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# Combining oligothiophene with oligo-(D,L-lactide) into a complex, branched topology toward a functional interface aimed at biomedical applications

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## INTRODUCTION & AIM

The last decades have witnessed an increasing interest in advanced electroactive biomaterials based on conducting, π-conjugated polymers with a “rod-*graft*-coil” architecture, for use in different biomedical applications. Such topology offers, in addition to the freedom of various combinations of chemistries, also the opportunity to program, optimize and control, from the molecular design stage, the processing-structure-properties relationship and the self-assembly pathway. The present report focus on the study of those properties of an oligothiophene *grafted* with oligo-(D,L-lactide) (**OTh-PDLLA**) that allow to establishing its suitability as a biomaterial. Thus, its capability for forming thin films, on either rigid or flexible supports, using for processing solvents with different polarities and variable concentrations and films surface properties were explored employing dynamic laser-scattering (DLS), contact- angle measurement and atomic force microscopy (AFM). The results of the **OTh-PDLLA** interactions with normal human gingival fibroblasts (NHGF) cells proved the oligomer’s biocompatibility, this being the first that advocate for **OTh-PDLLA** potential as electroactive biointerface or as active layer in flexible and/or implantable transient electronics.

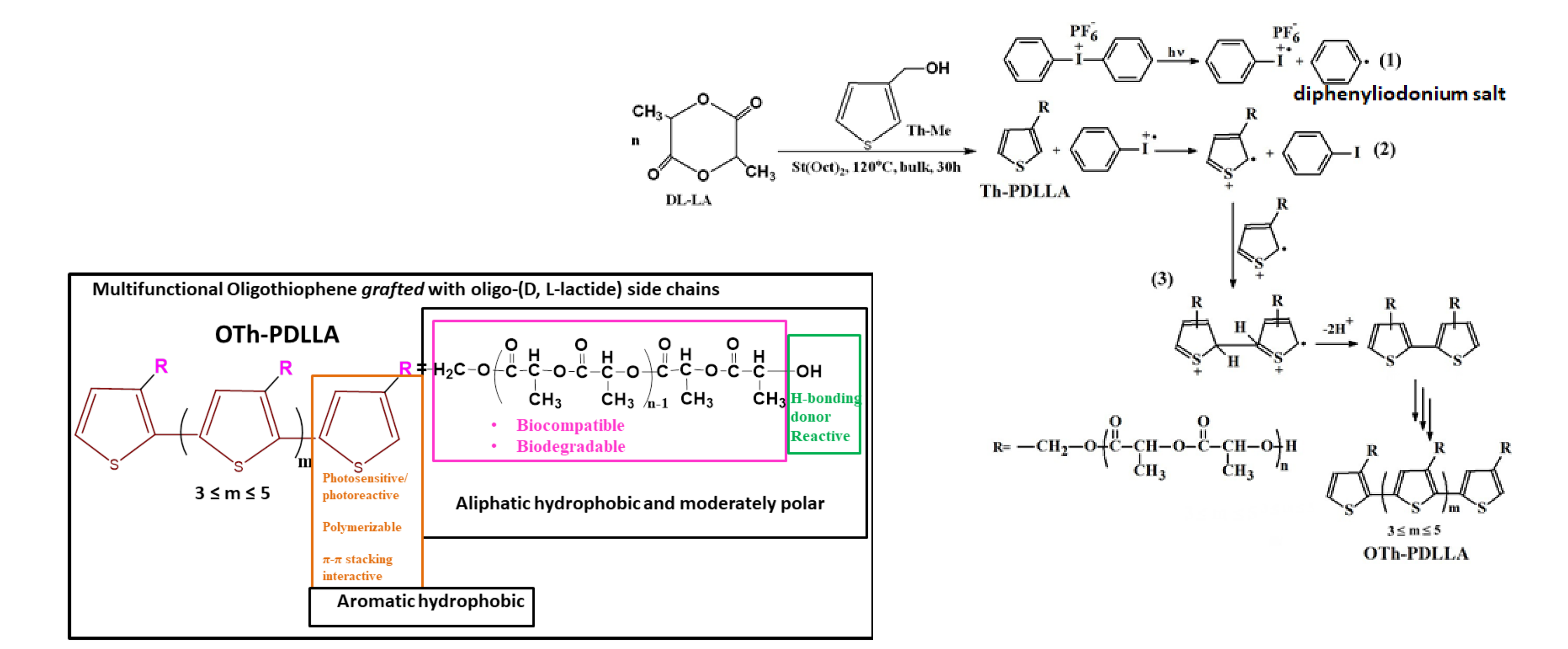


**Figure 1. Design criteria and synthesis pathways of OTh-PDLLA, adapted from** [1].

**Figure 1. AFM images for OTh-PDLLA films obtained from its dispersion in Chl at c=10mg/ml ( a)) and c= 1mg/ml (b))**

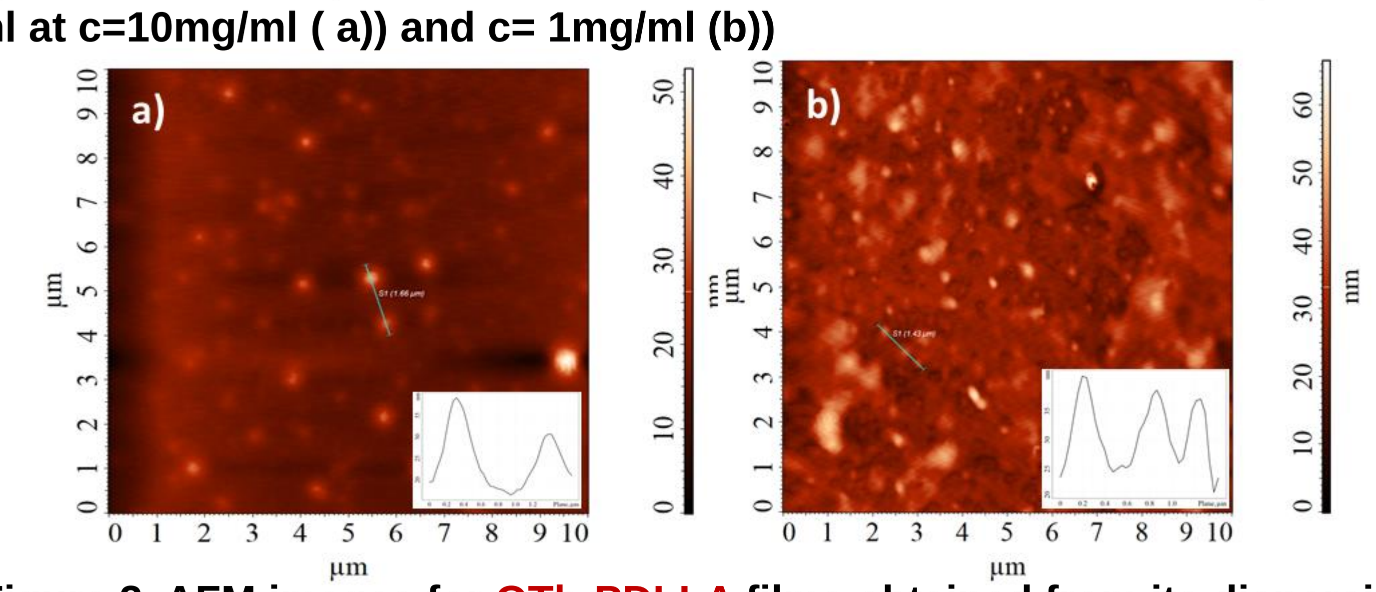

**Figure 2. AFM images for OTh-PDLLA films obtained from its dispersion in DMSO at c=10mg/ml deposited on glass (a)) and PLA film (b))**

