



# Hydrous Electrolyte Gated OFETs: Improved Device Stability by Adding Antioxidants

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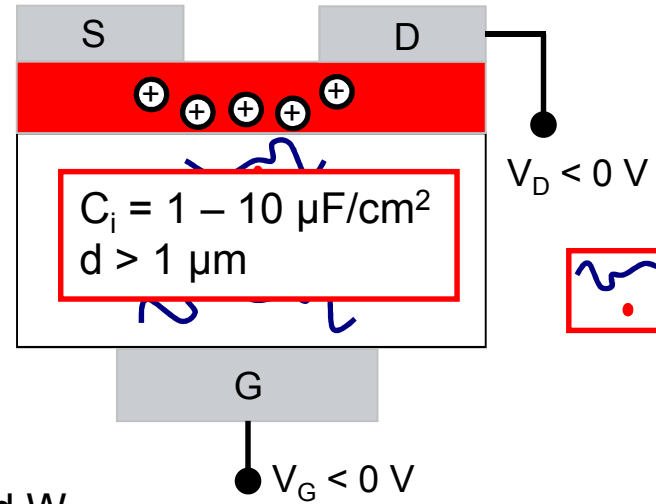
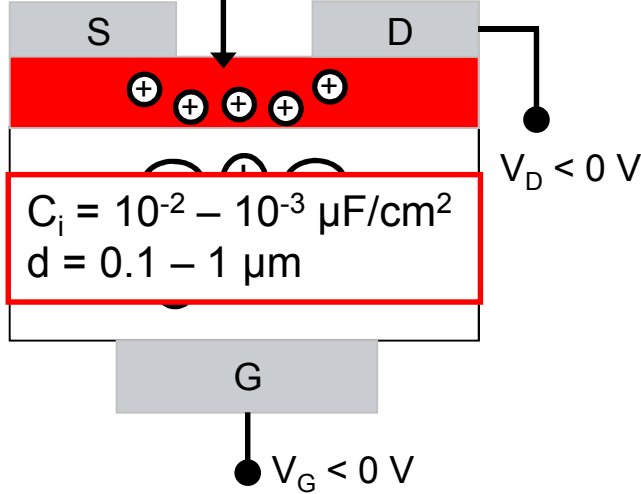


## Outline

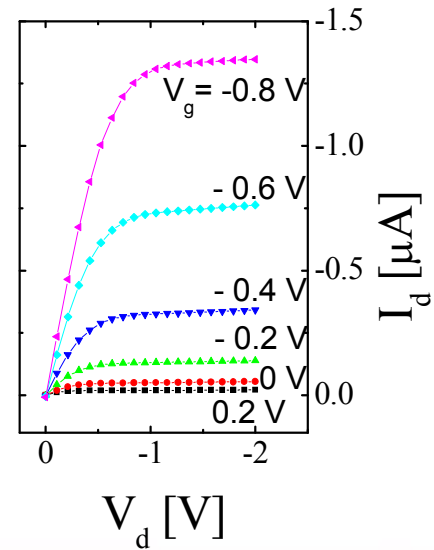
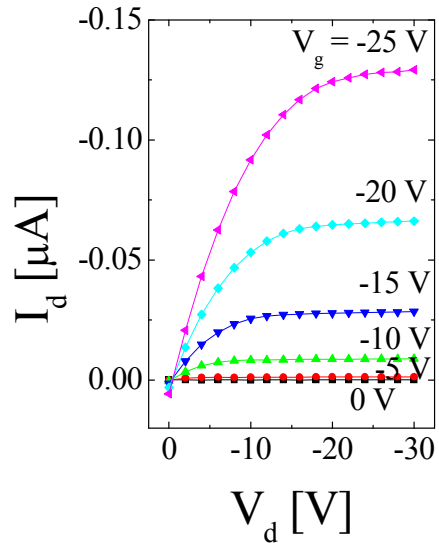
- OFETs vs. Electrolyte Gated OFETs
- The Nafion Gated OFET ("MemFET")
- Oxidative Degradation
- Sterically Hindered Phenolic Antioxidant
- Conclusions
- Acknowledgements

