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Solar-driven photocatalytic degradation of amoxicillin using TiO_2/Carbon Quantum Dots nanocomposites immobilized in electrospun polycaprolactone fibers

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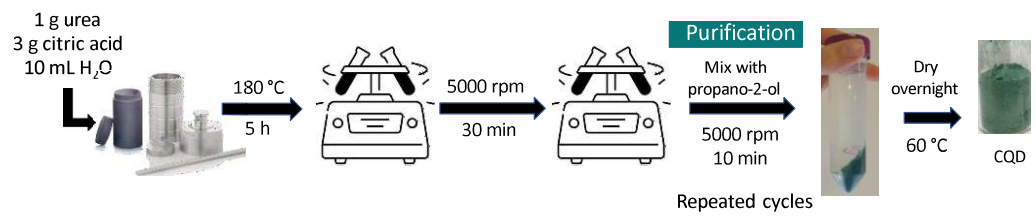
INTRODUCTION

The persistence of antibiotics in water contributed to antimicrobial resistance, as conventional treatments fail to fully remove them. Solar- driven photocatalysis offers a sustainable way to degrade these contaminants. TiO2 modified with Carbon Quantum Dots (CQDs) enhances light absorption, while immobilization in polycaprolactone (PCL) nanofibers allows easy recovery and reuse.
This work aims to develop and evaluate TiO2/CQDs photocatalysts embedded in electrospun PCL nanofibers for the solar-assisted degradation of amoxicillin. These study focuses on optimizing photocatalytic performance and demonstrating the potential of this composite material for sustainable water treatment applications.

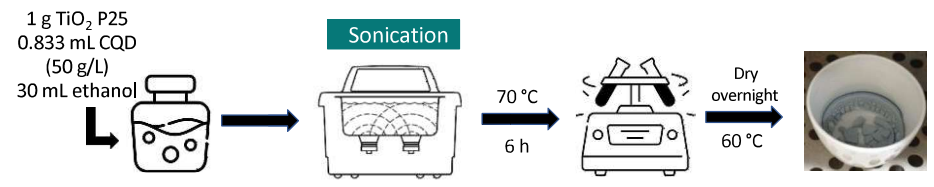
METHODOLOGY

Carbon Quantum Dots Synthesis

CQD were synthetized by a simple hydrothermal treatment

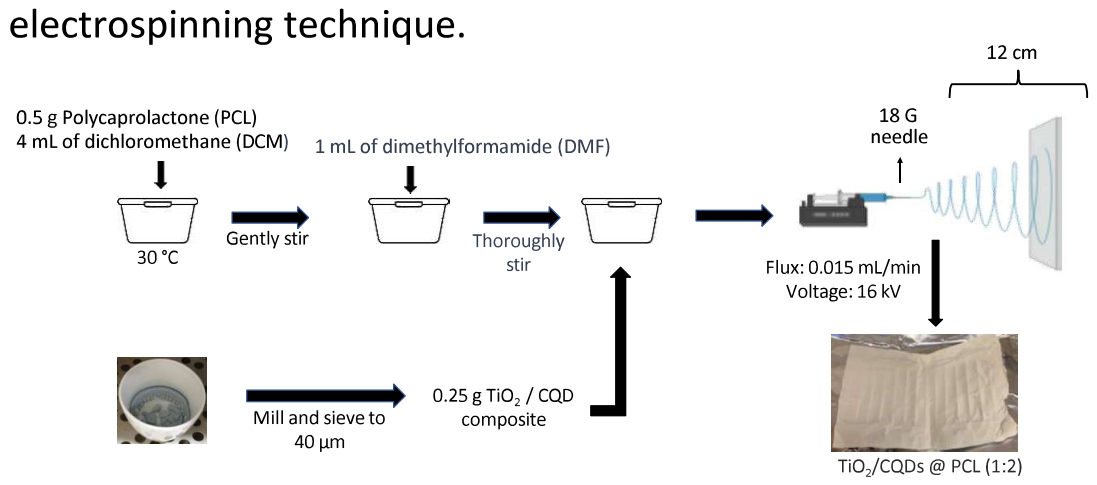


TiO_2/CQD nanocomposite synthesis



Incorporation of TiO_2/Carbon Quantum Dots into Polycaprolactone nanofibers

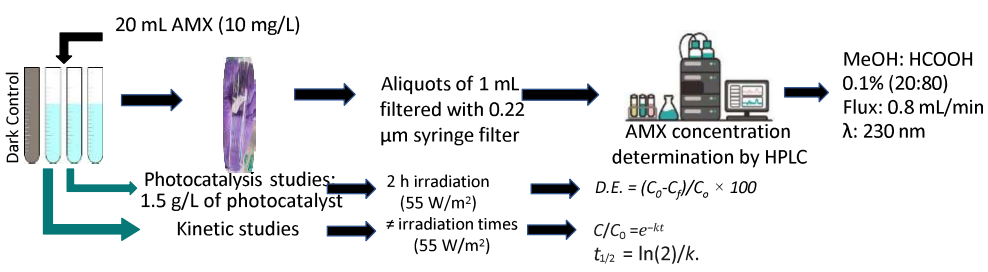
The composite was then incorporated into a matrix of polycaprolactone (PCL) biopolymer nanofibers using the electrospinning technique.



