BIOASSEMBLY OF DTTO-BASED OLIGOTHIOPHENES WITHIN LIVING CELLS

Nicol Spallacci[1], Mattia Zangoli[1], Soraia Flammini[1], Angela Tino[2], Giuseppina Tammasini[2], Marika Iencharelli[2], Claudia Tortiglione[2], Francesca Di Maria[1]

[1]Consiglio Nazionale Ricerche (CNR-ISOF), Via Piero Gobetti, 101, Bologna, 40129, Italy, nicol.spallacci@isof.cnr.it; [2]Consiglio Nazionale Ricerche (CNR-ISASI), Via Campi Flegrei, 34, Pozzuoli, 80078, Italy, marika.iencharelli@isasi.cnr.it

Among the different classes of organic materials, thiophene-based compounds have stimulated widespread interest because of their attractive properties and large potential in countless applications, spanning from organic electronics to biology.[1] In particular, several molecular derivatives of thiophene resulted to be excellent biocompatible fluorophores capable of spontaneously crossing the cell membrane without the need for specific vectors. Among them, the green fluorescent 3,5-dimethyl-2,6-diphenyldithieno[3,2-b:2',3'-d]thiophene 4,4-dioxide (DTTO), intriguingly, when administered to live systems, is able to assemble into fluorescent and conductive microfibers interconnecting cells (Figure 1 A, B).[2] Interestingly, it was found that small changes in the peripheral units of the central DTTO core do not hinder the ability of this molecule to form supramolecular architectures inside live cells, suggesting that DTTO encodes in its structure all the information required to organize itself into 1D fibers. Here, we present the synthesis and electro-optical characterization of new DTTO molecules with different peripheral functionalities. These modifications aim to influence the compounds' functional characteristics as well as their aggregation behavior. Finally, biological investigations on cells and more complex organisms, such as Nematostella vectensis, reveal that these new DTTO compounds are non-toxic and, most of them, maintain their ability to aggregate into fibers intracellularly (Figure 1 A, C).

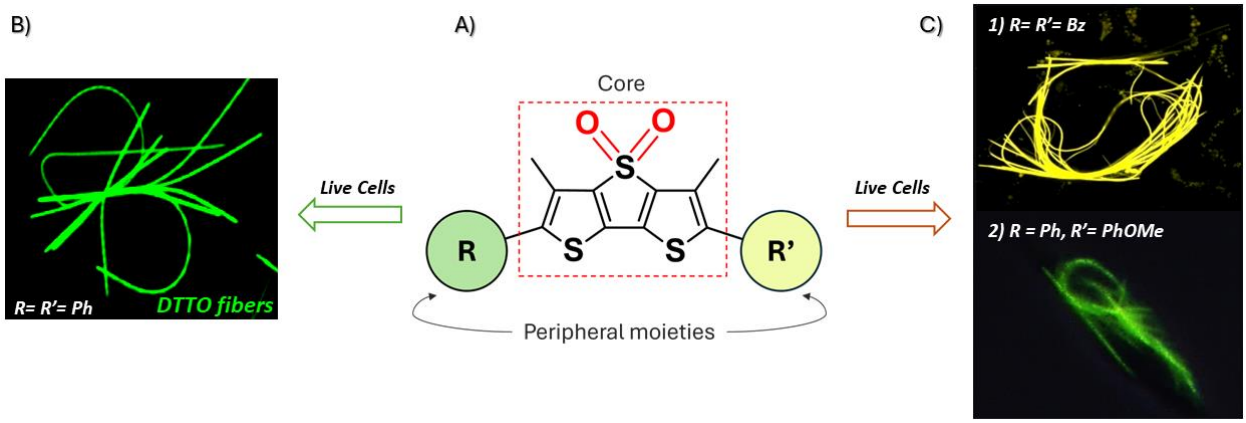

Figure 1. A) General molecular structure of DTTO-based oligothiophenes; B, C) Fibers formed in live fibroblast cells using DTTO and DTTO-derivatives (substituted with R= R'= benzothiadiazole and R=phenyl, R'= m-methoxyphenyl), respectively.

Keywords: Thiophenes, Fluorescence, Oligomers, Microfibers, Cells

REFERENCES

[1] Mishra, C. Q. Ma, J. L. Segura, P. Bäuerle, "Functional Oligothiophene-based Materials: Nanoarchitectures and Applications" in Handbook of Thiophene-Based Materials (I. F. Perepichka, D. F. Perepichka eds.), pp. 1-131, Chichester: John Wiley & Sons, 2009.

[2] a) I. Palamà et al., "Live-Cell-Permeant Thiophene Fluorophores and Cell-Mediated Formation of Fluorescent Fibrils", Journal of the American Chemical Society, vol. 133, no. 44, pp. 17777–17785, 2011. b) I. Palamà et al., "Biocompatible and biodegradable fluorescent microfibers physiologically secreted by live cells upon spontaneous uptake of thiophene fluorophore", Journal of Materials Chemistry B, vol. 3, no. 1, pp. 151–158, 2015.