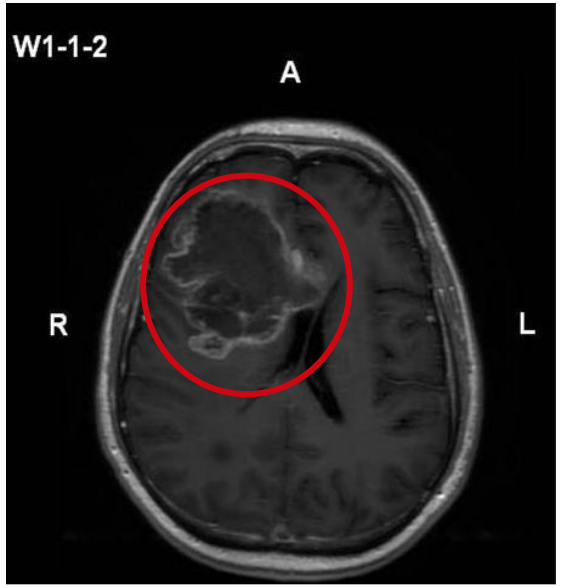
Nanomaterials 2026: Innovations and Future Perspectives

Development of photoactive delivery systems based on polymeric nanofibers for localized therapy against glioblastoma

Pedro Valentín Badía Hernández

Sara M.A. Pinto, Rocío Díaz-Puertas, María Losada-Echeberría, Mariette M. Pereira, Pilar García-Morales, Ricardo Mallavia

Glioblastoma and current treatment

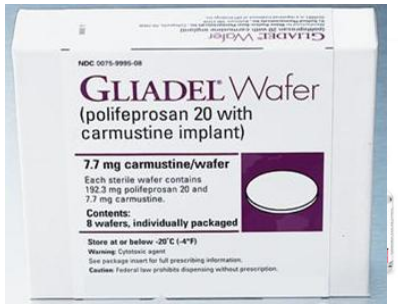


80% mortality rate

Surgery

Chemotherapy

Radiotherapy



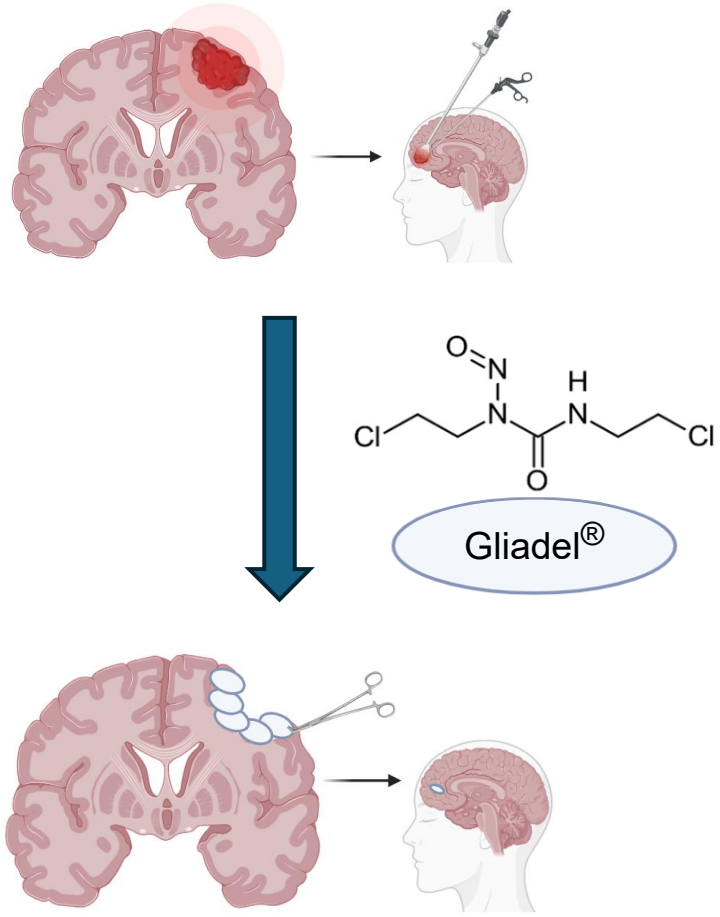
Temozolomide (TMZ)

Carmustine (BCNU)

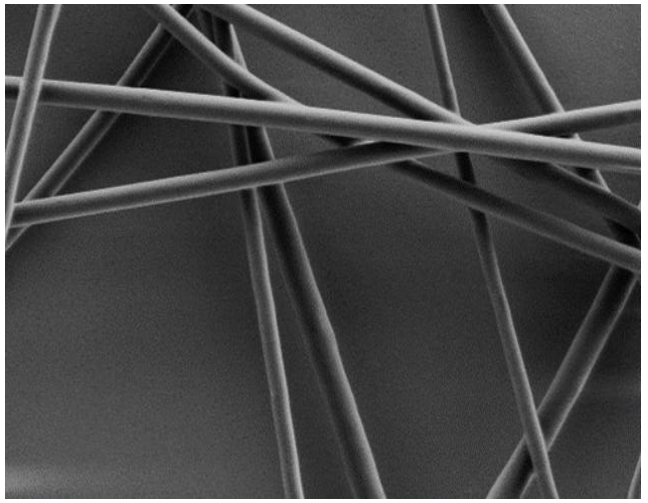
Doxorubicin (DOX)

Biomaterials for local administration

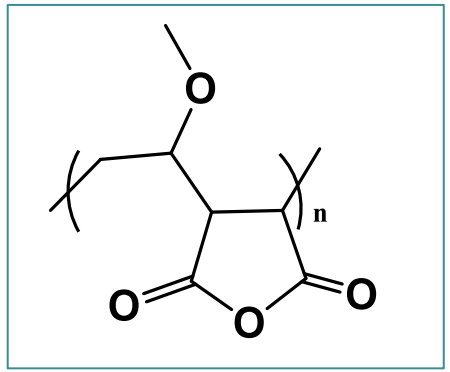
Post-surgical local therapy



Nanostructure biomaterials



Electrospun nanofibers

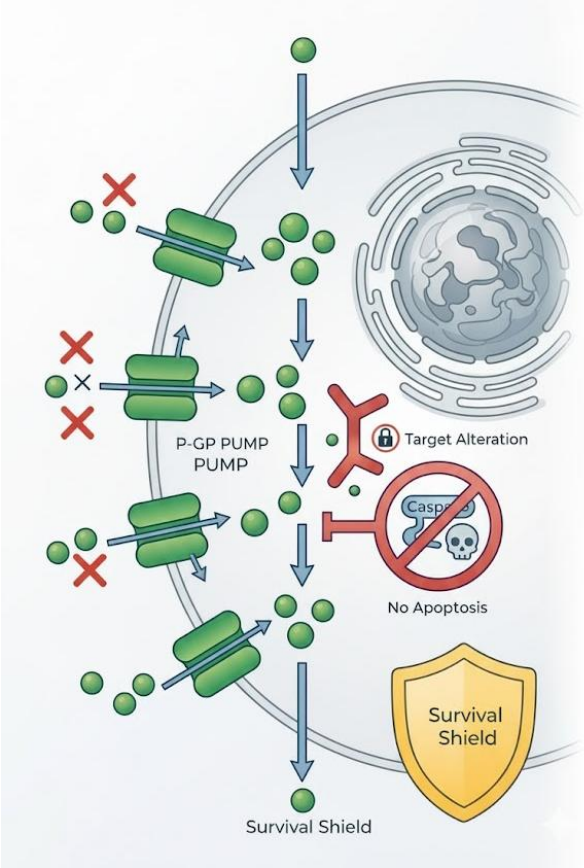


Poly (methyl vinyl ether-*alt*-maleic) (PMVEMA)

