Bimodal nanoprobes based on cationic quantum dots and Gd^{3+} chelates prepared by covalent and dative bonds for optical and magnetic resonance imaging

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INTRODUCTION

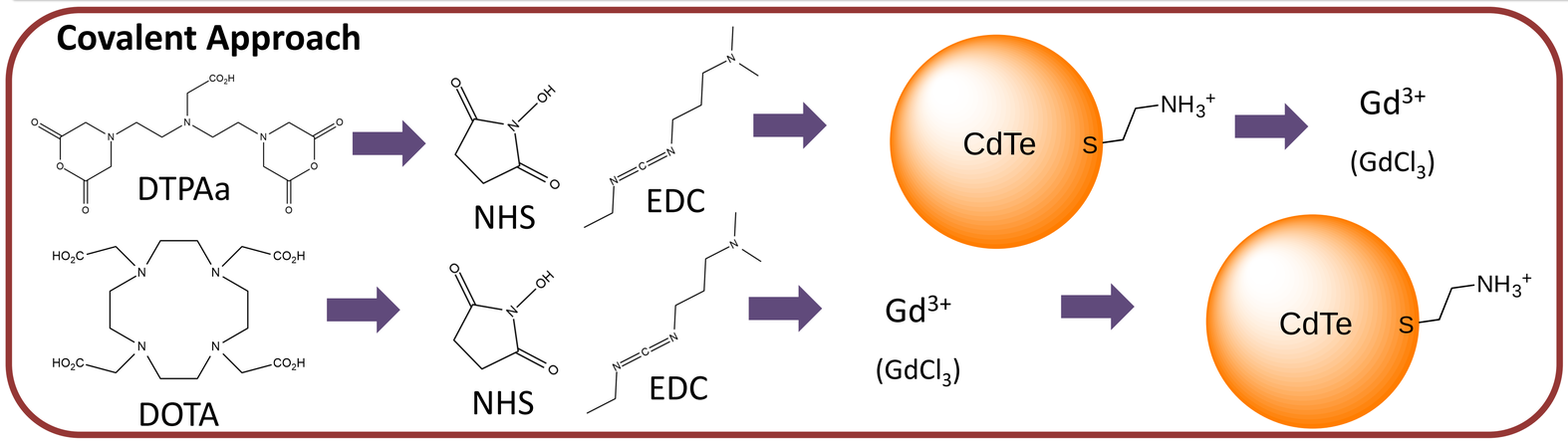
Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic technique that allows the visualization of soft tissues. Despite offering advantages over other methods, it has low sensitivity, making it necessary sometimes to use contrast agents (CAs). To improve de CAs efficiency, new strategies have been developed. Among them are the bimodal systems that associate nanoparticles and gadolinium chelates.[1]

Quantum dots (QDs) are fluorescent nanoparticles, made of semiconductor material, that have unique optical properties. These nanoparticles have been widely used in biomedicine, because they have an active surface, allowing conjugation with (bio)molecules. Thus, they can contain a large number of Gd^{3+} complexes on their surface, consequently increasing the contrast enhancement.[2]

In this work, CdTe QDs functionalized with cysteamine were conjugated to gadolinium complexes (DOTA e DTPA), obtaining bimodal systems with optical and paramagnetic properties.

METHODOLOGY

Covalent Approach



Covalent

System A1: 1) DTPAa + EDC+NHS; 2) QD; 3) Gd^{3+}

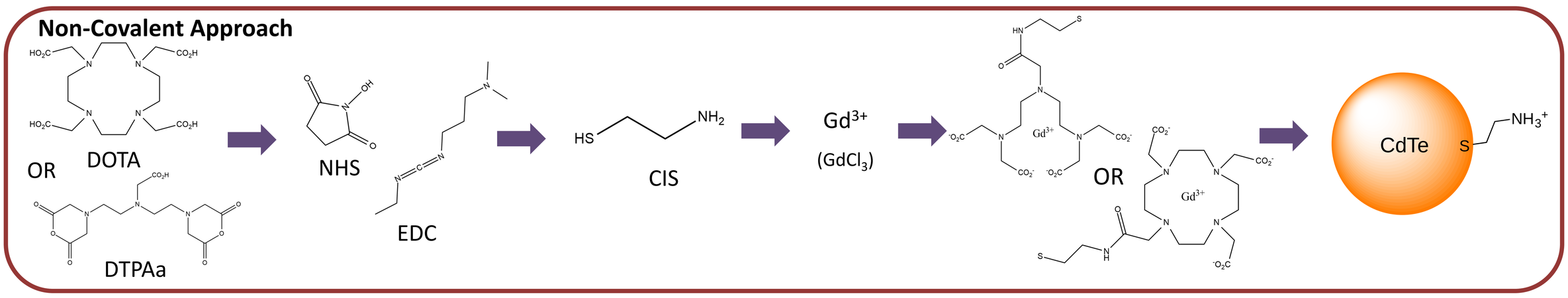
System A2: 1) DOTA + EDC+NHS; 2) Gd^{3+} ; 3) QD