# OFET vs. Electrolyte Gated OFET

p-channel semiconductor

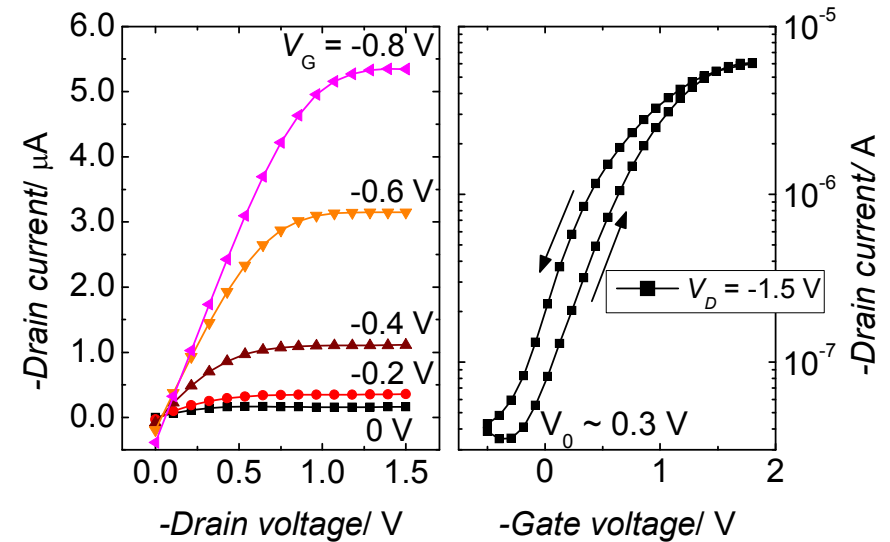
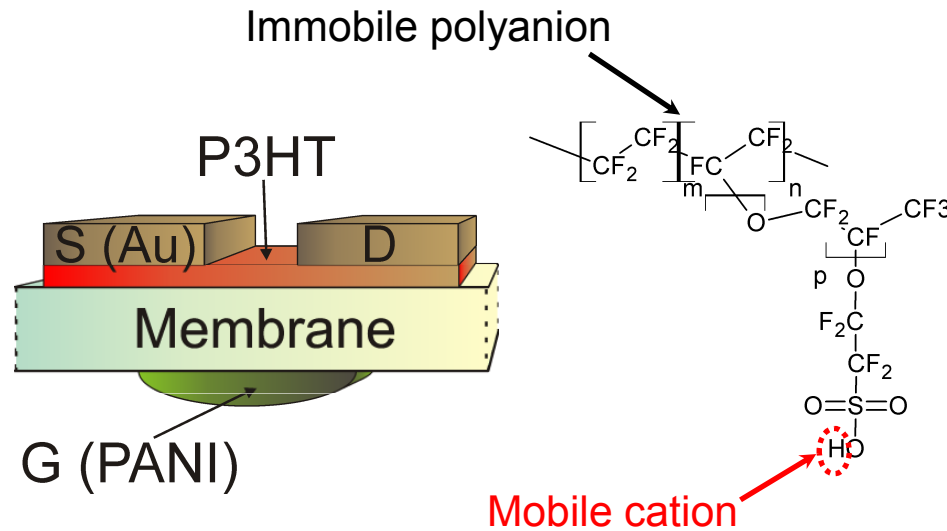


Identical L and W



# The MemFET

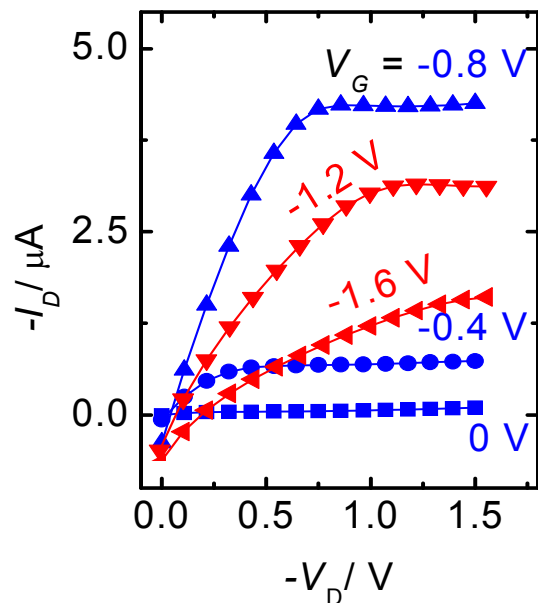
## PTFE:PFSA (Nafion) polyelectrolyte membrane:



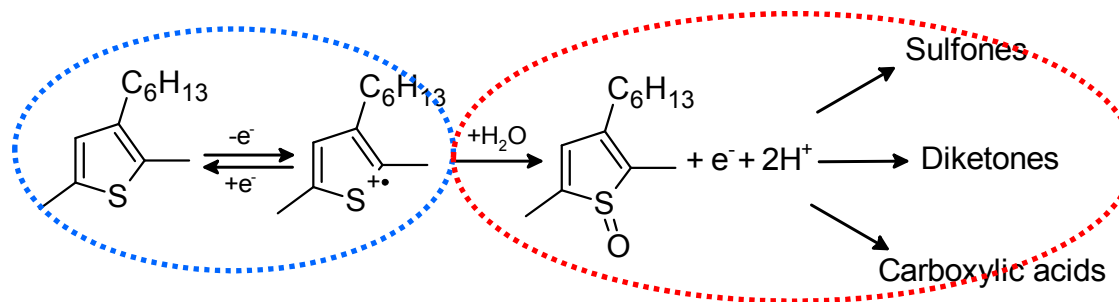
### Membrane features:

- ✓ Counter-ion covalently bound to base-polymer → Immobility.
- ✓ Thick and self-supportive (50 - 150  $\mu\text{m}$ ).
- ✓ Chemical resistance.
- ✓ Layers can be applied both on top and underneath.
- ✓ Multifunctional properties.

# Hydrous Electrolytes Cause Degradation by Oxidation

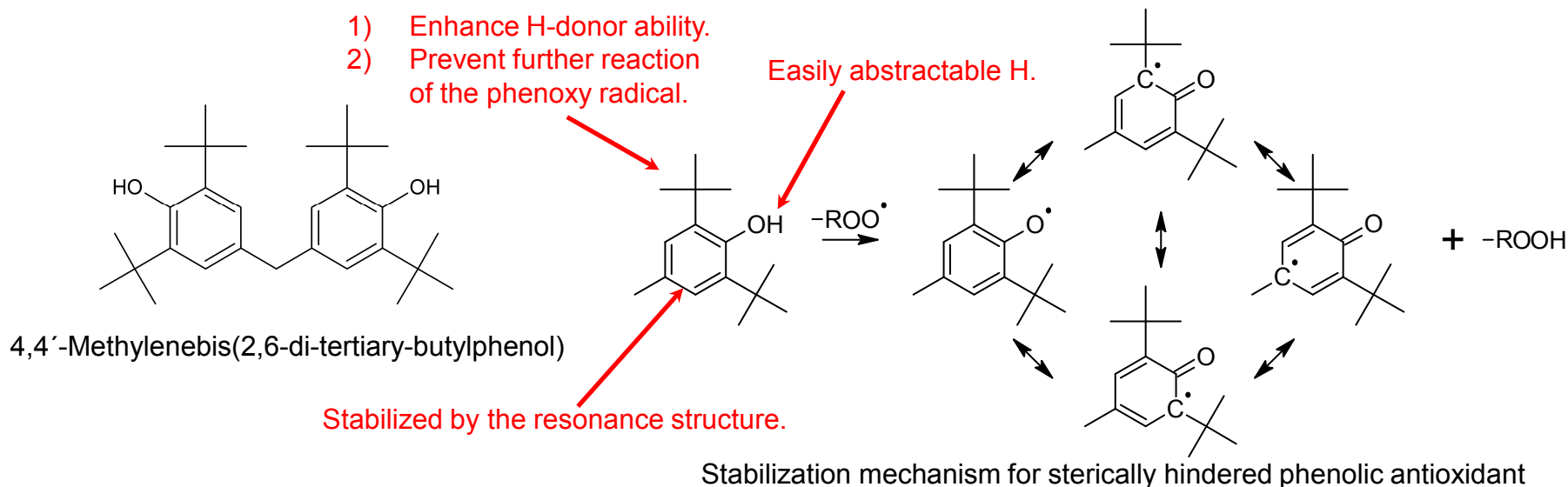


Proposed degradation mechanism for P3HT



Water electrolysis bad for OFETs!

