Realization and characterization of organic diode rectifier

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Interreg France-Wallonie-Vlaanderen LUMINOPTEX

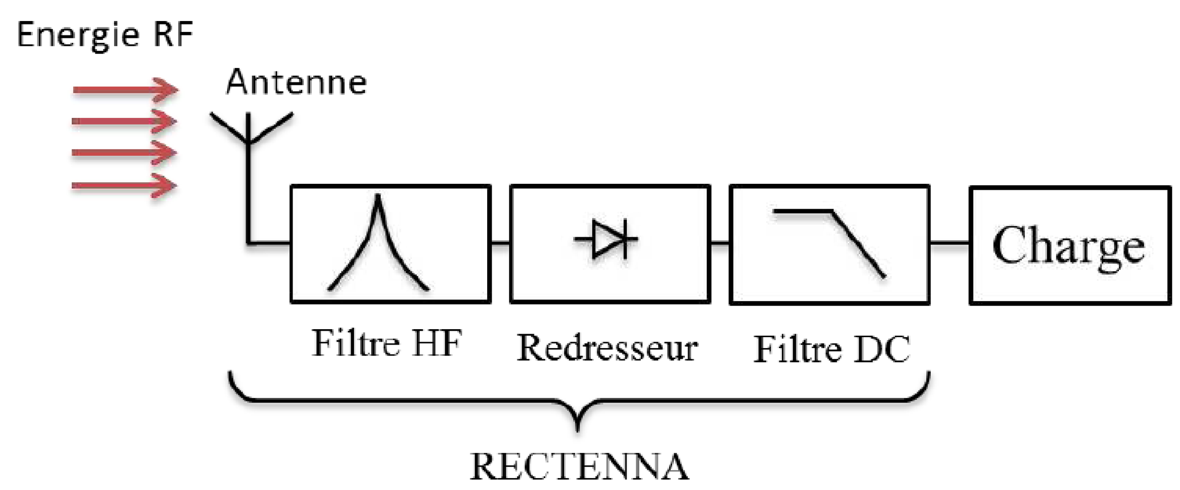
Abstract

Organic diodes have attracted a lot of attention as rectifiers operating at 13.56 MHz which is the current standard carrier frequency for low cost passive RFID tags. Recently, many efforts have been applied toward to extend the operational band width of these diodes to the ultra high frequency range.

The main objective of this work (Project INTERREG Luminoptex) is to develop organic diode rectifier operating @ UHF to be used in rectenna (energy harvesting circuit to power OLEDs in textile) . This can be achieved by using organic semiconductor materials with high carrier motilities and device architectures that yield ideal diode with high rectification ratio.

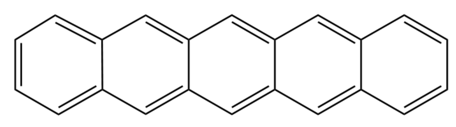
In this work , we have realized organic diode with p type small molecule (pentacene) and n type polymer (Polyera N2200) .We have treated gold with two self assembled monolayers (SAMs): pentafluorobenzenthiol (PFBT) and 11-(pentafluorobenzyloxy)-undecane-1-thiol) HS-C11-O-C-C6F5 . The resuls show high rectification ratio with the first SAM up to 10^7 for pentacene diode.

Introduction and experimental details

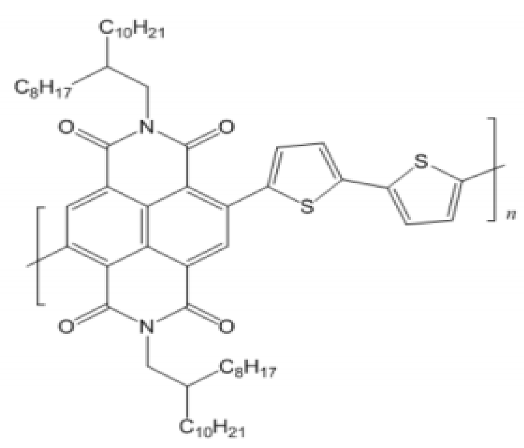


Rectanna (rectifying antenna)

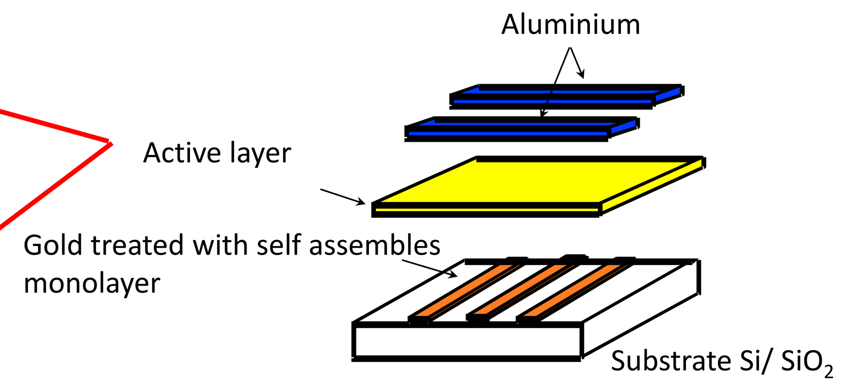
The schottky diode is the main part of the Rectenna in order to rectify the input AC signal and deliver the DC output signal required to power the main circuit.



