DEVELOPMENT OF HYBRID NANOSTRUCTURE BASED ON RUTHENIUM AND NIOBIUM NANOPARTICLES FOR USE IN FILTER MEMBRANE

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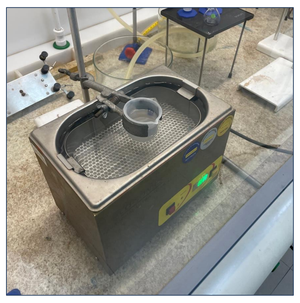
INTRODUCTION

- Carbon quantum dots (CQDs) are nanoscale carbon-based materials known for their photoluminescence, chemical stability, and biocompatibility. Their unique properties make them ideal for enhancing hybrid nanostructures, improving conductivity, reactivity, and overall stability. When combined with metals like ruthenium and niobium, these materials can revolutionize filtration membrane performance.
- Filtration membranes are critical in separating contaminants from liquids or gases, playing a vital role in water purification, air quality control, and industrial processes. The development of membranes incorporating advanced nanostructures offers the potential for improved efficiency, durability, and selectivity, directly addressing global environmental challenges.
- This research has significant environmental implications, particularly in mitigating pollution and reducing energy demands in filtration processes. By enabling cleaner water and air, these technologies contribute to the sustainability of ecosystems and align with global goals for a greener future.
- Furthermore, the synthesis of hybrid nanostructures follows green chemistry principles, emphasizing waste reduction and environmentally friendly methods. Replacing less sustainable materials with nanostructured alternatives ensures a lower ecological footprint.
- The correlation with sustainable energy systems is notable, as clean water and air are essential for maintaining renewable energy sources like hydropower. This study highlights how nanotechnology and sustainability intersect to advance environmental science and green innovation.