The electrospun fibers were analyzed by SEM (Scanning Electron Microscopy) operating at an acceleration voltage of 10 kV. To prepare the nanofibers for analysis, they were deposited onto a silica surface, pre-coated with a 10 nm thick Au-Pd (80-20 weight %) film.

Photodegradation studies

The nanofibers were tested for the photocatalysis of 10 mg/L of AMX in phosphate buffer (PBS) 0.001 mol/L, pH 8.0, using 1.5 g/L of photocatalyst and irradiation in a solar radiation simulator during 2 h.



RESULTS & DISCUSSION

- **Characterization of nanofibers-TiO_2/CQD @ PCL (1:2) by microscopy**

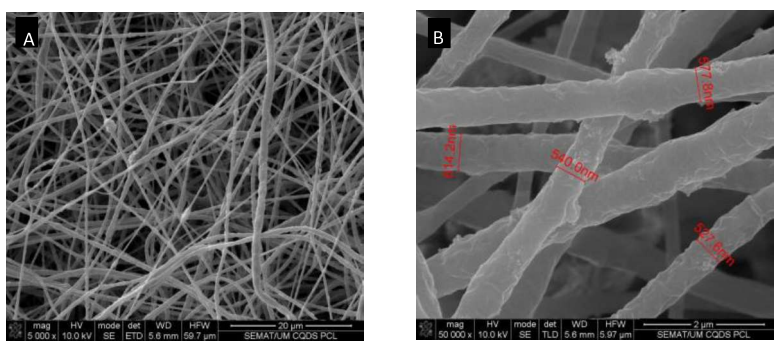


Figure 1. Microscopy images of TiO_2/CQD @ PCL (1:2) in SEM with (A) 5000 x and (B) 50000 x of magnification, respectively.

- **Photodegradation studies**

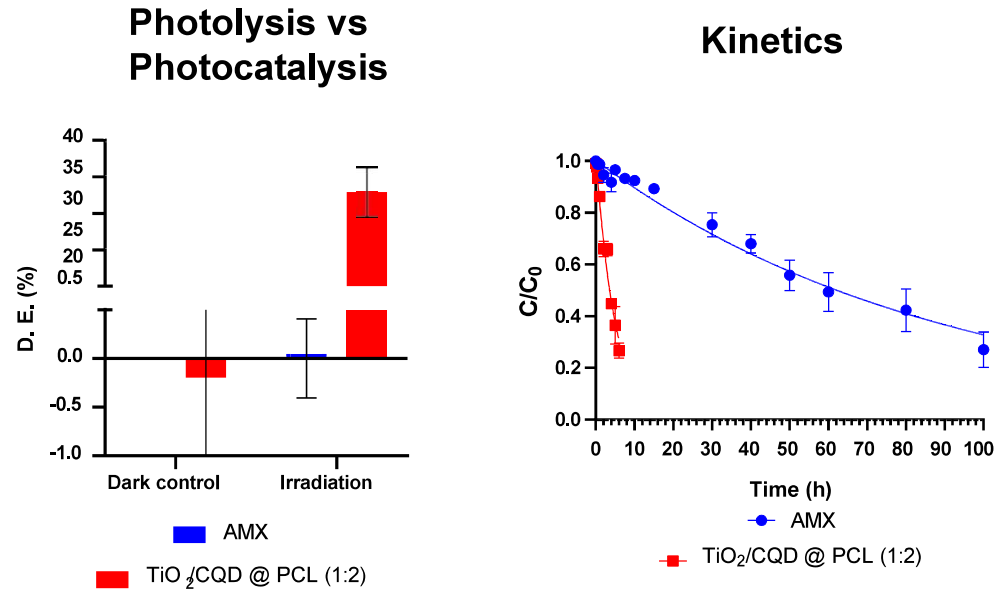


Figure 2. (A) Preliminary results for the application of 1.5 g/L of TiO_2/CQD @ PCL (1:2) for the removal of 10 mg/L of AMX and (B) Kinetics of photodegradation of AMX in presence and absence of photocatalyst.

Table 1. Data on pseudo-first order rate constants (k (h^{-1})), determination coefficient (R^2) and half-life times ($t_{1/2}$ (h)) obtained for with and without photocatalyst under simulated solar radiation for 10 mg/L AMX photodegradation.

Sample	k ± SD (h^{-1})	r^2	$t_{1/2}$ ± SD (h)
Photolysis	0.0112 ± 0.0002	0.9518	62 ± 1
Photocatalysis	0.201± 0.006	0.9651	3.45 ± 0.03

Increase of 18 TIMES AMX removal!

CONCLUSION & FUTURE WORK

The presented results constitute a promising and sustainable treatment for antibiotics' efficient removal from water. The electrospun PCL nanofibers dopped with TiO_2/CQD nanocomposites afforded a simple and easy recoverable photocatalyst. Next in line, the continuation of the optimization of the photocatalyst application will be studied, various cycles of application will be performed, and the stability of the nanofiber will be evaluated.

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