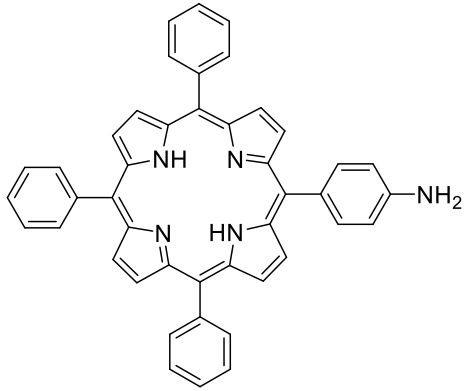
Malleable
Easy to synthesize
Administration: local, oral, or topical
Low storage and transportation costs

Polymer functionalization for active biomaterials

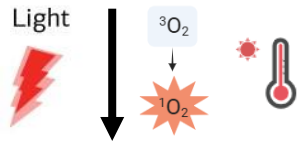
Drug Resistance



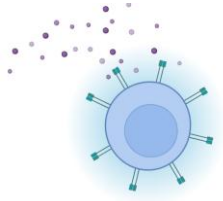
Photodynamic therapy (PDT)



Tetraphenylporphyrin (TPP)

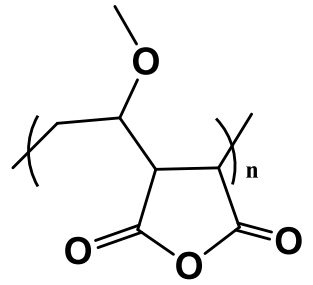


Tumor cell death



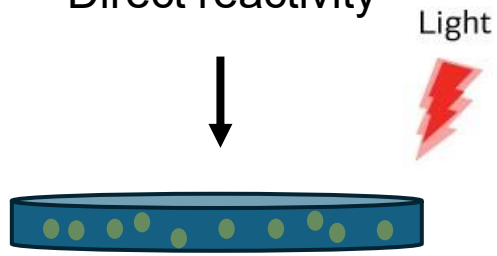
Cell recruitment

Polymer + Photosensitizer



PMVEMA

Direct reactivity



Photoactive biomaterial

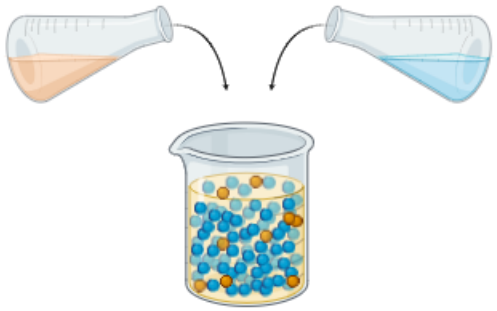
Main aim

To develop photoactive delivery systems based on PMVEMA nanofibers for combined therapy against glioblastoma

- Development and characterization of electrospun PMVEMA nanofibers as drug deliver systems for antineoplastic DOX and BCNU.
- Evaluation of their effect in cell models.
- Functionalization and characterization of PMVEMA with porphyrins for PDT.

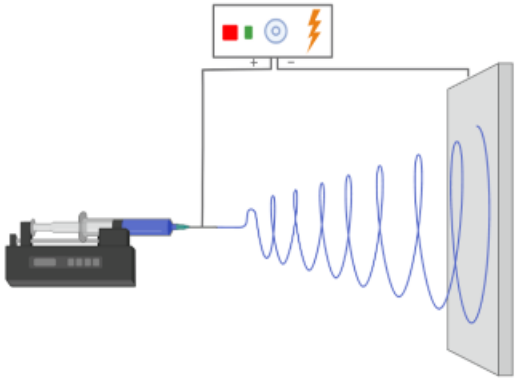
Nanofiber synthesis

Doxorubicine (DOX) or Carmustine (BCNU)



PMVEMA dissolution
Antineoplastic drug (% w/w)

PMVEMA dissolutions (w/w):
- PMVEMA-Ac at 20 % in water
- PMVEMA-Es at 25 % in ethanol



Synthesis by
Electrospinning

Parameters considered:
- Voltage (kV)
- Distance (cm)
- Flow (mL/h)

Characterization of nanofibers

→ Scanning electron microscopy (FESEM) Confocal mircoscopy

Morphology and composition

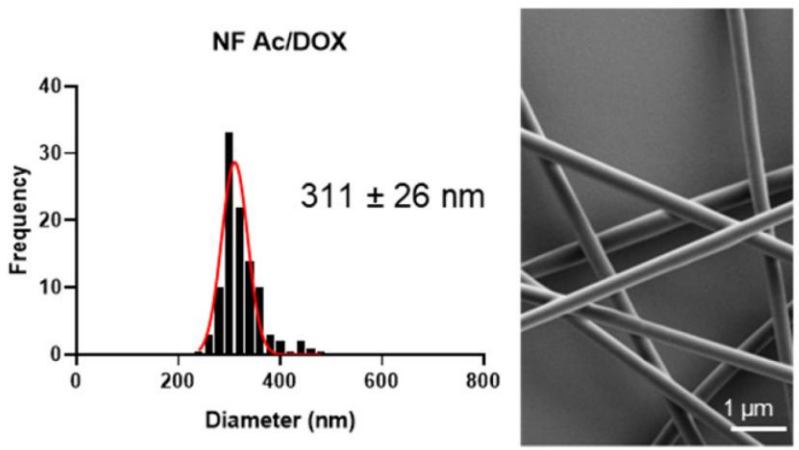
→ Liquid chromatography (HPLC-UV)