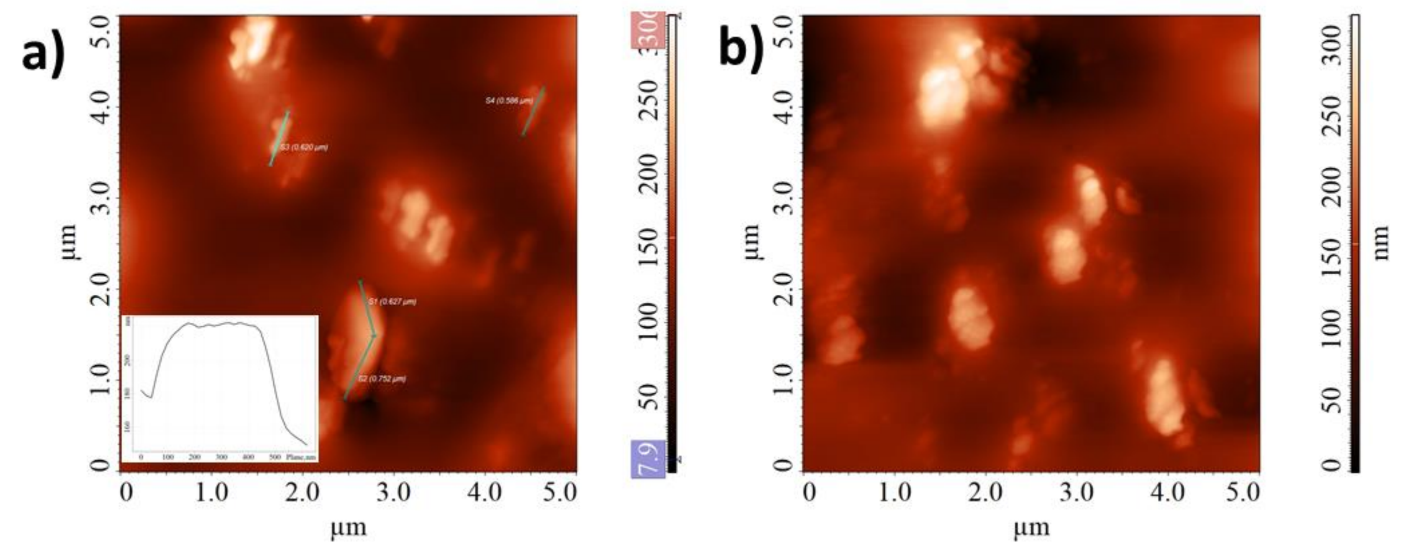

**Table 2. Hydrodynamic radii, water contact angle, surface roughness of OTh-PDLLA films and particles size in dry state measured by AFM**

| Sample | Particle size by DLS(nm) | Water Contact angle (degree) of oligomer's films deposited on | | [2]Roughness by AFM (nm) | | Particle size by AFM (nm) |
|---|---|---|---|---|---|---|
| | | Glass [1](78) | PLA [1](82) | Glass (2.55) | PLA (36.5) | Glass |
| OTh-PDLLA DMSO,10mg/ml | 600;5100 | 83 | 80 | 53 | 73 | width=600, height =40 |
| OTh-PDLLA CHCl3,10mg/ml | 947 | 85 | - | 15 | - | 600 |
| OTh-PDLLA CHCl3,1mg/ml | 934 | 74 | | 41 | - | 450 |

[1]Values of water contact angle for uncovered supports; [2]Calculated for 10x10μm[2] area scanning;

**Figure 3. In vitro cell viability of NHGF seeded on OTh-PDLLA films obtained from its dispersion at c=10mg/ml deposited on glass (a)) and PLA film (b))**

