



# Graphene oxide and poly(3-hexylthiophene) nanoscale interface interactions probed by KPFM

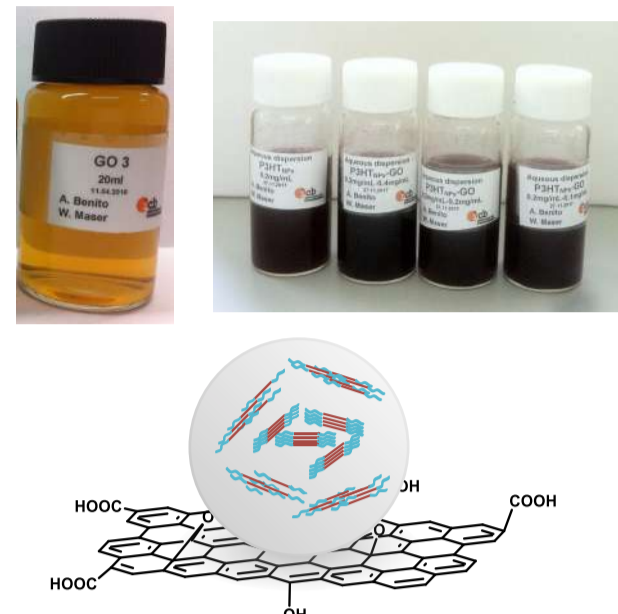
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## Introduction