Encapsulation efficiency and release kinetics

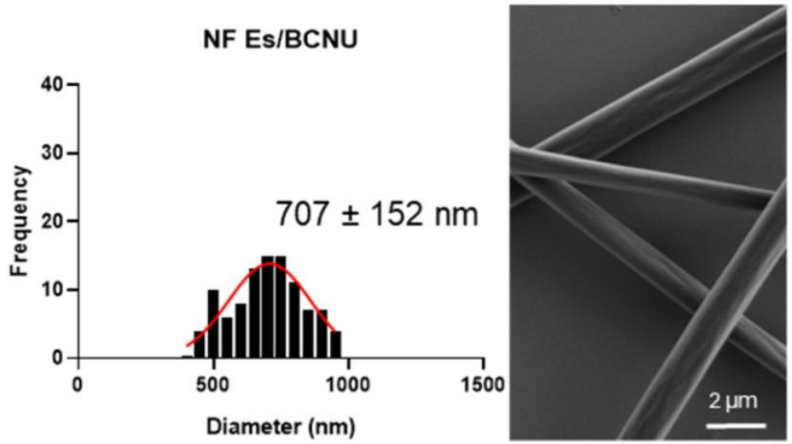
Cell viability assay (MTT)

→ Effect on gliobastoma patient cell lines from the Hospital General Universitario de Elche (HGUE-GB) and 3D model development