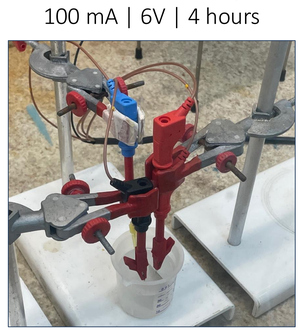
METHODOLOGY

Synthesis of Cdots and Ruthenium Nanoparticles

EtOH + NaOH
US 20 min

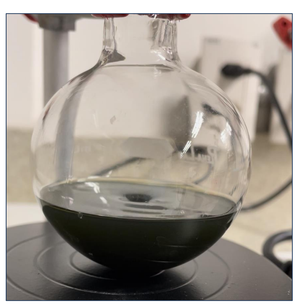


Chronoamperometric Voltammetry
100 mA | 6V | 4 hours



CDots

EtOH + $RuCl_3$ + CDots
Agitation | 4 hours

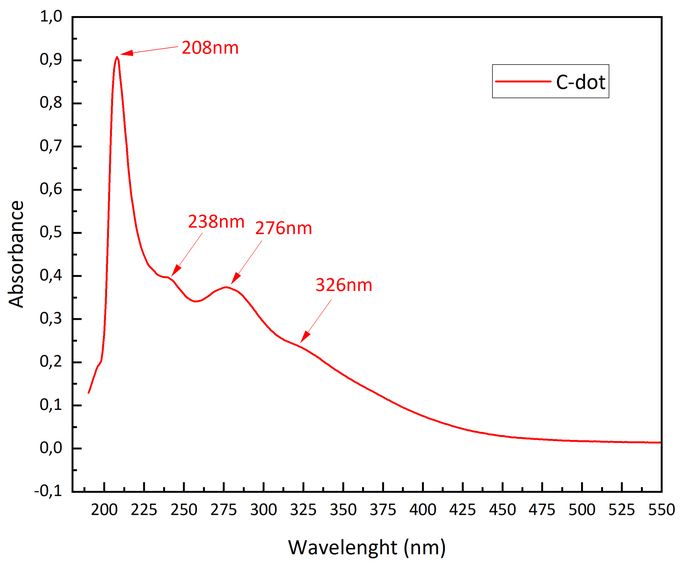


Application in Membranes

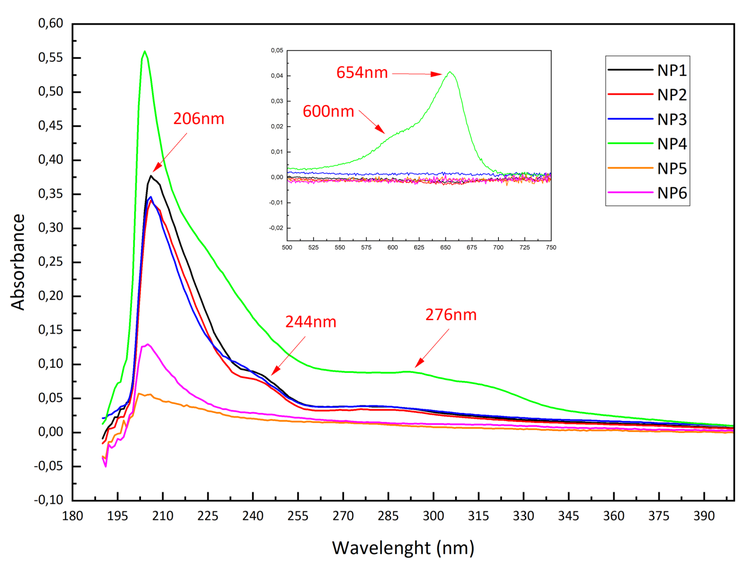
- Membranes
  - Cellulose
  - Nylon
- Analytes
  - Methylene Blue
  - Bisphenol A
  - Methyl Orange
- Deposition
  - MnD (membrane with n 0.5mL depositions)
  - MIS (*in situ* membrane deposition)