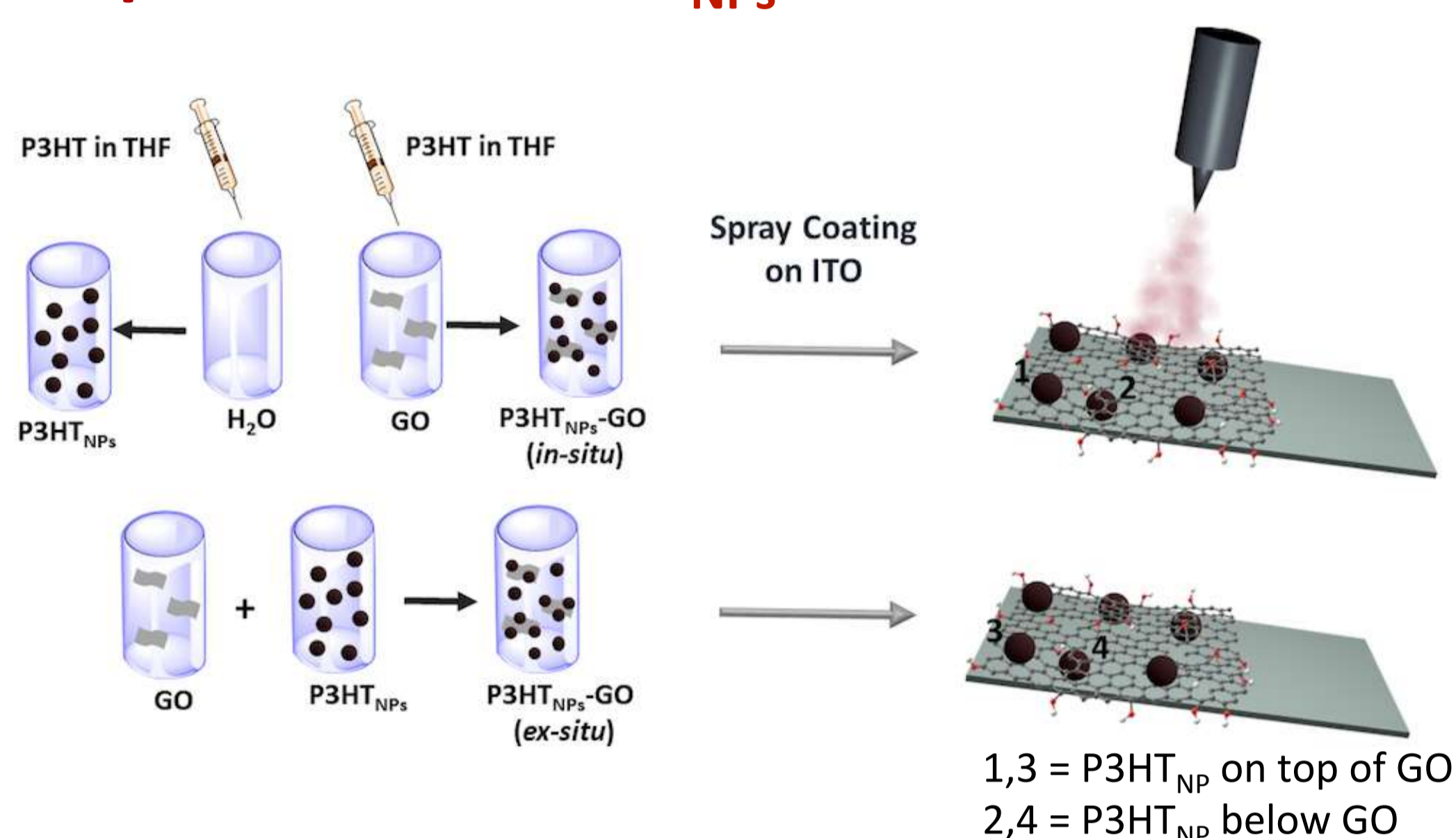


Graphene oxide (GO) is a chemically modified form of graphene containing many different types of oxygen functional groups on its basal plane and edges. Their presence imparts hydrophilicity and allows for ease of processing from water dispersions. We recently have shown that sheets of graphene oxide critically affect the aggregate structure of water dispersible nanoparticles P3HT<sub>NPs</sub> and thus the performance of optoelectronic thin film devices.<sup>1</sup>

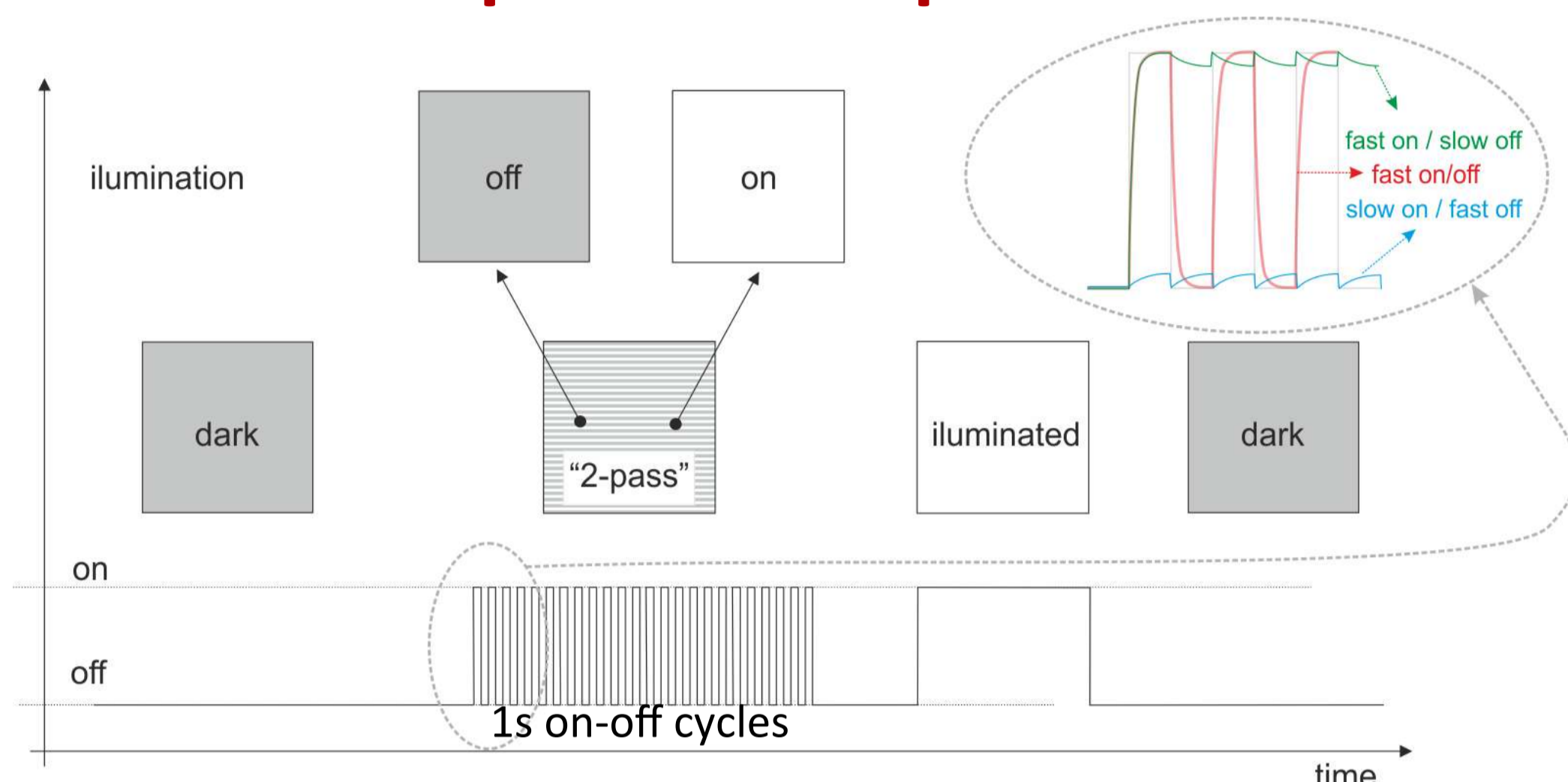
In this work we elucidate the photogenerated charge transfer dynamics of (P3HT<sub>NPs</sub>-GO) ensembles with defined aggregate structure across their interface by Kelvin Probe Force microscopy (KPFM).<sup>2,3</sup>