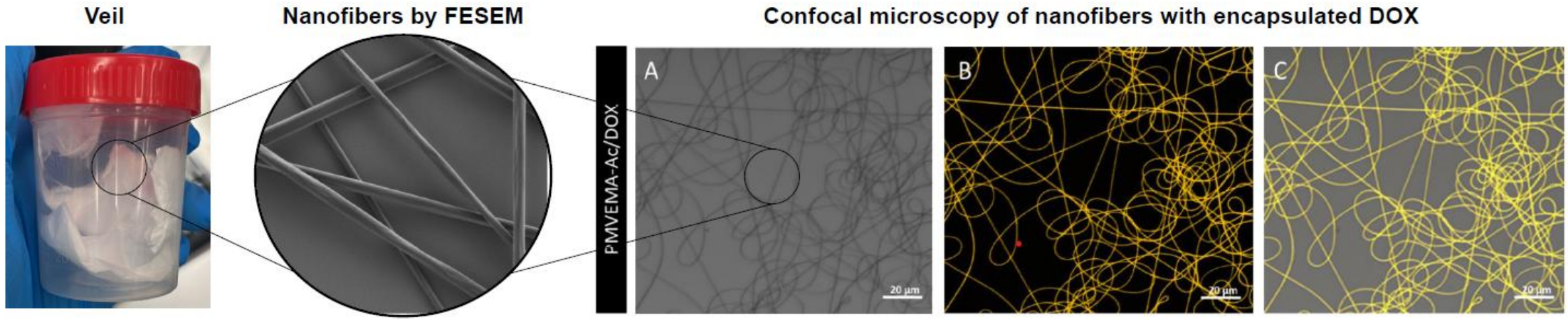
Loaded nanofibers characterization



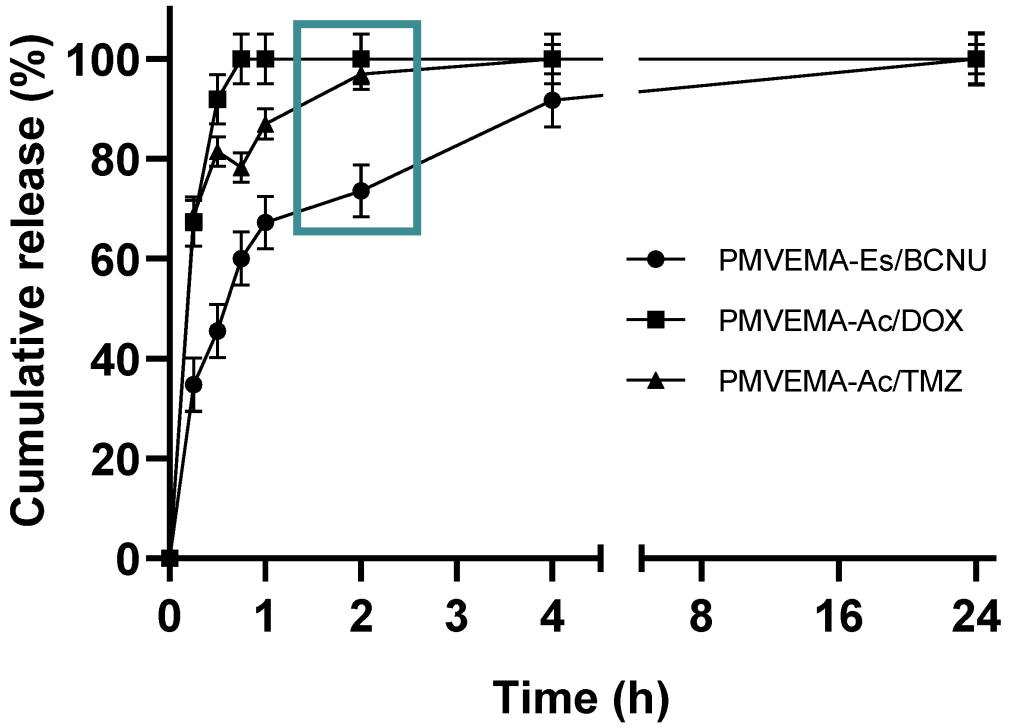
PMVEMA-Ac/DOX 1 %



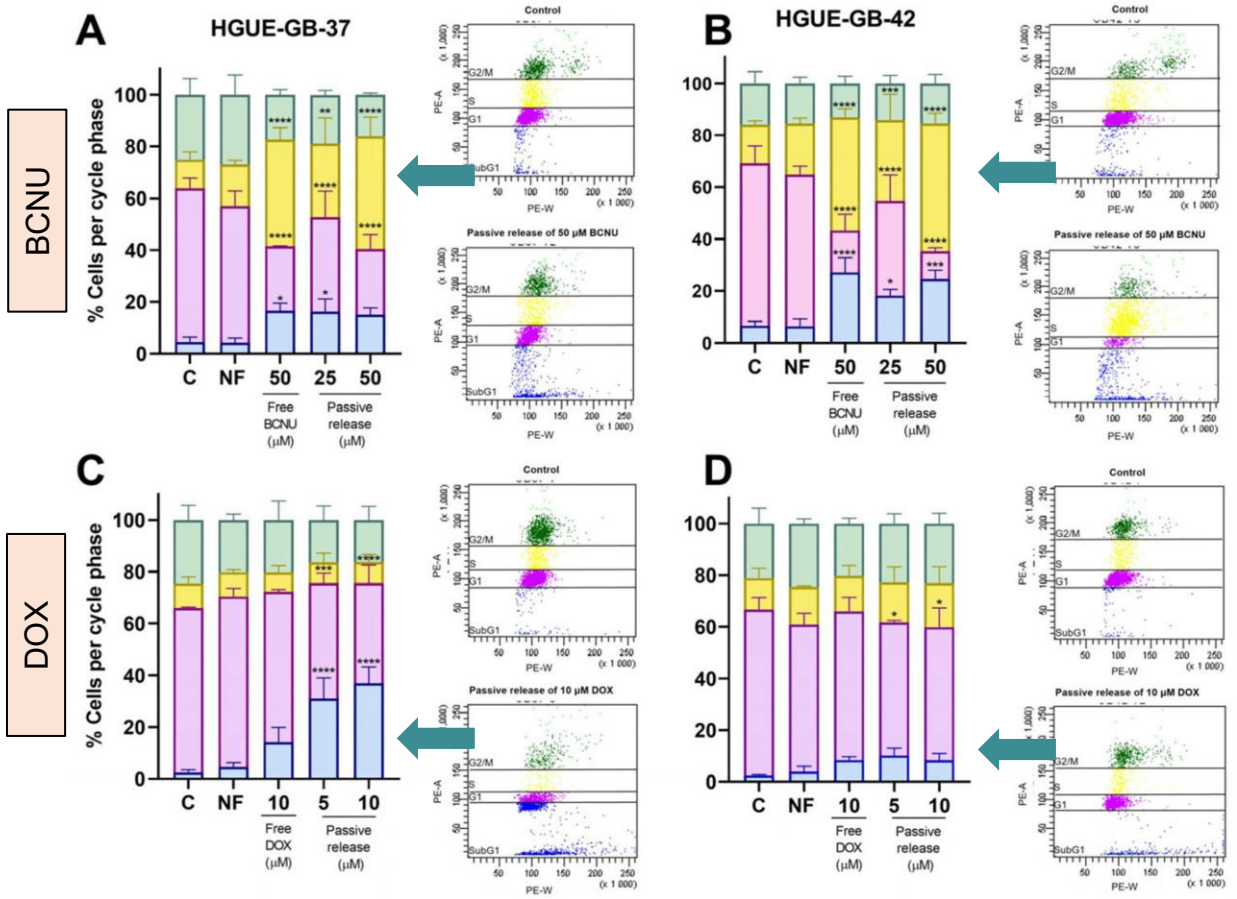
PMVEMA-Es/BCNU 8 %



Kinetic release and effect on cell cycle



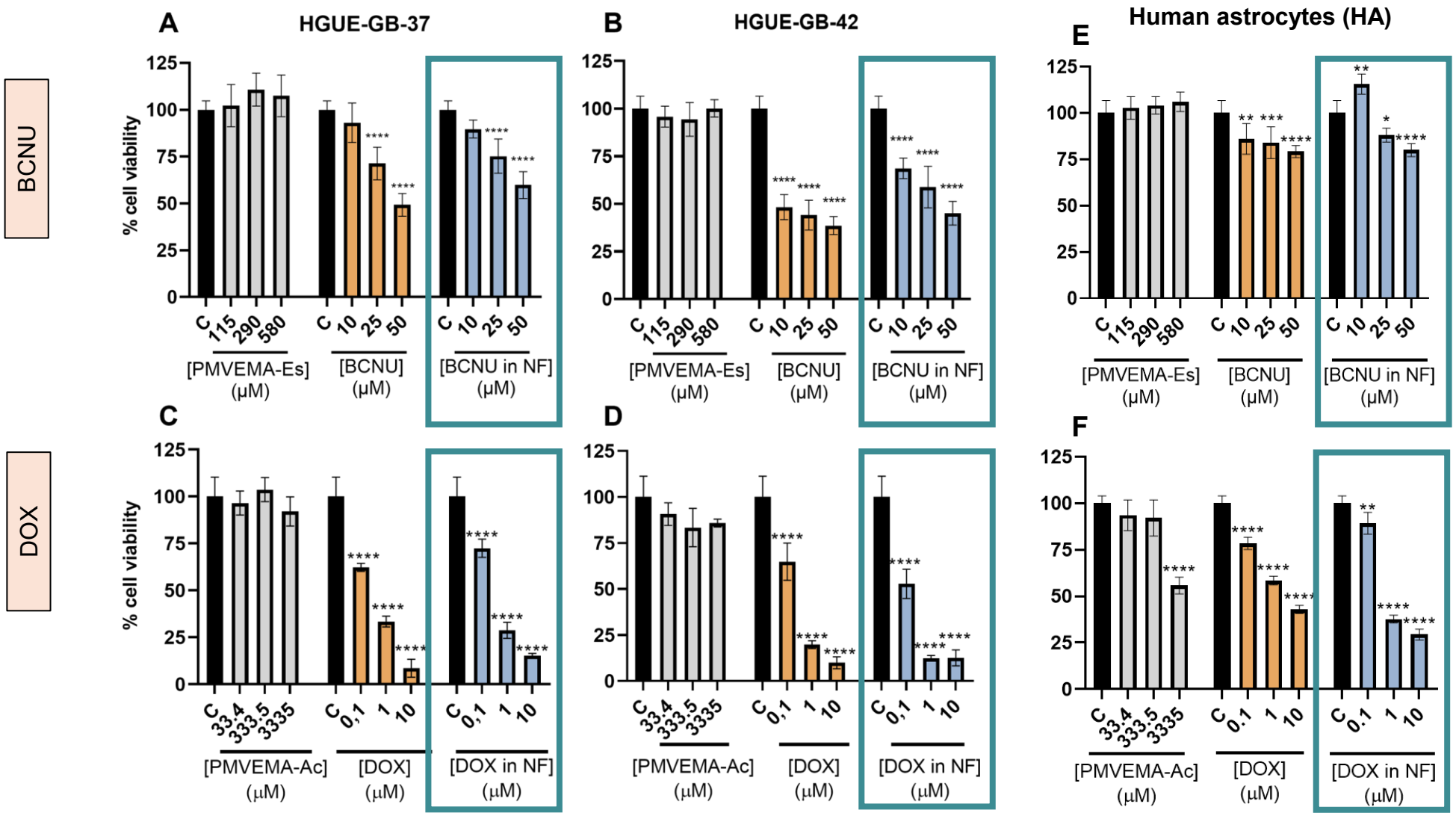
Conditions: 37°; PBS; pH 7.4



S phase – Cytostatic

SubG1 phase – Cytotoxic

In vitro cell testing of loaded nanofibers



Ongoing work

Article 8 September 2025

Electrospun PMVEMA Nanofibers Developed as a Fast-Release Platform for Antineoplastic Drugs Tested in Glioblastoma Primary Cultures

Pedro Valentín Badía-Hernández[1], Joan Moll Carrió[1], María Fuentes-Baile[1,2], María Losada-Echeberría[1], Rocío Díaz-Puertas[1], Amalia Mira[1], Miguel Saceda[1,2], Pilar García-Morales[1] and Ricardo Mallavia[1,*]

[1] Instituto de Investigación, Desarrollo e Innovación en Biotecnología Sanitaria de Elche (IDiBE), Universidad Miguel Hernández de Elche, 03202 Alicante, Spain