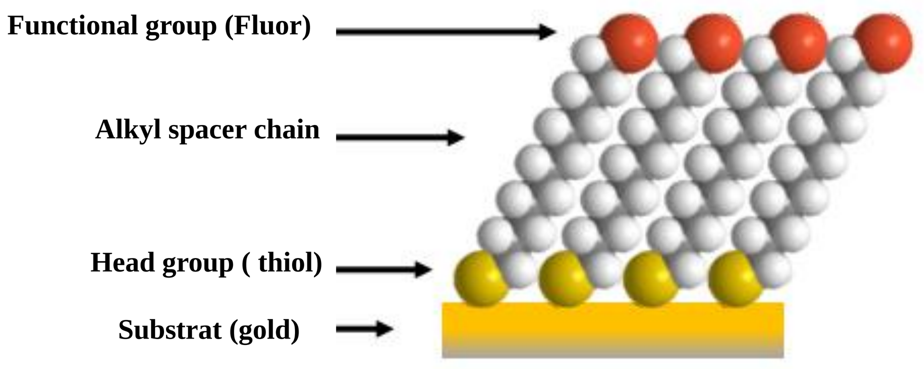
Pentacene



Polyera N2200

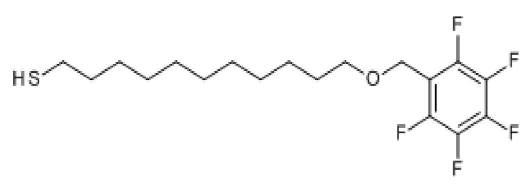


Structure of diode realized



Structure of SAM on gold substrate

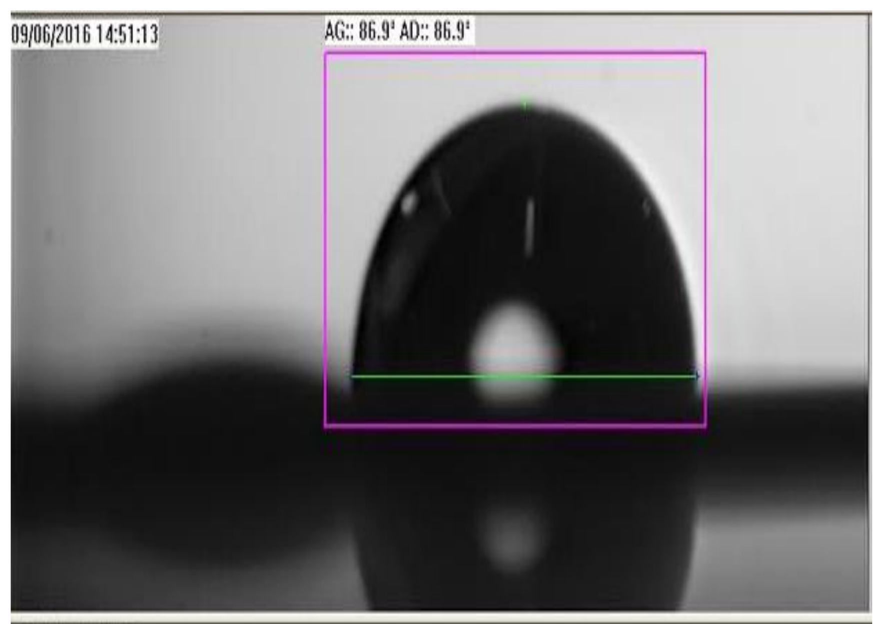
PFBT



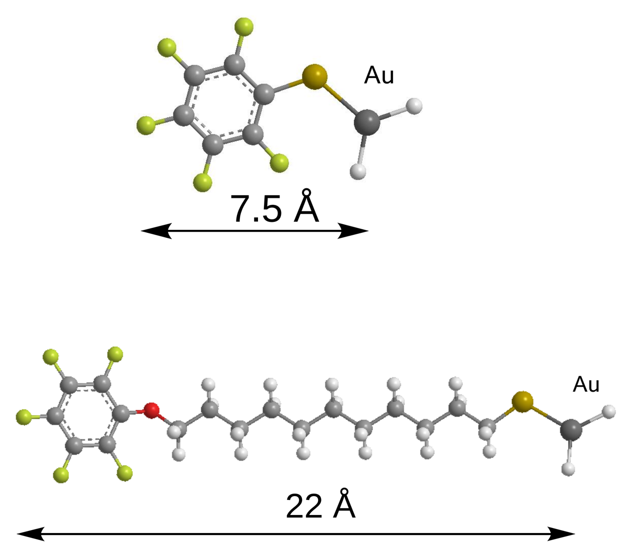
$HS-C_{11}-O-C-C_6F_5$

Chemical structure of SAMs used.