<sup>1</sup>E. Istif et al, Adv. Funct. Mater 2018, 1707548; <sup>2</sup>E. Palacios-Lidón, Nanotechnology 2009, 20, 085707; <sup>3</sup>E. Palacios-Lidón, Nanoscale 2019, 11, 11202

## Preparation of P3HT<sub>NPs</sub>-GO ensembles

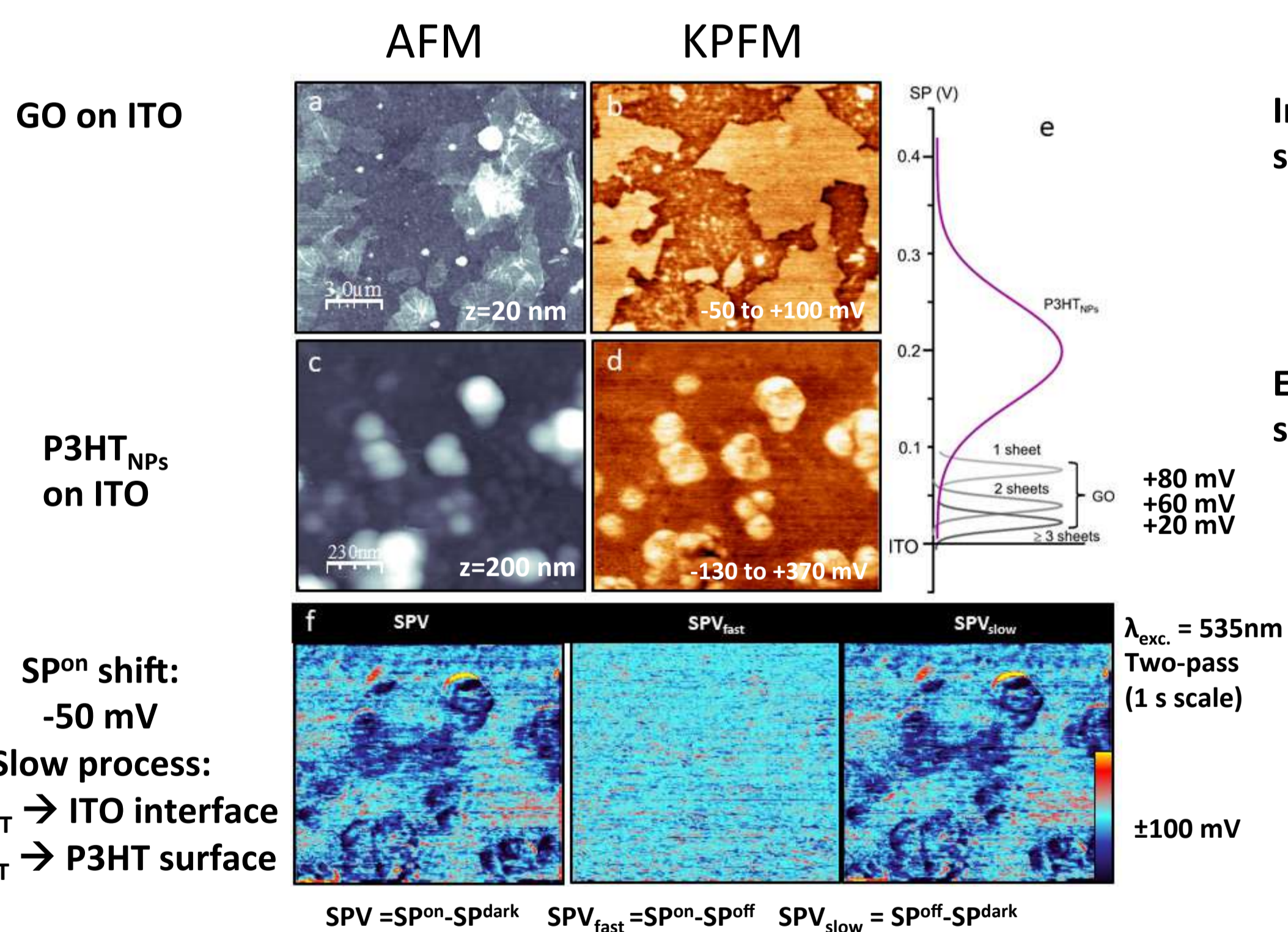