PRELIMINARY RESULTS

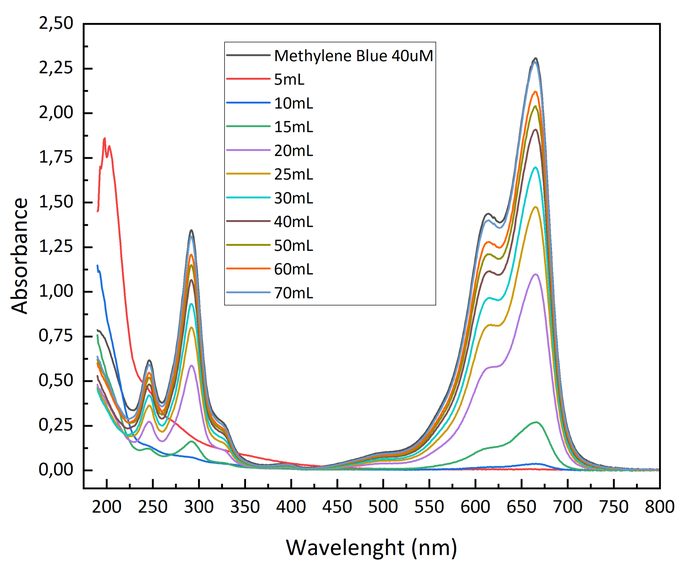
UV-Vis spectrum of the CDots



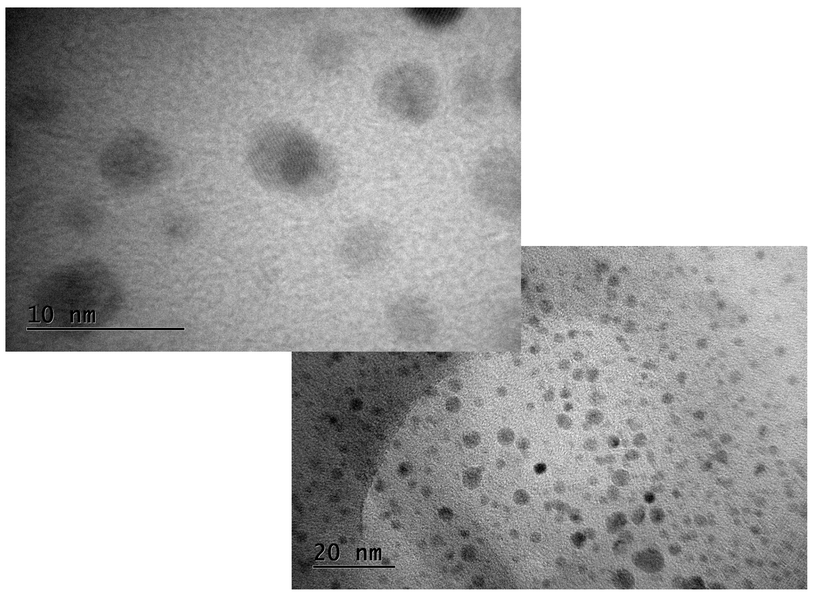
UV-Vis spectrum of the Ru Nanoparticles



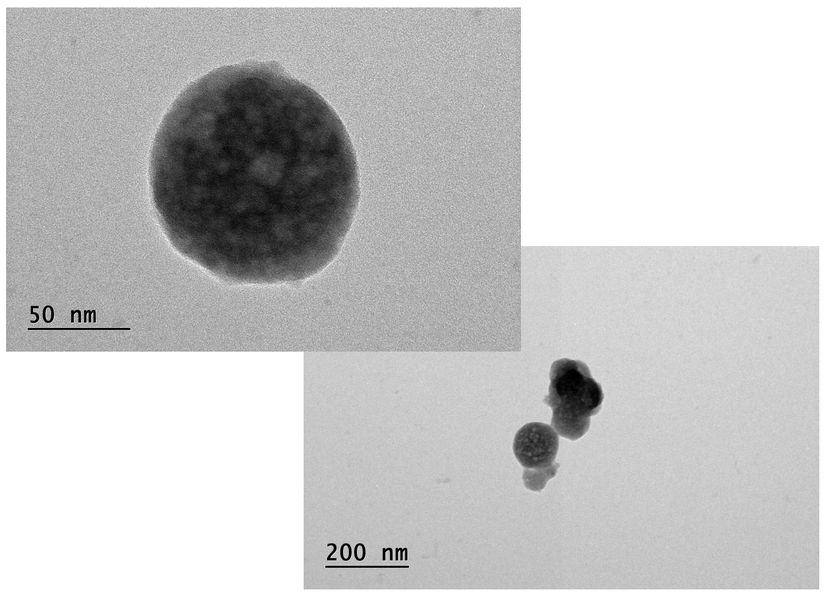
UV-Vis spectrum the Methylene Blue saturation test



TEM images of the CDots



TEM images of the Ru Nanoparticles



Saturation test of Methylene Blue in the modified membrane

Volume (mL)	Absorbance	Concentration (uM)	Retention
0	0,0000	0,0000	100,00%
5	0,0079	0,1368	99,66%
10	0,0371	0,6426	98,39%
15	0,2685	4,651	88,37%
20	1,0987	19,03	52,42%
25	1,4746	25,54	36,14%
30	1,6973	29,40	26,50%
35	1,7935	31,07	22,33%
40	1,908	33,05	17,37%
45	2,0069	34,76	13,09%
50	2,0409	35,35	11,62%
55	2,1064	36,49	8,78%
60	2,1208	36,74	8,16%
65	2,1477	37,20	6,99%
70	2,2825	39,54	1,16%
75	2,2396	38,79	3,01%
80	2,2115	38,31	4,23%
85	2,2336	38,69	3,27%
90	2,2557	39,07	2,32%
95	2,2065	38,22	4,45%
100	2,2989	39,82	0,45%
Blank Solution 40uM	2,3092	40,00	0,00%

CURRENT STATUS & NEXT STEPS

- The synthesis of the Carbon Quantum Dots and the Ruthenium Nanoparticles was as expected. Next, Niobium will me used to test the synthesis as well;
- The preliminary tests of filtration with Methylene Blue were satisfactory. The next steps include improve the volume filtrated and avoid bleeding of the material to the water;
- Further characterizations of the materials synthesized will be made;
- New membranes and materials such as sugarcane bagasse and bamboo powder are going to be tested as the substrate for the filter;

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CAPES
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