PMVEMA functionalization with fluorophores to synthesize polymeric nanofibers for biomedical applications

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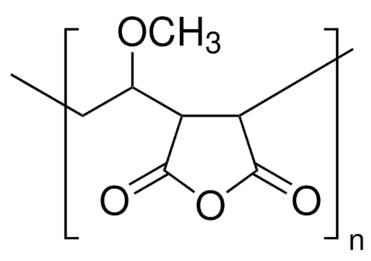
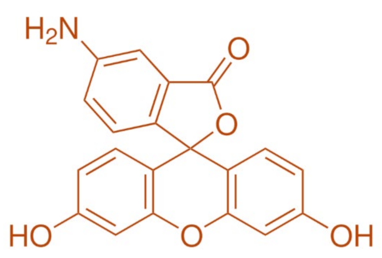
INTRODUCTION

To assess disease progression, multiple factors must be monitored simultaneously. Therefore, the observation of complex biological processes relies heavily on the rational design and synthesis of stable fluorescent molecules that emit in the visible and near-infrared spectrum [1]. The combination of organic fluorophores with water-soluble, biodegradable polymers or polymeric nanoassemblies has opened up new possibilities for their biomedical applications in areas such as bioprobes, bioimaging, and theranostics.[2–5].

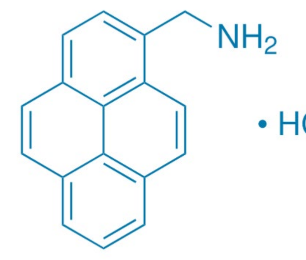


Poly (methyl vinyl ether-alt-anhydride maleic)
(**PVMEMA**)

Fluorophores



5-Aminofluorescein (**5AF**)

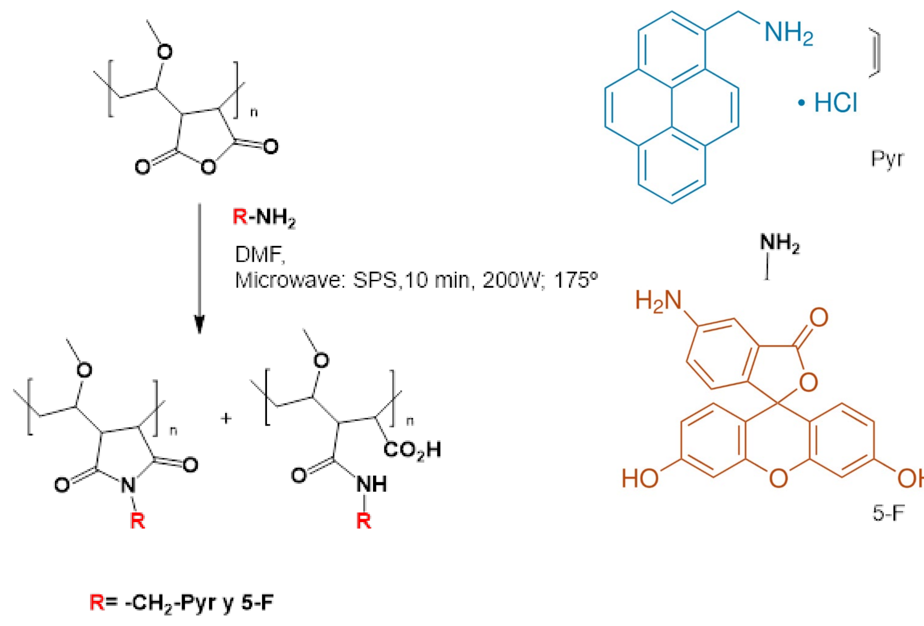


1-Pyrenemethylamine (**Pyr**)

Polymeric nanofibers

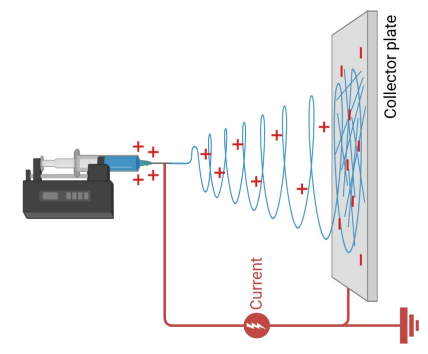
- Easy to synthesize (electrospinning)
- Highly malleable
- Oral, local or topical administration
- Low-cost portability and storage