## KPFM: Two-pass technique

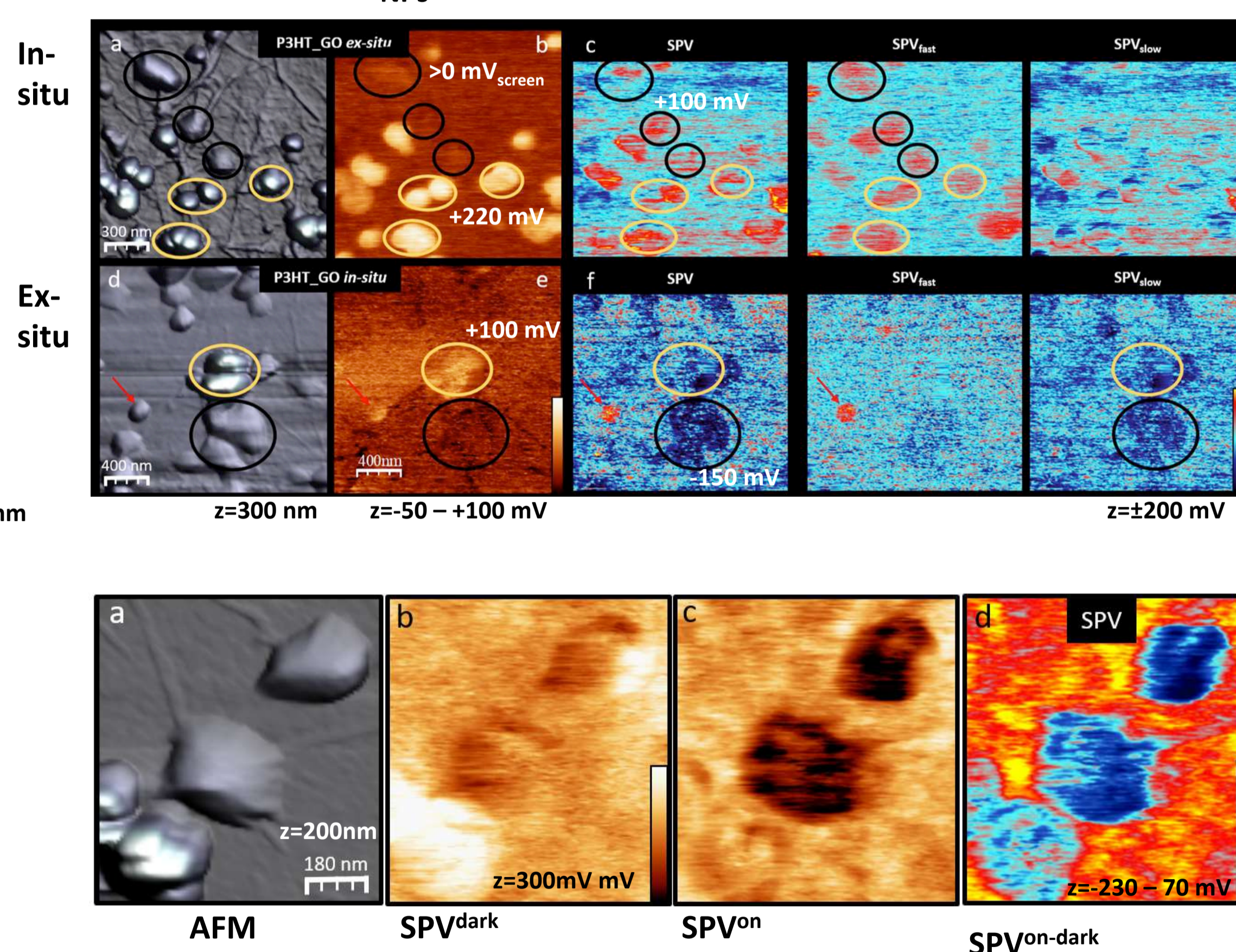


SFM: home-built; Tip ( $k=3\text{N/m}$ ;  $f=75\text{ kHz}$ );  
AFM:  $a_{\text{set}}/a_{\text{free}} = 0.9 - 0.95$ ; non-contact; KPFM:  $U_{\text{ac}} = 500\text{ mV}$  a  $v_{\text{el}} = 7\text{ kHz}$