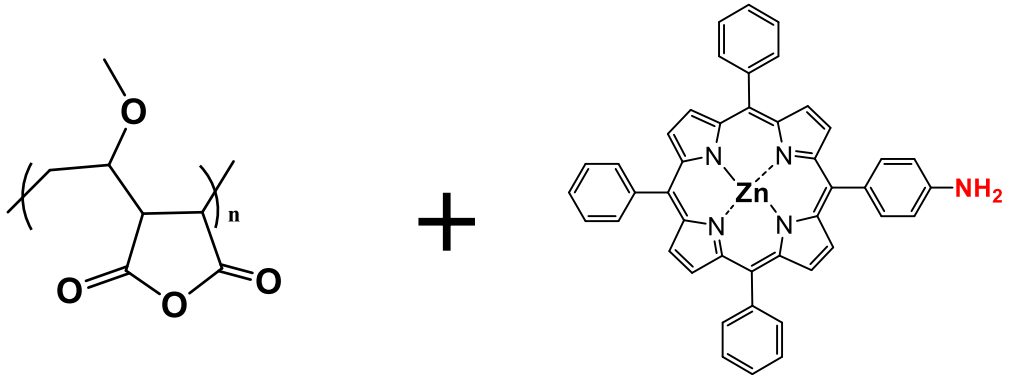
[2] Fundación para El Fomento de la Investigación Sanitaria y Biomédica de la Comunidad Valenciana (FISABIO), Hospital General Universitario de Elche, Unidad de Investigación, 03203 Alicante, Spain

* Author to whom correspondence should be addressed.

Pharmaceutics **2025**, *17*(9), 1172; https://doi.org/10.3390/pharmaceutics17091172

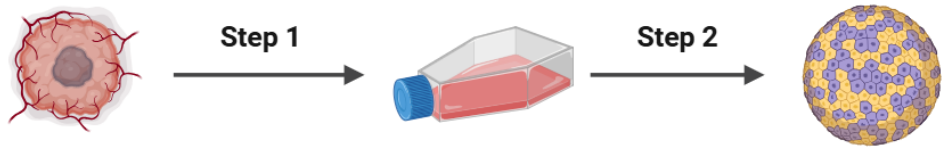
This article belongs to the Special Issue Nano-Based Technology for Glioblastoma