MATERIALS AND METHODS

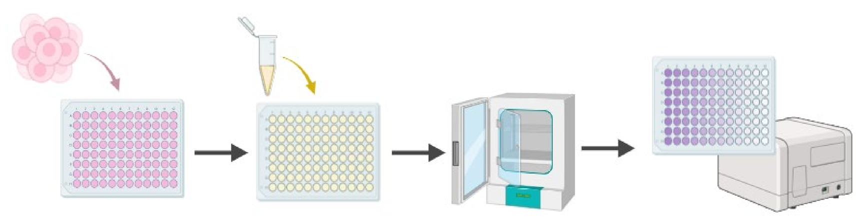


Polymer-fluorophore functionalization reactions. Microwave synthesis of copolymers in 3 different concentrations of fluorophores (#1 0,25 mmol; #2 0,5 mmol; and #3 1 mmol)

Characterization of the copolymers and nanofibers. Spectroscopy (UV-Visible, FTIR and fluorescence) and microscopy (optical, confocal and FESEM).

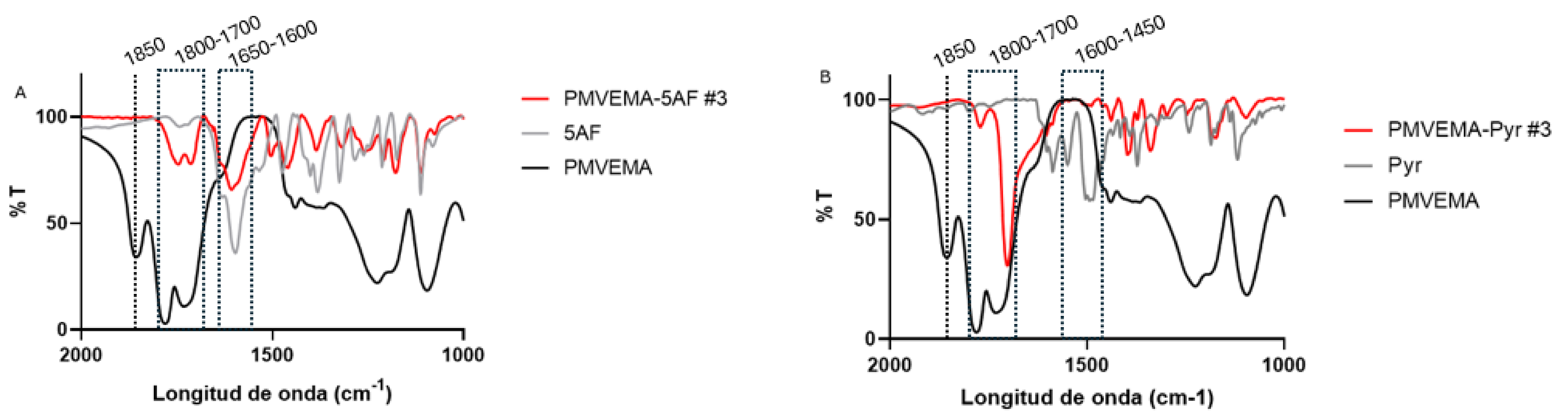


Synthesis of nanofibers by electrospinning. PMVEMA-Es 25 % in ethanol with 5AF and Pyr at 1% (w/w to polymer).