Non-covalent

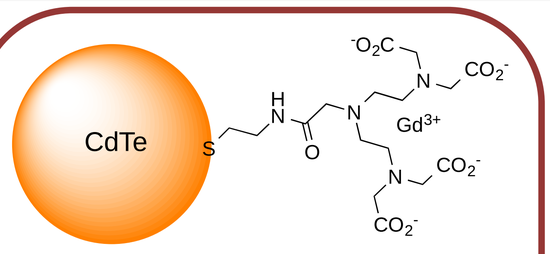
System C1: 1) DTPAa + EDC+NHS; 2) CIS; 3) Gd^{3+}; 4) QD

System C2: 1) DOTA + EDC+NHS; 2) CIS; 3) Gd^{3+}; 4) QD

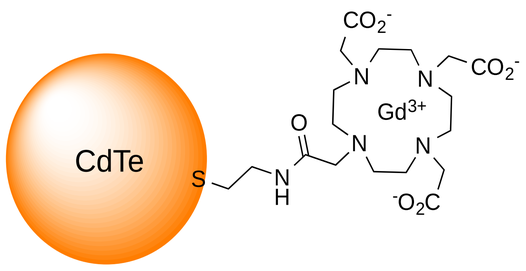
Non-Covalent Approach



RESULTS

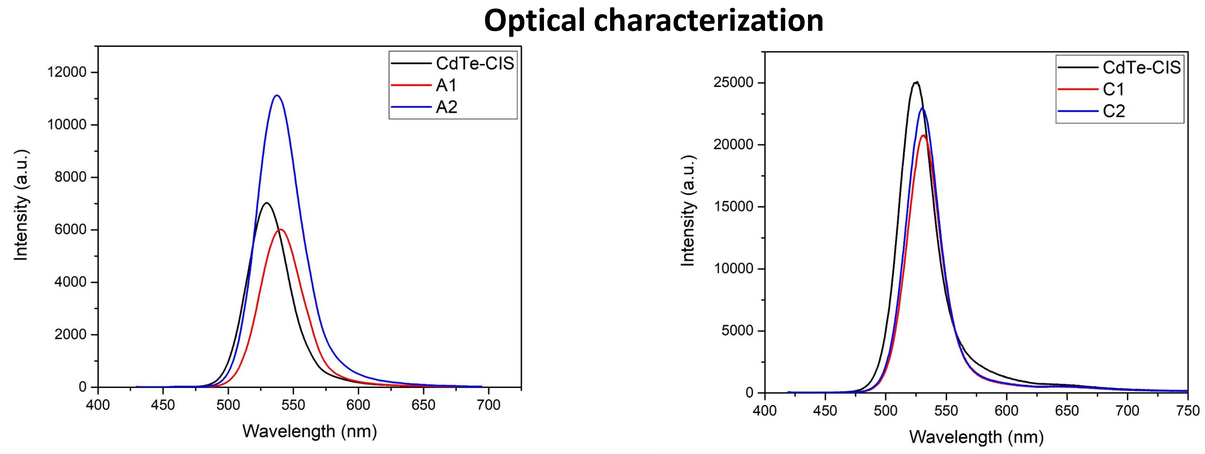


CdTe-DTPA-Gd
(A1 e C1)



CdTe-DOTA-Gd
(A2 e C2)

Optical characterization



Relaxometric characterization

Systems	T_1 (ms)	r_1^* ($mM^{-1}s^{-1}$) Per Gd	r_1^* ($mM^{-1}s^{-1}$) Per QD
CdTe-CIS	3630	-	-
A1	1710	7,3	29,5
A2	1376	13,7	43,1
C1	1750	6,2	25,1
C2	2400	3,3	10,3

$$r_1 = \frac{1}{T_1 \times [Gd^{3+}]}$$

CONCLUSION

For CdTe-DTPA-Gd systems, it was not observed a significant difference between the two methodologies. However, for the bimodal systems CdTe-DOTA-Gd, the covalent approach seems more adequate, since the relaxometric properties were enhanced, giving CAs with a relaxivity value of 3 times higher thant the clinically used DOTA-Gd. The results obtained showed that these systems are promising bimodal agents for biological studies by fluorescence and MRI.

References:

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[2]Pereira, G.; Leite, E. S.; Pereira, G. A. L.; Fontes, A.; Santos, B. S. Quantum Dots. In: Margarita Sanchez-Dominguez, Carlos Rodriguez-Abreu. (Org.). *Nanocolloids*. 1ed.: Elsevier, 2016, 1, 131-158.

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