Polymer functionalization



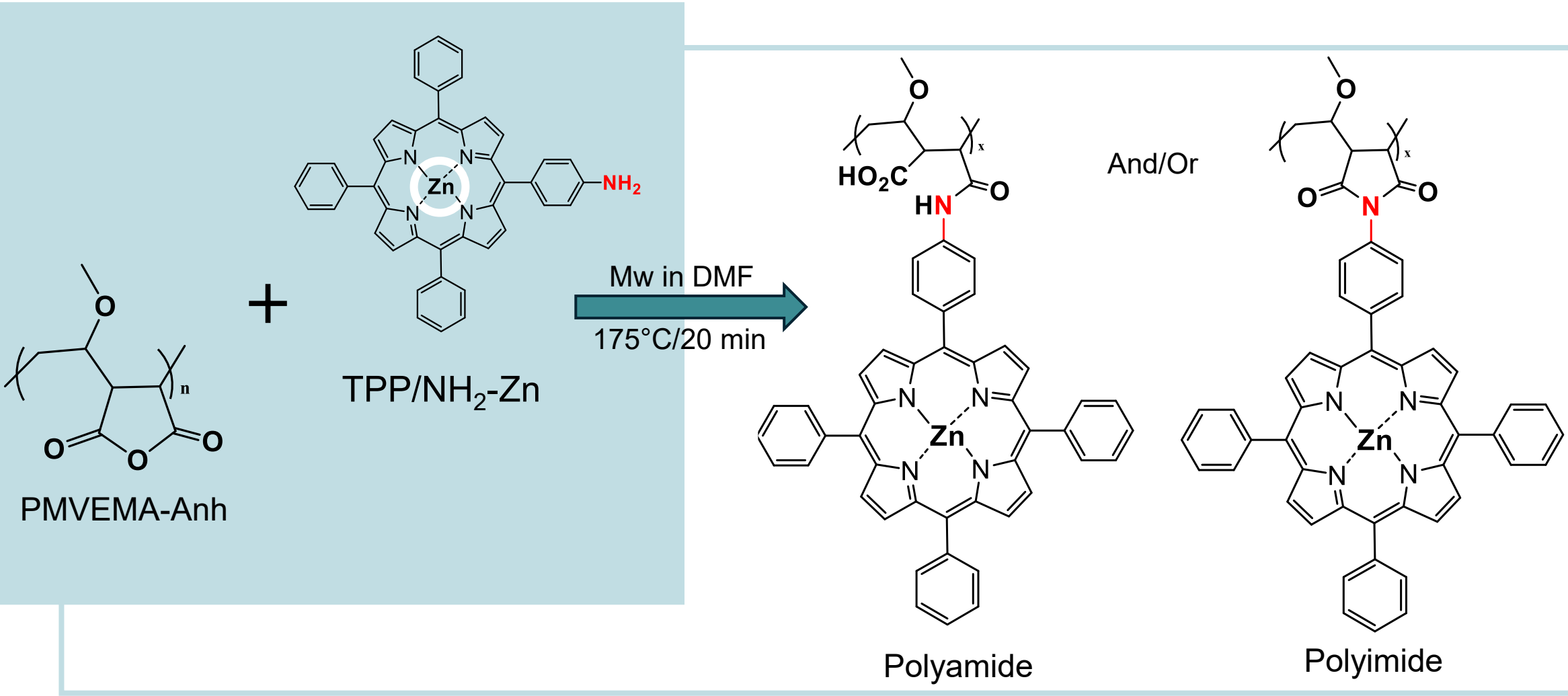
PMVEMA-Anh + TPP/NH_2-Zn

3D mixed glioblastoma model

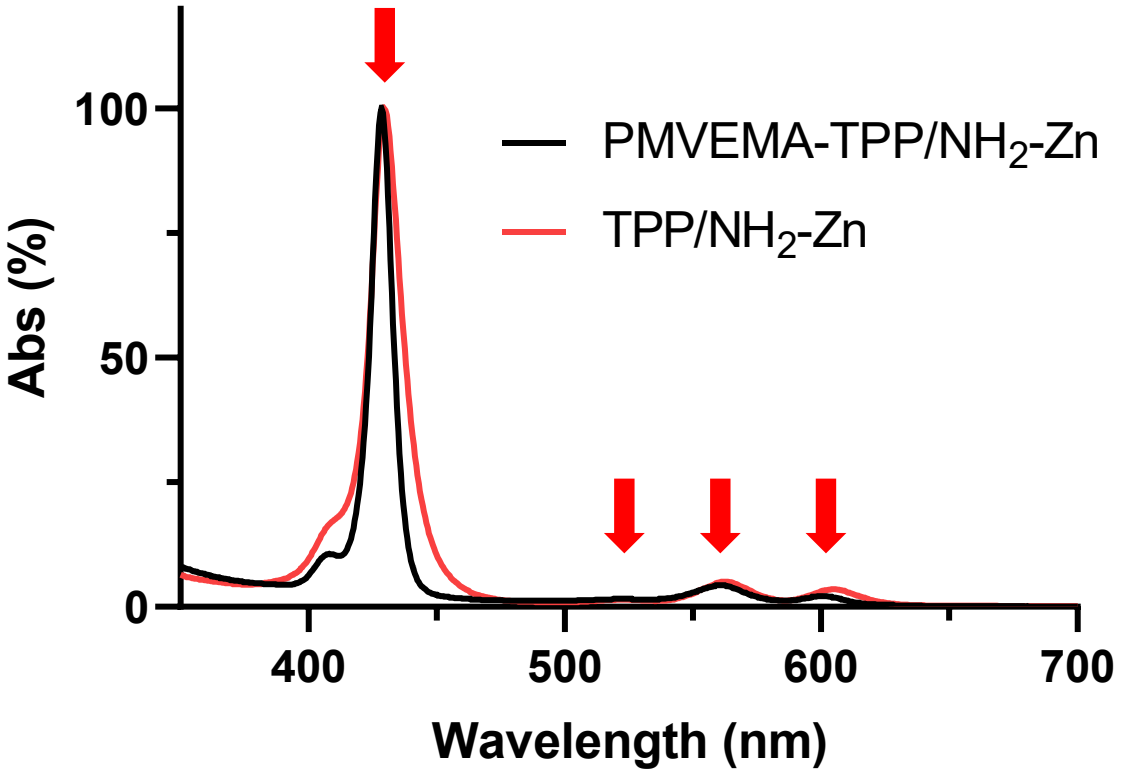


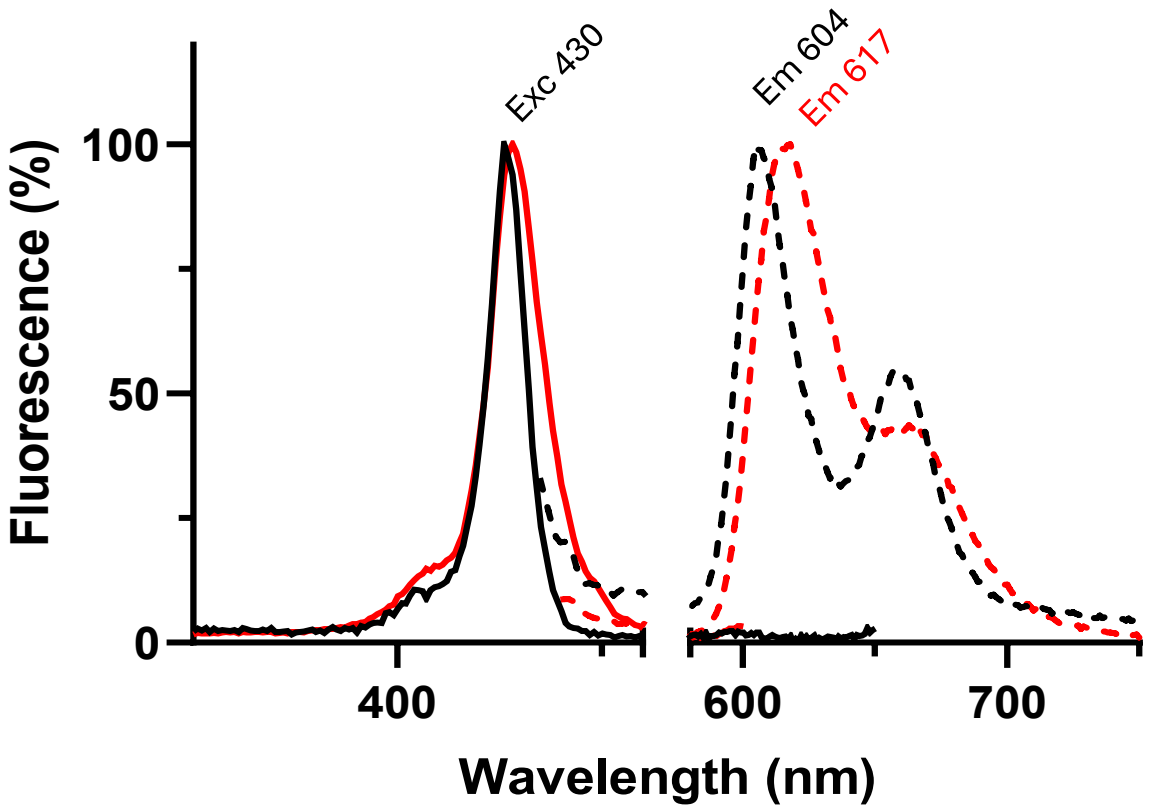
Glioblastoma patient → 2D cell culture → 3D cell culture