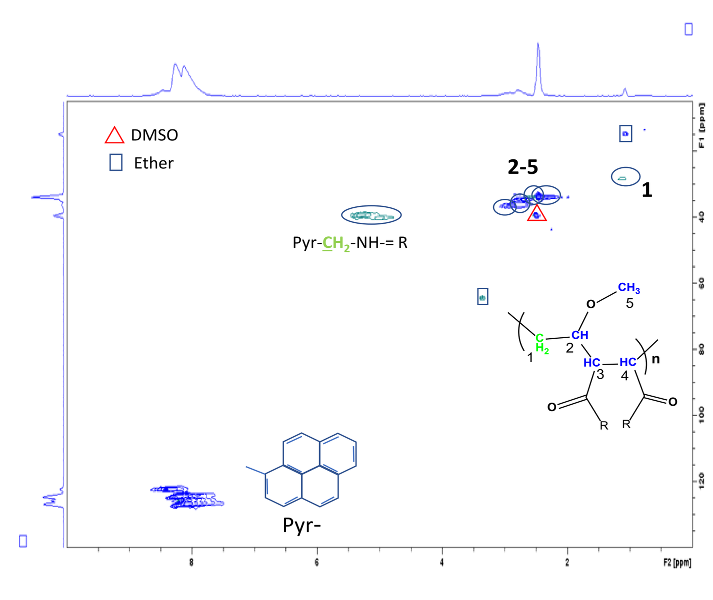


MTT cell viability assay. HaCaT lines were treated with both copolymers (PMVEMA-5AF and PMVEMA-Pyr).

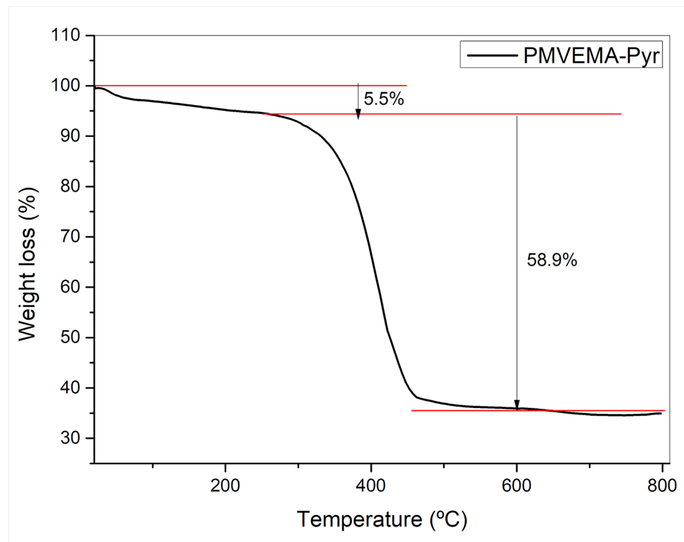
RESULTS



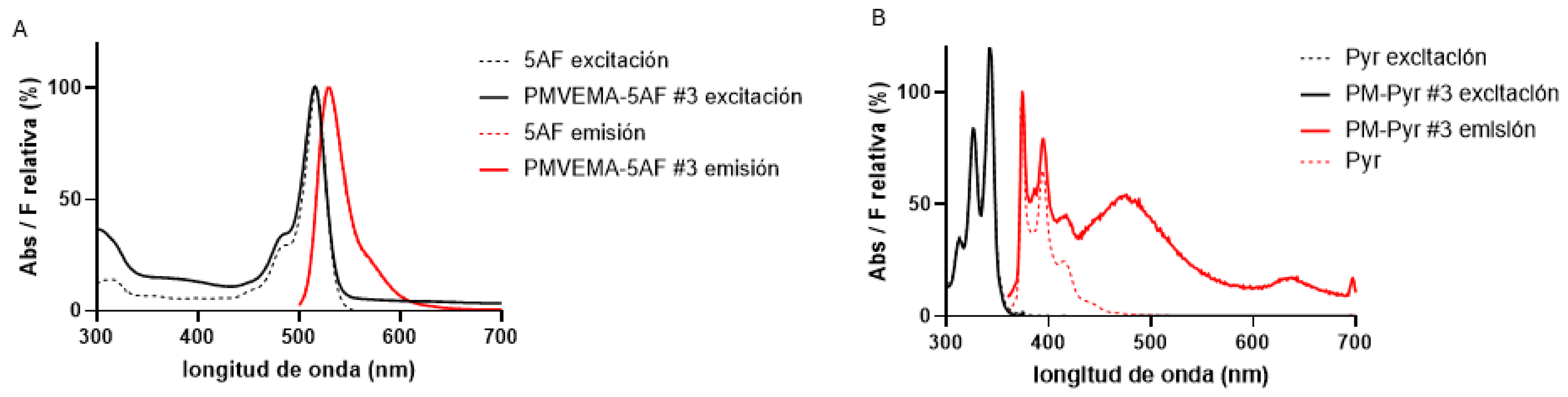
FTIR spectroscopy. The peak in 1850 cm⁻¹ in both cases shows a band's reduction from PMVEMA. Between 1800-1700 cm⁻¹ the copolymer shows C=O groups that belong to the fluorophores. The peaks at 1650-1600 cm⁻¹ in the 5AF and at 1600-1450 cm⁻¹ in the Pyr spectrums also belong to the fluorophores.