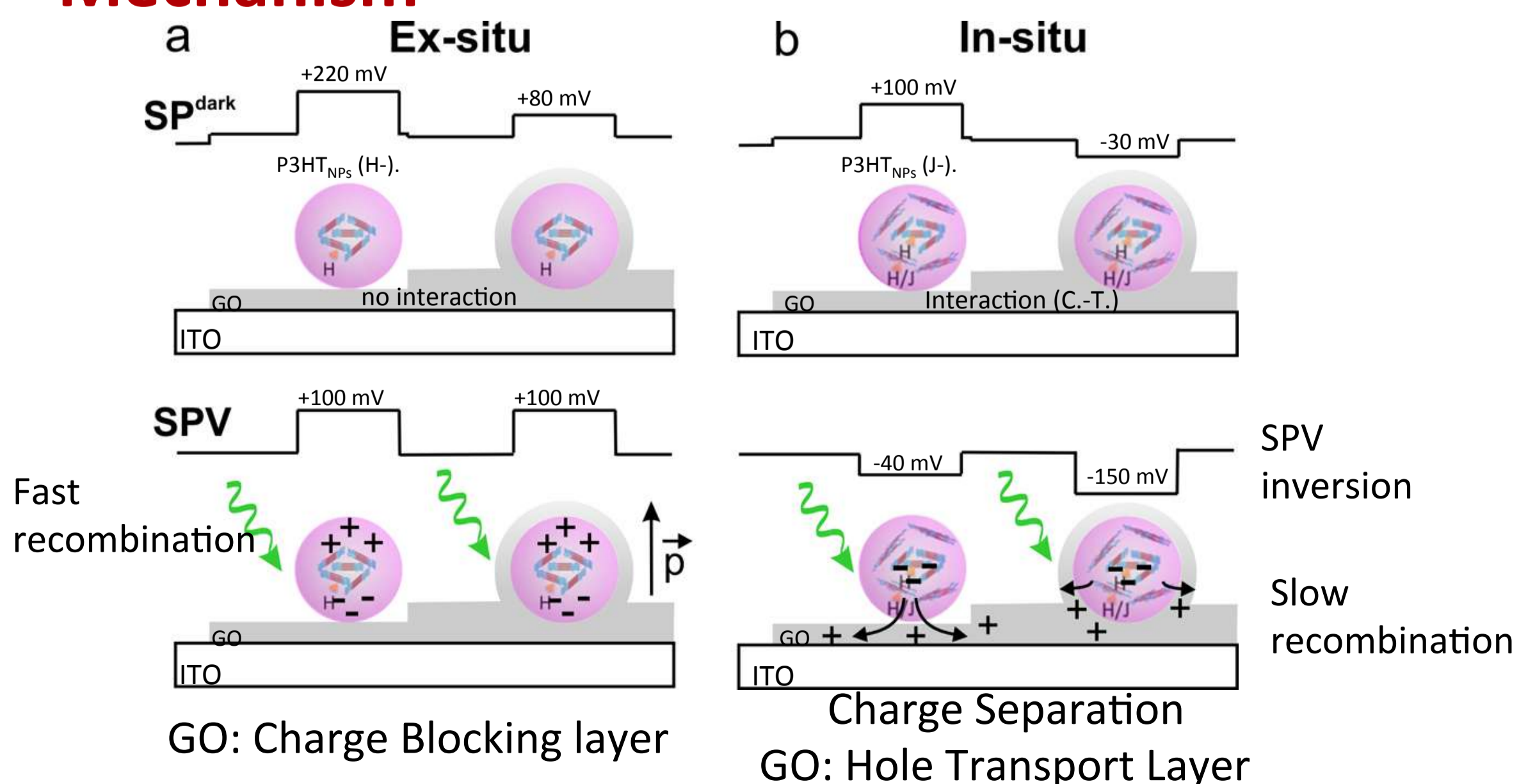
## KPFM STUDIES: Surface potential (SP) and Surface photovoltage (SPV)



## P3HT<sub>NPs</sub> on GO (top and down configuration)



## Mechanism



P3HT<sub>NPs</sub>: SP substructure  
Low SP on GO: C.-T. P3HT<sub>NPs</sub> → GO (modified E<sub>f</sub>) → D-A C.-T.  
SPV: P3HT more negative; GO positive patches (10 nm scale)  
h<sup>+</sup> transferred from P3HT to GO (10 nm scale at 1 s time scale)

## Conclusions

- GO acts as HTL
- P3HT<sub>NPs</sub>-GO (in-situ): Photoactive layered system
- GO acts as CBL
- P3HT<sub>NPs</sub> - GO (exsitu) non-interacting system