Functionalization of PMVEMA with TPP/NH_2-Zn



UV/ Fluorescence characterization of PMVEMA-TPP/NH_2 -Zn



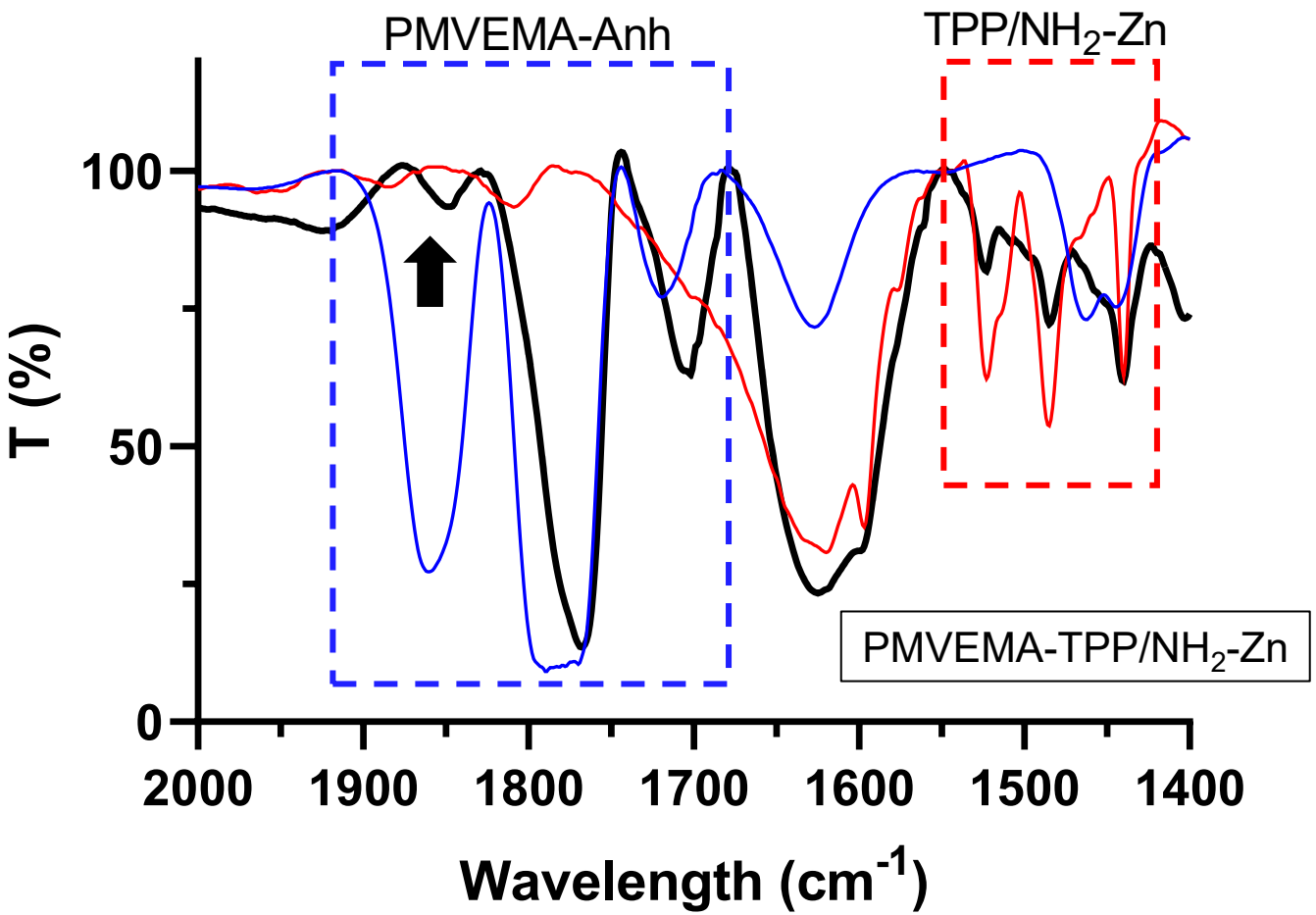


$$\text{Functionalization efficiency } \lambda\ (\text{FE}) = \frac{[\text{TPP/NH}_2\text{—Zn}]}{m_p/Vp}$$

FE/1g Polym= 77.1%

Hypochromic shift

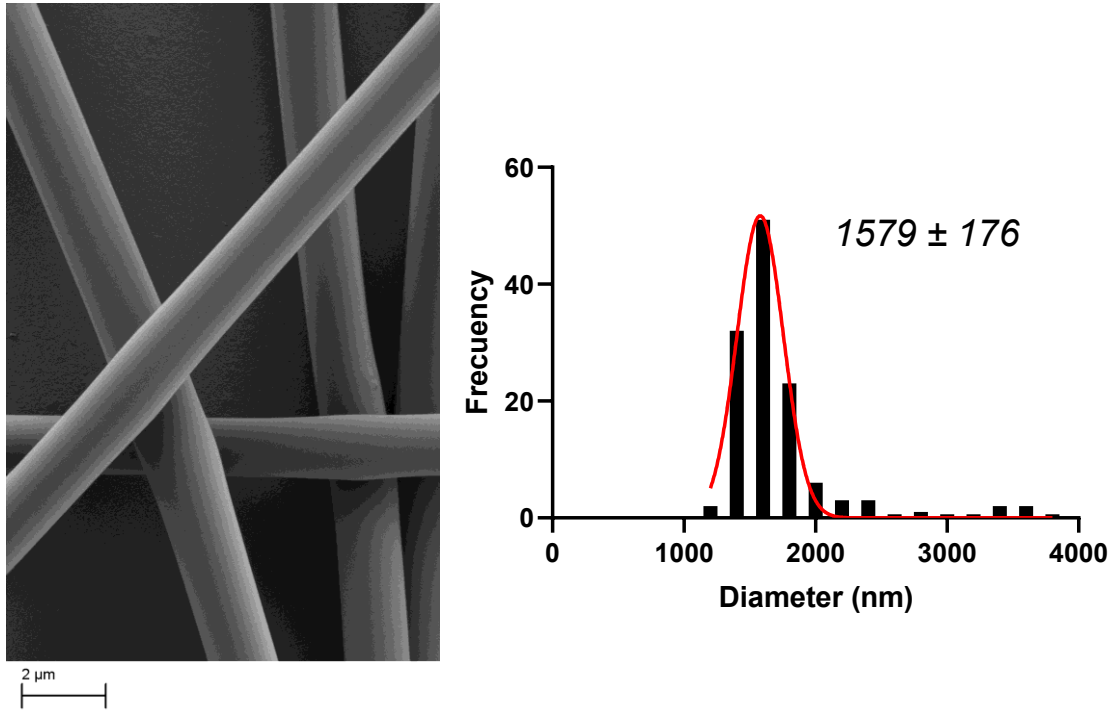
FTIR characterization of PMVEMA-TPP/NH_2-Zn



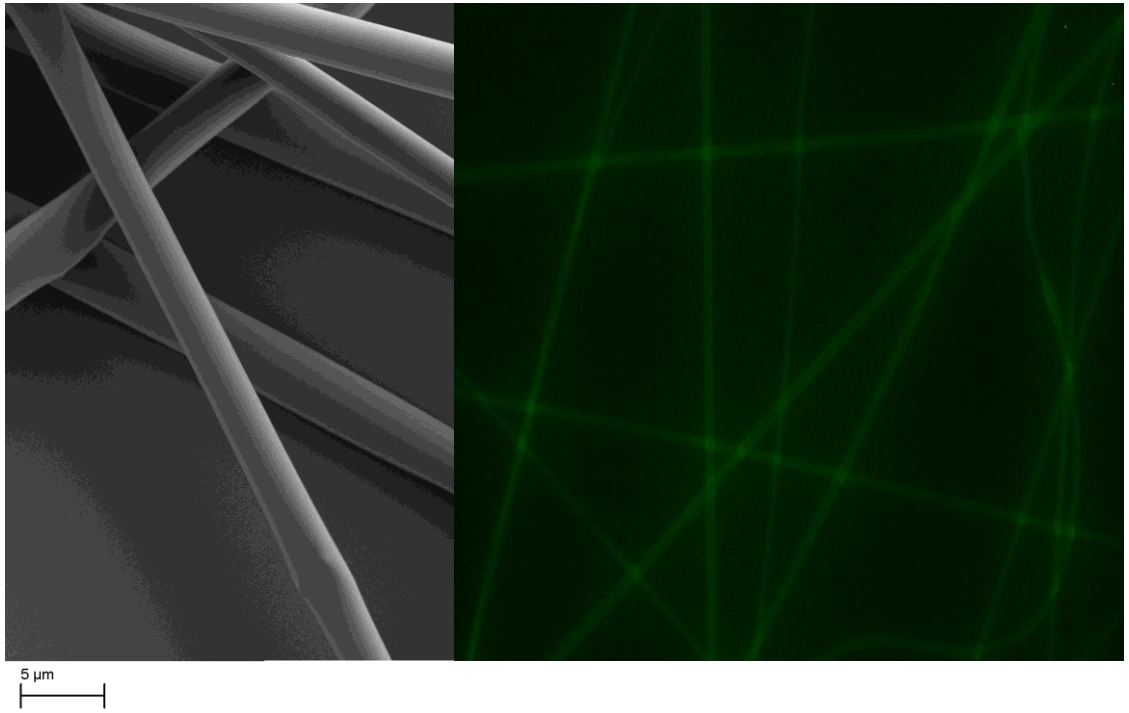
PMVEMA-Anh	PMVEMA-TPP/NH_2-Zn
1720	1704
1780	1767
1860	1849