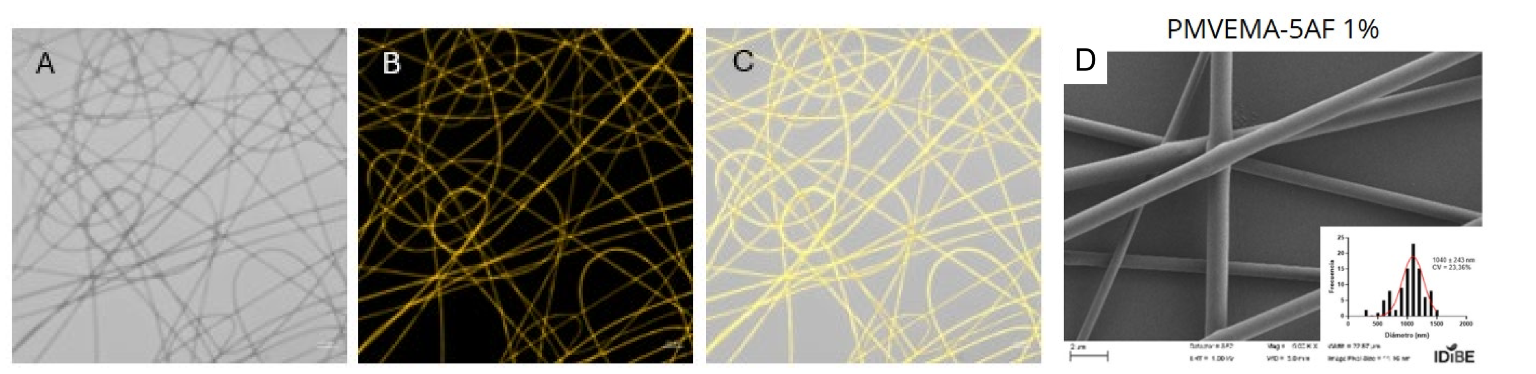
RMN. ^{1}H–^{13}C HSQC spectrum of PMVEMA-Pyr in DMSO-d_6 (as internal reference). Solvent signals were showed (square and triangle).



TGA. TGA-DGT curve of PMVEMA-Pyr. The main decomposition stage occurs at around 270 and 550 °C with a mass loss of 58.9%.



Excitation and emission spectrums. The UV spectrums showed two main peaks: at 517 nm in 5AF and at 347 in Pyr. The controls and copolymers were then excited at these wavelengths and the obtained peaks, at 529 and 374 nm, respectively, were shifted to the right due to the Stokes shift.



5AF characterization by microscopy.. (A, B, C) PMVEMA-5AF #3 at 1% w/w to polymer nanofibers observed by confocal microscopy. The nanofibers presented fluorescence in the excitation range of wavelengths of 469/38 nm. (D) PMVEMA-5AF #3 at 1% w/w to polymer observed by FESEM microscopy. The average diameter of the nanofibers was 1040 ± 243 nm, with a variation coefficient (CV) of 23.36%.

Conclution

Functionalization of the PMVEMA with the fluorophores 5AF and Pyr led to the successful incorporation of fluorescent copolymers into nanofibers. These results demonstrate the potential of these nanofibers as fluorescent platforms for biomedical applications such as bioimaging and bioprobe development.

References

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