Photosensitization of phthalocyanine-ruthenium compounds conjugated to CdTe-quantum dot as potential theranostic agents

Tássia J. Martins[1](PG), Leandro N. C. Máximo[1](PG), Laísa B. Negri(PG), Nicholas R. S. Gobo[3](PG), Juliana C. Biazzotto[2](PG), Kleber T. de Oliveira[3](PQ), *Roberto S. da Silva[2](PQ).

***silva@usp.br**

[1] *Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto - FFCLRP/USP.*
[2] *Faculdade de Ciências Farmacêuticas de Ribeirão Preto – FCFRP/USP.*
[3] *Departamento de Química – Universidade Federal de São Carlos.*

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Introduction

Photodynamic therapy (PDT) is a medical treatment that consist in activate a photosensitizer by visible light irradiation, in the presence of molecular oxygen producing reactive oxygen species against cancer cells[1]. In this context, there is great need for the technologies of PDT to expand its use to various cancer types. We have studied the use of PDT as either replacement cancer therapy and as activatable theranostic agents to be applied in a suitable animal model. To achieve this goal we found that phthalocyanine-ruthenium compounds ([Ru(Pc-R)]) bonded to quantum dots (QD) is a very promising molecular system. The synthesis of [Ru(Pc-R)]---QD will allow us to assess the energy transfer process among both sites and its effect under singlet oxygen production as well mapping the subcellular localization. Thereby, we present in this work the synthesis and characterization of novel substituted [Ru(Pc-R)], photochemical, photobiological studies and interaction assays with CdTe-MPA quantum dots.

Results and Discussion

[Ru(Pc-NH_2)] (figure 1) was characterizated by mass spectrometry, infrared and UV-vis spectroscopy.

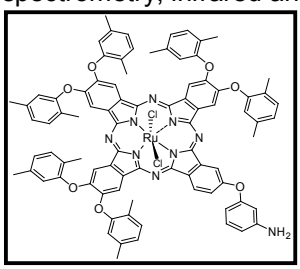

Figure 1. Chemical structure of substituted ruthenium phthalocyanine RuPcR.

The mass spectrometry shows a *m/z* sign in 1512,466 atributted to [RuCl(Pc-NH_2)]. The UV-vis spectrum exhibits characteristic intraligand bands of phthalocyanines at 320 and 630 nm. The infrared spectrum shows bands in 1585 cm^{-1} (δ NH_2), 1219 cm^{-1} (ν C-O), 774 cm^{-1}(substituted aromatic ring). Some photophysical and photochemical properties of [Ru(Pc-R)] like compounds are showed on table 1.

The fluorescence quenching of CdTe-MPA quantum dots by [Ru(Pc-NH_2)] showed a linear shape suggesting that only one process occur. By the process centered on phthalocyanine fluorescence, no variation in intensity was observed by change QD concentration.

Table 1. Parameters of [Ru(Pc-R)] compounds.

Compound	Fluoreresence Quantum yield	$^1\Delta O_2$	K_{SV}
[Ru(Pc-R)	4.1 x 10^{-3}	0.09	6.5x10^4
[Ru(Pc)	3.0 x10^{-2}	0.45	-

Biological assays with [Ru(Pc-R)] in melanoma cancer cell line could be observed by fluorescence microscopy pointed out by internalization process (figure 2).

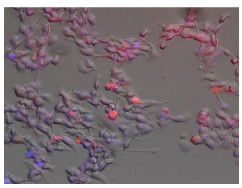

Figure 2. Fluorescence microscopy of [Ru(Pc)] compound in B16F10 cells.

Cell viability was found to decrease by light irradiation process and dependent on the energy and laser potency. For [Ru(Pc)], for example, a value of 25 % was described.

Conclusions

[Ru(Pc-R)] compounds are active against cancer cells. The cell viability depends on the subcellular localization as well of $^1\Delta O_2$. Energy transfer process could be observed in quantum dot function.

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[1] K. Ishii, M. Shiine,Y. Shimizu, S-I Hoshino, H. Abe, K. Sogawa, N. Kobayashi, J. Phys. Chem. B, 2008, 112, 3138-3143.