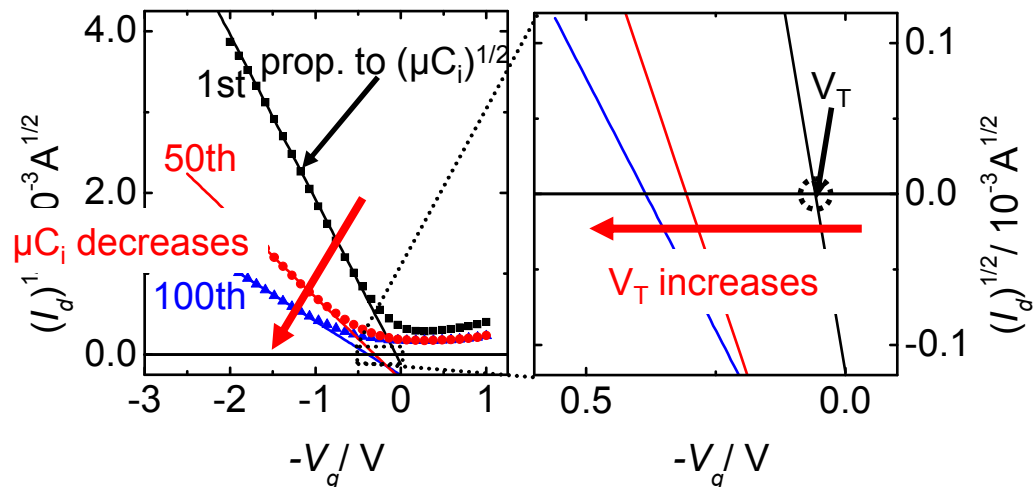
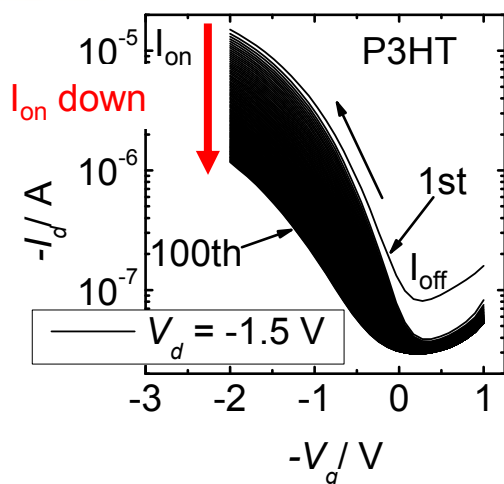
# Sterically Hindered Phenolic Antioxidants