Characterizations of SAMs

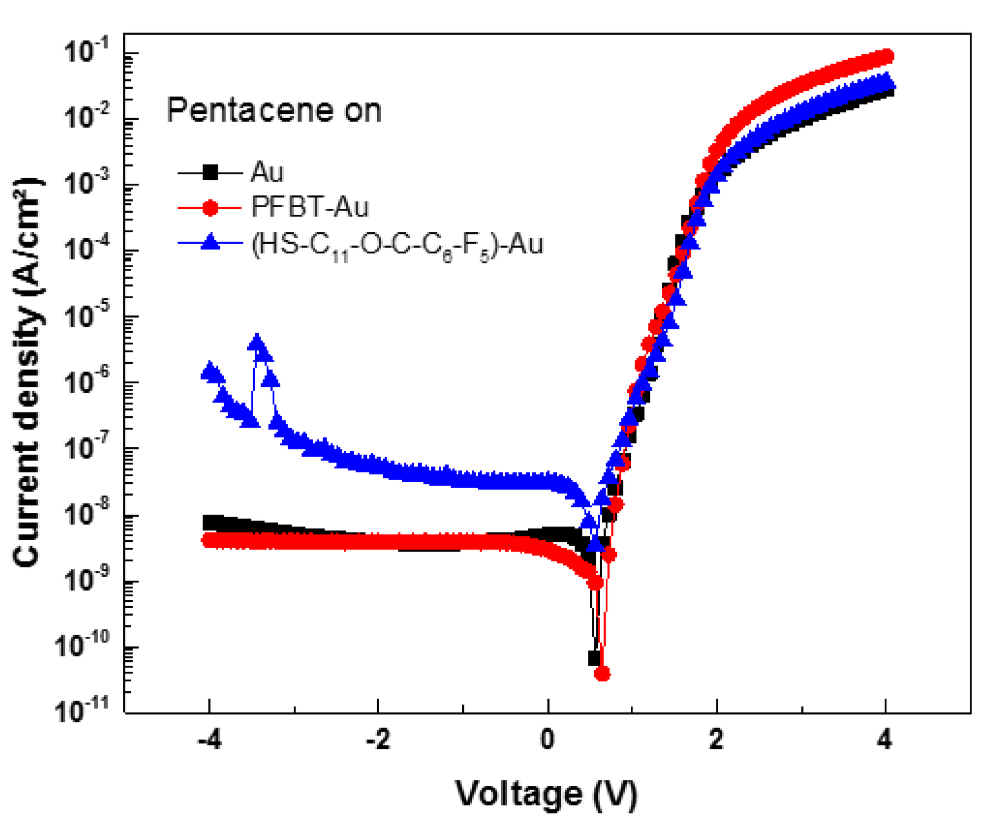


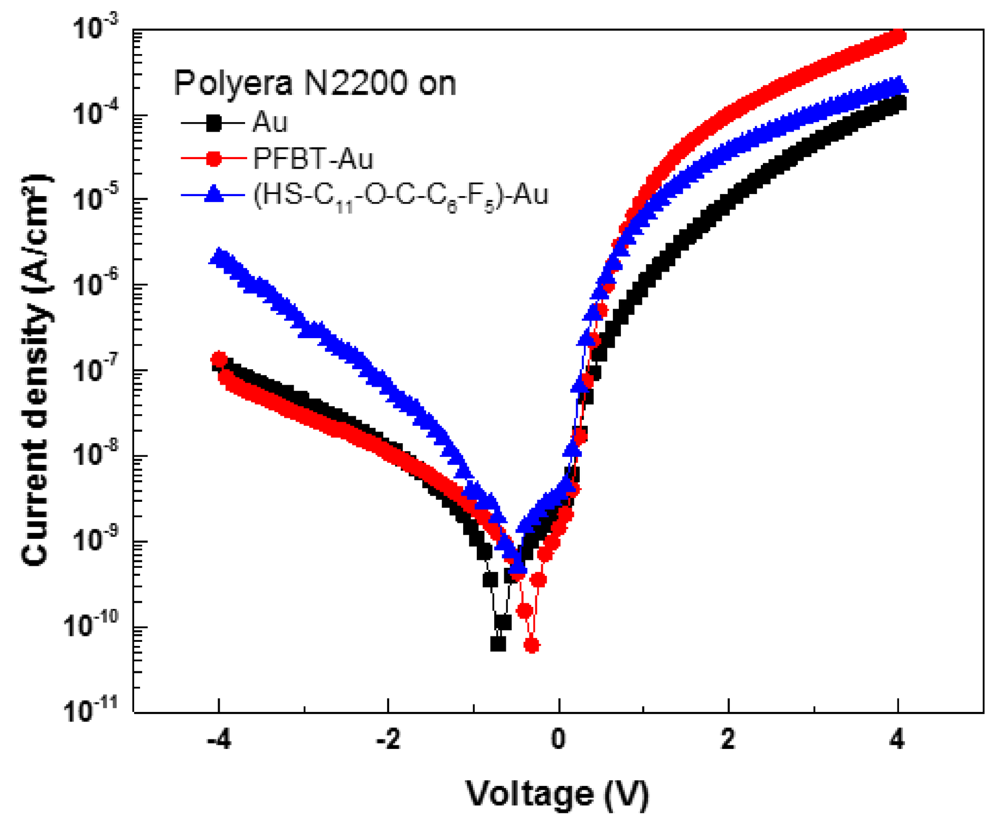
Contact angle



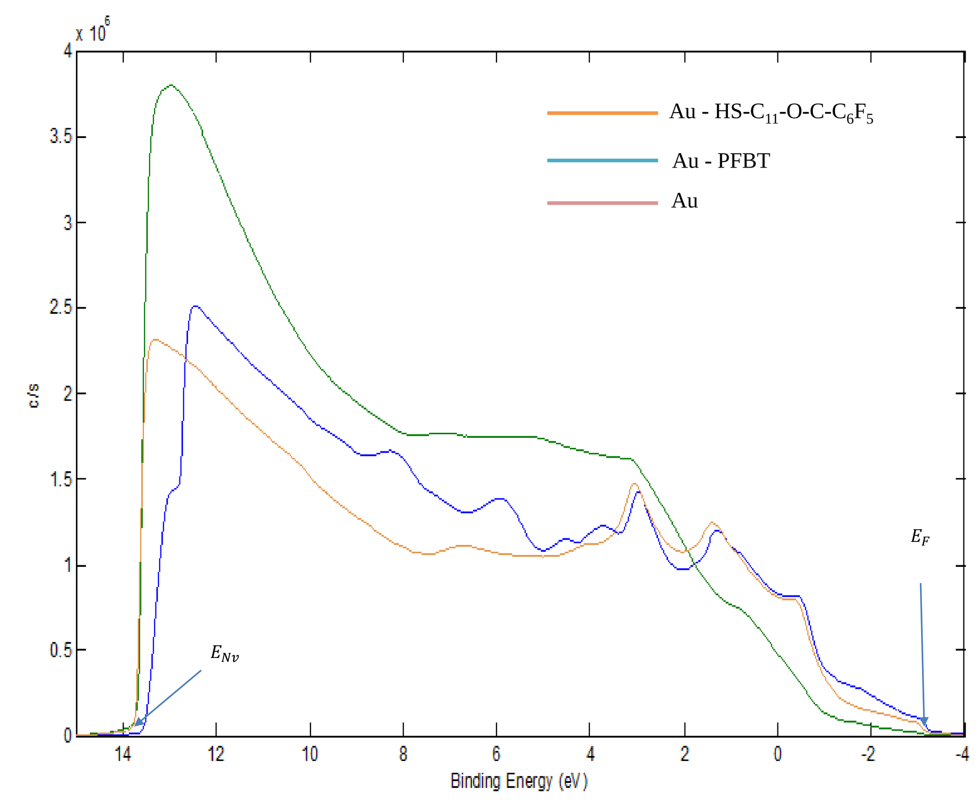
Thickness

Results





DC current density–voltage characteristics for pentacene and Polyera N200 diodes with and without SAM coating on the Au anode.



UV photoelectron spectroscopy :UPS

As a result, the diode with PFBT-treated Au exhibits a high forward bias current density and a low reverse bias leakage. In addition , the rectification ratio of the PFBT-coated Au anode is found to be 2.13* 10^7 for pentacene diode and 6 *10^3 for polyera N200 @ 4V; values that are between 1 and 2 orders of magnitude higher then gold without SAM and with $HS-C_{11}-O-C-C_6F_5$.

Measurements of the work function of gold with and without SAM show work function of -4.39 eV for Au and $Au-HS-C_{11}-O-C-C_6F_5$, and -4.53 eV for Au-PFBT. As a consequence, the PFBT SAM lowers the injection barrier for hole injection.

Conclusion and perspectives

- We studied the J-V characteristics of Schottky diodes with and without treated gold by self assembled monolayer.
- These diodes will be used for measurement in high frequency and integrated then in textile.
- Other materials with high mobility will be used to achieve high rectification ratio and high cut-off frequency.

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