RUTHENIUM COMPLEXES ENCAPSULATED IN NANOSTRUCTURED SOL-GEL SILICA MATRICES

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Ruthenium complexes are very promising as anti-tumoral drugs, due to their selective activity and reduced cytotoxicity when compared to the traditional platinum complexes, widely used in chemotherapy [1]. On the other hand, it is a prime concern to specifically attack the malignant cells causing minimum collateral effects, which is attainable by targeted controlled delivery of the drugs encapsulated in nanoporous materials. The ideal carrier must be bioresorbable, with non-toxic degradation products, and assure a drug release kinetics that meets the treatment requirements.

The sol-gel process emerges as a very promising approach to synthesise those devices, given the fact that it is soft and versatile. The drugs may be encapsulated during the synthesis without risking decomposition and the capability to synthesize nanostructured matrices with tailored properties has been extensively stressed [2]. In the case of silica, an adequate control of the synthesis parameters allows producing materials ranging from dense xerogels to very light aerogels, from hydrophilic to highly hydrophobic, with very different porous structures and dimensions [3]. This potential justifies the recent interest in using sol-gel silica matrices to the encapsulation of catalysts and pharmaceutical drugs, in the first case to enhance the catalytical performance and in the latter to eventually use those devices in controlled drug delivery [4].

The purpose of the present work is to mimetize a controlled drug delivery system by encapsulating Ru complexes in nanoporous sol-gel silica matrices and, in a first stage, to characterize the structural modifications induced by the dopant on the matrix and vice-versa.

The following Ru complexes were rehearsed:

- HexaamineRu(III) chloride $[Ru(NH_3)_6]Cl_3$;
- Triruthenium dodecacarbonyl $[Ru_3(CO)_{12}]$;
- Ruthenium(III) nitrosylnitrate $[RuNO(NO_3)_3]$;
- Ruthenium(III)chloride oxide, ammoniated, or ruthenium red, $[(NH_3)_5RuORu(NH_3)_4ORu(NH_3)_5]Cl_6$.

They are schematized in Figure 1.

The pure Ru complexes were earlier characterized by diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) and diffuse reflectance UV-Vis spectroscopy. In aqueous solution, infrared attenuated total reflection (ATR) and UV-Vis spectroscopies were used.

The silica matrices with and without complexes were prepared using tetraethylorthosilicate (TEOS) as precursor and iso-propanol as the co-solvent, by a two step process, consisting

of acid hydrolysis and neutral condensation. Given the low solubility of some of the Ru complexes in the initial sol, an important parameter under study was the water/TEOS molar ratio.

Other parameters explored were the catalysis conditions, the complex concentration with respect to silica, the stage of incorporation and the drying velocity.

All the matrices were thoroughly characterized by diffuse reflectance infrared and UV-Vis spectroscopies, and also by nitrogen gas-solid adsorption isotherms and envelope density measurements.

It was possible to conclude that the encapsulation of the Ru complexes, even in small contents, increased the gelation times and induced modifications in the silica structure.

The complexes hexaaminoruthenium and Ru-red undergo redox reactions as the sol-gel process occurs, contrarily to triruthenium dodecacarbonyl and ruthenium(III) nitrosylnitrate, which only interact with the matrix.

In the case of triruthenium dodecacarbonyl a preferential orientation within the matrix pores is proposed .

References:

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[3] A. Fidalgo, M. E. Rosa, L. M. Ilharco, Chem. Mater., **15** (2003) 2186.
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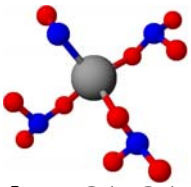
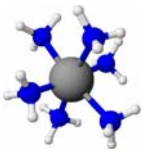
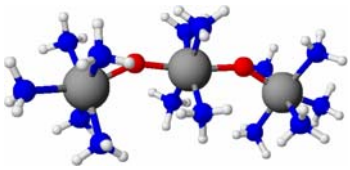
Figure 1: Schematic structures of the ruthenium complexes under study



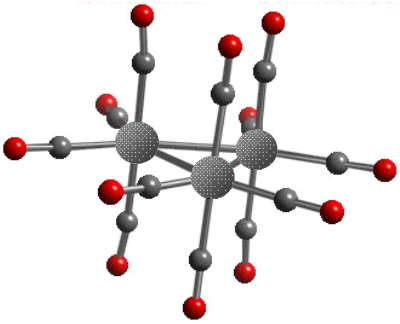
$[RuNO(NO_3)_3]$



$[Ru(NH_3)_6]^{3+}$



$[(NH_3)_5RuORu(NH_3)_4ORu(NH_3)_5]^{6+}$



$[Ru_3(CO)_{12}]$