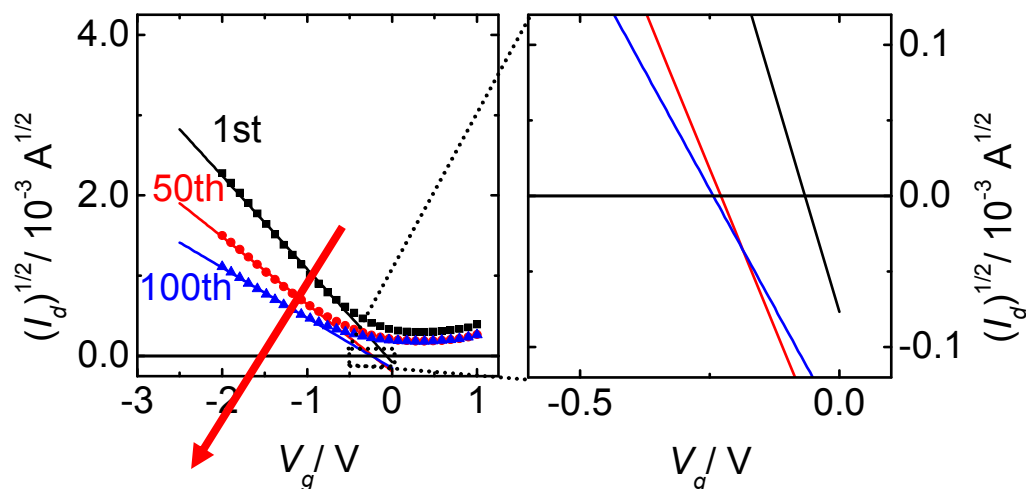
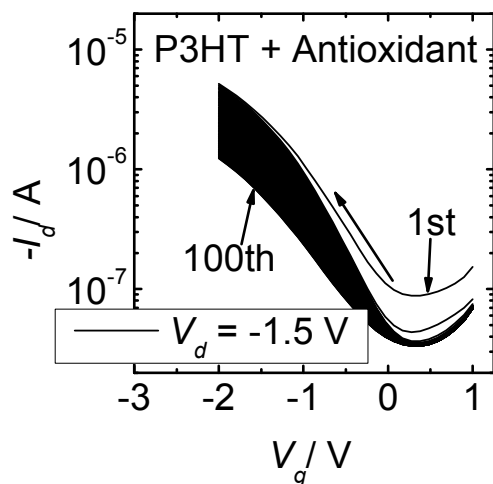
**Sterically Hindered Phenolic Antioxidants:** Well known for protecting polyolefins against degradation [1].

- Have earlier been proposed to inhibit oxidative degradation of conjugated polymers [2,3].
- However, the conclusions have been ambiguous.

# Sterically Hindered Phenolic Antioxidants



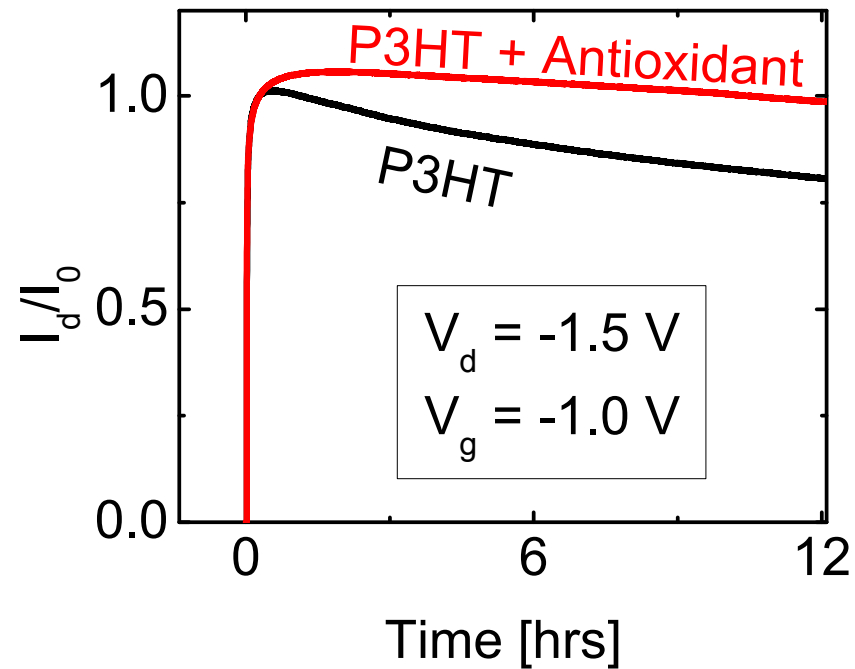
Note!  $V_T$  increases  $\rightarrow$  More electric potential required to *turn on* the transistor  $\leftrightarrow$  **Disrupted conjugation!**



Moisture consumed  $\rightarrow$  Membrane dries out  $\rightarrow$   $C_i$  decreases!

# Sterically Hindered Phenolic Antioxidant

MemFETs statically biased for 12 hours.







## Conclusions

- ✓ Electrolyte gated OFETs provide high performance at low voltages ( $< 3$  V).
- ✓ Above a certain threshold voltage the hydrous electrolyte gated OFETs degrade by oxidation.
- ✓ Sterically hindered phenolic antioxidants protect conjugated polymers from oxidative degradation.



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**Thank You!**



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