PMVEMA-TPP/NH_2-Zn as a copolymer in nanofiber synthesis

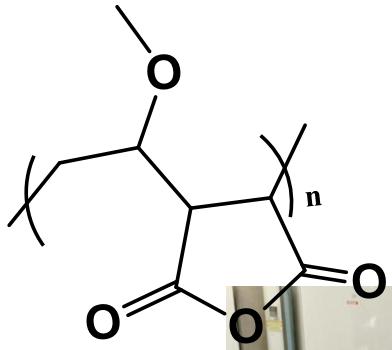
PMVEMA-Es/PMVEMA-TPP/NH_2-Zn 1% (w/w)

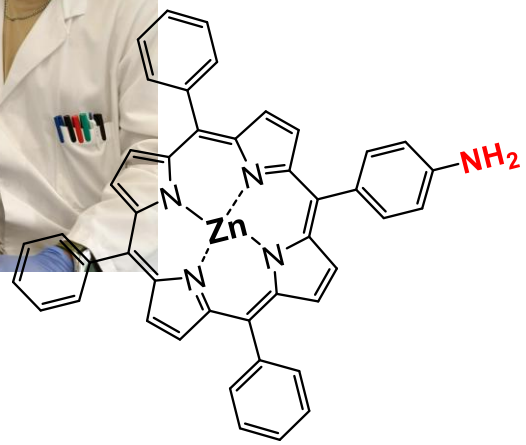


PMVEMA-Es/PMVEMA-TPP/NH_2-Zn 2% (w/w)



Conclusions





- Biomaterials

Electrospun PMVEMA-derivate nanofibers were able to encapsulate DOX and BCNU with a loading efficiency comparable to clinically approved versions of drug delivery systems.

- *In vitro* glioblastoma model

The loaded drugs keep their antitumor activity and reduces glioblastoma cell viability with minimum effects in human astrocytes.

- Polymer modification

PMVEMA has been successfully functionalized, further characterization should be performed to use it for PDT treatment.

Future perspectives

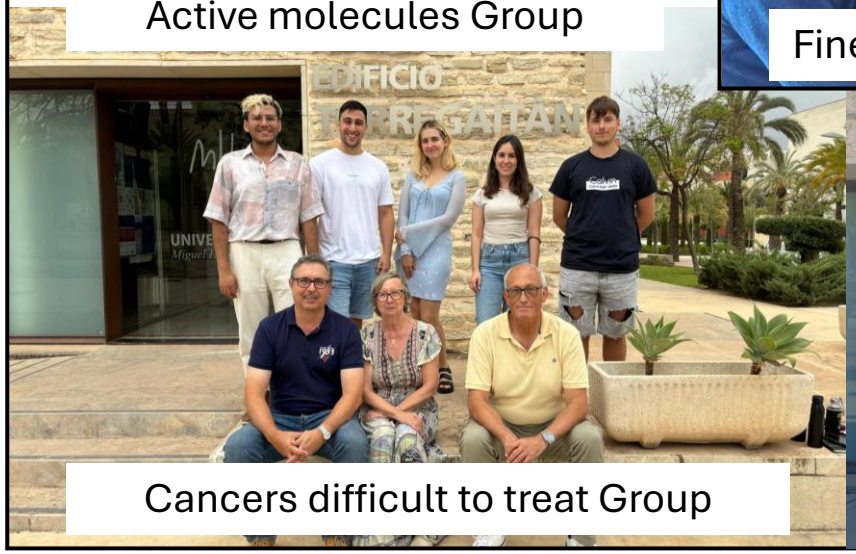
Establish a glioblastoma/astrocyte mixed 3D cell model to studied combined PDT therapy.

Acknowledgements

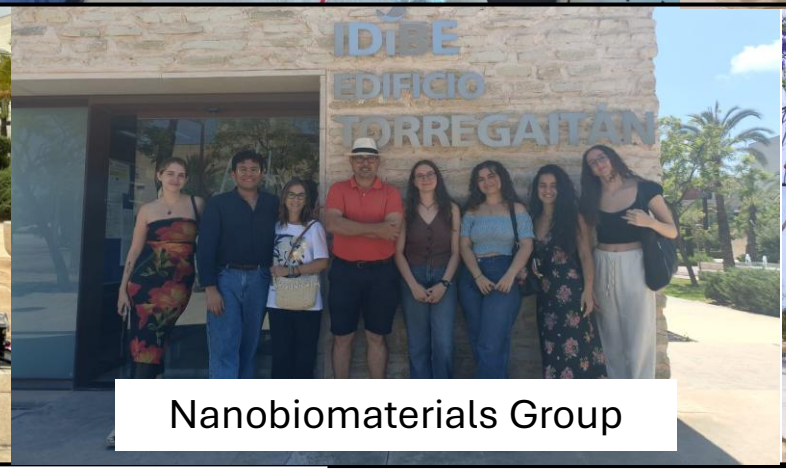
Active molecules Group

Fine Chemicals and Synthesis Group

University of Coimbra



Cancers difficult to treat Group



Nanobiomaterials Group

University of Miguel Hernández

PID2021-12353OB-C21 CONTACT INFORMATION
EU-FEDER/GVAIDIFEDER/2018/020 “Una forma de hacer Europa”

GOBIERNO DE ESPAÑA
MINISTERIO DE EDUCACIÓN Y CIENCIA

Nanomaterials 2026: Innovations and Future Perspectives

Development of photoactive delivery systems based on polymeric nanofibers for localized therapy against glioblastoma

Pedro Valentín Badía Hernández

Sara M.A. Pinto, Rocío Díaz-Puertas, María Losada-Echeberría, Mariette M. Pereira, Pilar García-Morales, Ricardo Mallavia