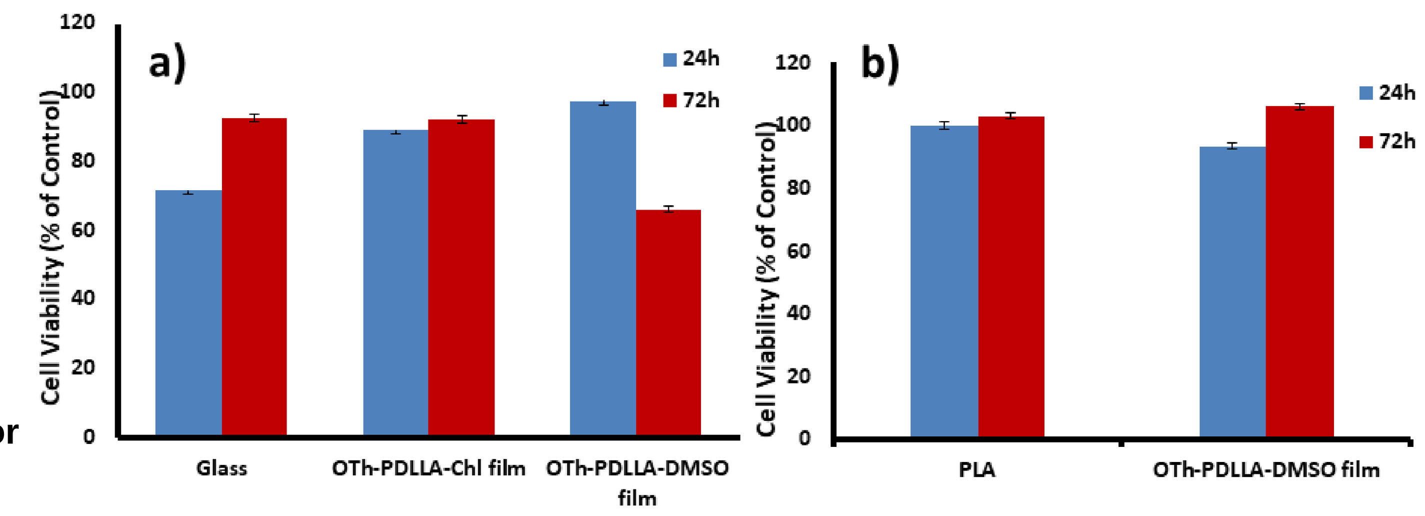


**Figure 4. Size distribution by intensity of particles formed by OTh-PDLLA in DMSO and Chl**

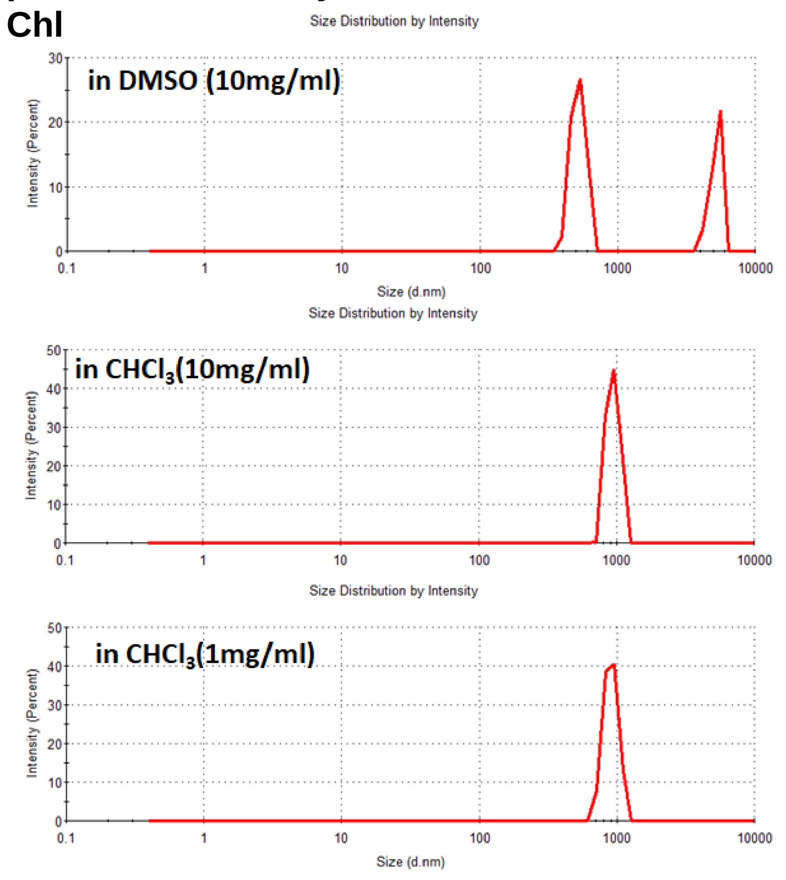


**Table1. Several physical properties of the used solvents for investigations and those of the OTh-PDLLA oligomer’s constitutive parts**

| Compound (e)[&] | Hansen Solubility parameters (MPa$^{1/2}$) | | | | Solvent-Polymer interaction parameters (χ) | | |
|---|---|---|---|---|---|---|---|
| | $\delta_d$ | $\delta_p$ | $\delta_H$ | δt | Chl | DMSO | $CH_2Cl_2$ |
| PDLLA | 18.6 | 9.9 | 6 | 22/20.5 | 0.32 | 0.28 | 0.99 |
| Thiophene;(2.86) | 18.9 | 2.4 | 7.8 | 20 | miscible[#] | | |
| P3HT | 18.5 | 2.8 | 4.51 | | | | |
| Chl (4.81) nonpolar in accord with its dielectric constant value | 17.8 | 3.1 | 5.7 | 19 | - | | |
| DMSO (46.68) Polar solvent with high dielectric constant | 18.2 | 6.3 | 6.1 | 20.3 | | | |

#- experimentally noticed; [&]- dielectric constant

## CONCLUSION

**The present study showed that OTh-PDLLA offer several ways to modulate films surface topography properties in order to adjust their interactions with biological entities as proteins or cells. Employing techniques like dynamic laser-scattering (DLS), contact- angle measurement and atomic force microscopy (AFM) changes in the in particle’s size, in wettability and films surface topography were investigated. Notably, keeping constant the nature of solvent but varying solution’s concentration the films roughness can be varied, while solvent polarity has more influence in films morphology than in their wettability. Using MTS assay the oligomer’s biocompatibility was also confirmed. These are important aspects that advocate for OTh-PDDLA potential use as biocompatible bioelectronic interface or, based on its structural potential for biodegradation, for transient electronics.**

## REFERENCES

Bendrea, A. D.; Cianga, L.; Göen Colak, D.; Constantinescu, D.; Cianga, I. Thiophene End-Functionalized Oligo-(D,L)-Lactide as a New Electroactive Macromonomer for the “Hairy-Rod” Type Conjugated Polymers Synthesis. *Polymers*. **2023**, 15, 1094

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