monitored quantum dots-cell interaction by using conventional and confocal fluorescent microscopy as well as flow cytometry. Our method shows that quantum dots are a promising class of fluorescent probes and can be conjugated to a variety of specific cell antibodies and can become a potential and low cost diagnostic tool for flow cytometry in blood analyses.

Luminescent semiconductor quantum dots (QDs) are a promising class of materials as markers of biological systems. Compared to organic fluorophores, QDs have an exceptional resistance to photodegradation, narrower photoluminescence with high quantum yield and broader absorption bands. Their highly active chemical surface allows them to be chemically manipulated according to the desired target molecule (e.g. proteins, peptides, organic and inorganic polymers, DNA and carbohydrates) in a biological system [1]. For this reason, simple, cheap and reproducible routes of QDs´s synthesis are the main goal of many research groups around the world.

The main objective of this work was to demonstrate the ability of our biocompatible water soluble CdTe/CdS QDs as biolabels for flow cytometry analysis. The synthesis of CdTe/CdS QDs was done using mercaptoacetic acid (AMA) and mercaptopropionic acid (AMP) as stabilizing agents. AMA and AMP also act as functionalizing agents. The resulting CdTe/CdS QDs can target biological membrane proteins and can also be internalized by cells. We applied the CdTe/CdS QDs as fluorescent biolabels of human lymphocytes. We compared the results obtained for lymphocytes treated and non-treated with permeabilizing agents for cell membranes.

Cells were analyzed by conventional and confocal fluorescence microscopy and also by flow cytometry. Figure 1(a) shows a fluorescent microscopic image of lymphocytes (excitation: 480 nm). Permeabilized cells present a higher fluorescent pattern than non permeabilized ones. Figure 1 (b) shows a representative flow cytometry analysis, using CdTe/CdS-AMA, of lymphocytes non-treated with permeabilizing agents. The fluorescence was detected in 532 nm – FL1-H channel, almost all cells were labeled by QDs. The CdTe/CdS-AMP QDs presented lower fluorescence intensity than CdTe/CdS-AMA QDs, but the CdTe/CdS-AMP QDs are more stable in physiological pH.

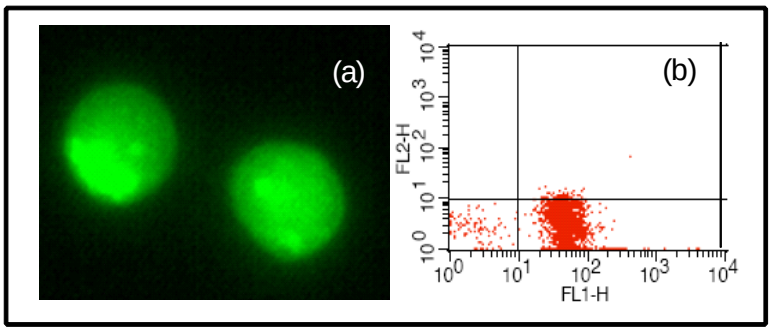

Figure 1: a) Fluorescent image of Lymphocytes labeled with CdTe/CdS. **b)** Flow cytometry analysis of lymphocytes non-treated with permeabilizing agents labeled with CdTe/CdS-AMA. The fluorescence was detected in 532 nm – FL1-H channel.

The synthesis presented by our experimental methods was achieved by applying a low cost, fast, precise and highly reproducible methodology. The results obtained point for QDs as a high efficient label for flow cytometry, very compatible with the lasers and filters used in this kind of equipments. These QDs can be conjugated to a variety of specific cell antibodies to become a potential and low cost diagnostic tool for flow cytometry in blood analyses.

[1] X. Michalet, F. F. Pinaud, L. A. Bentolila, J. M. Tsay, S. Doose, J. J. Li, G. Sundaresan, A. M. Wu, S. S. Gambhir, and S. Weiss, Science 538 (2005), 538-544.