



Hydrous Electrolyte Gated OFETs: Improved Device Stability by Adding Antioxidants

Nikolai Kaihovirta

Department of Natural Sciences, Åbo Akademi University

ISAB meeting, Åbo/Turku, Finland

nkaihovi@abo.fi

1.6.2010



UNIVERSITY OF HELSINKI



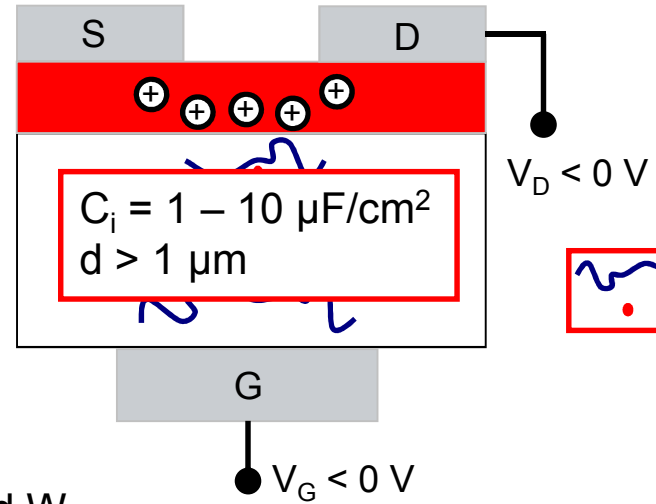
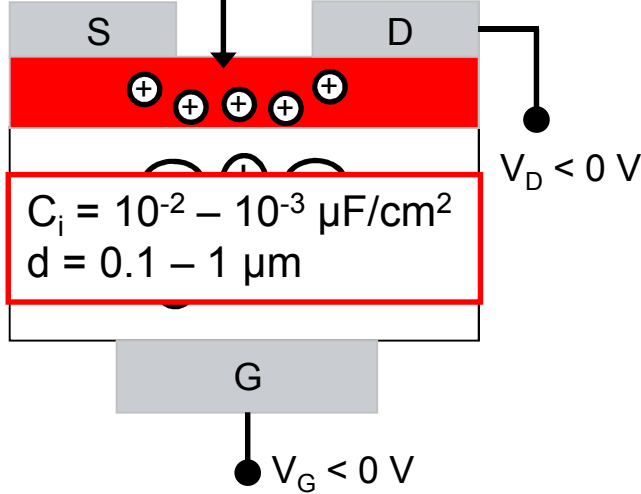


Outline

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

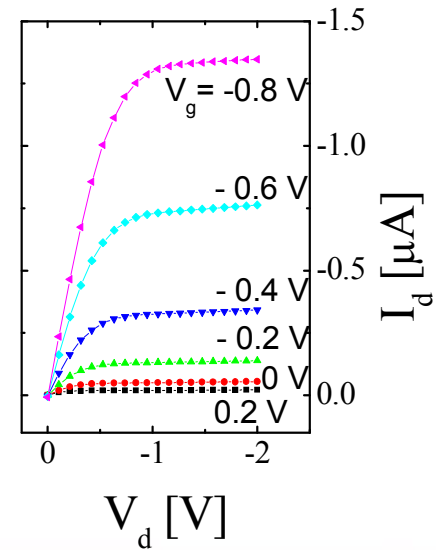
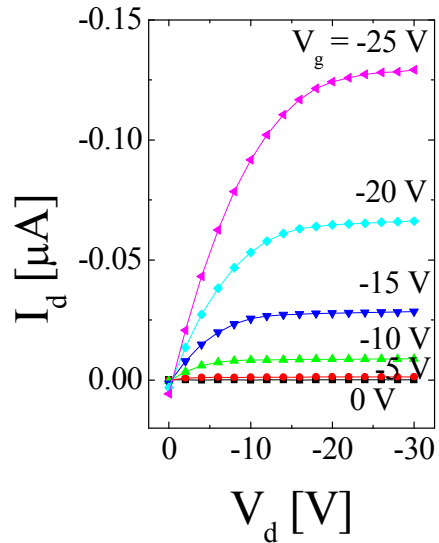
OFET vs. Electrolyte Gated OFET

p-channel semiconductor



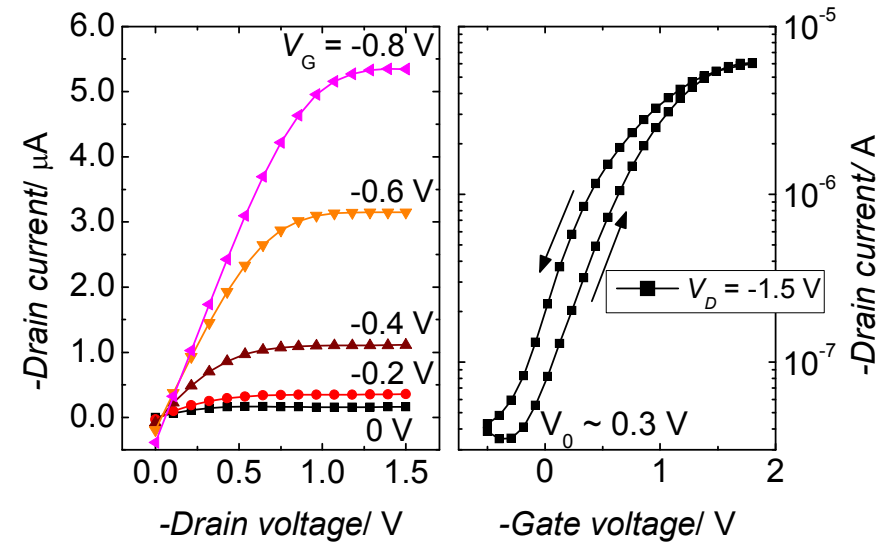
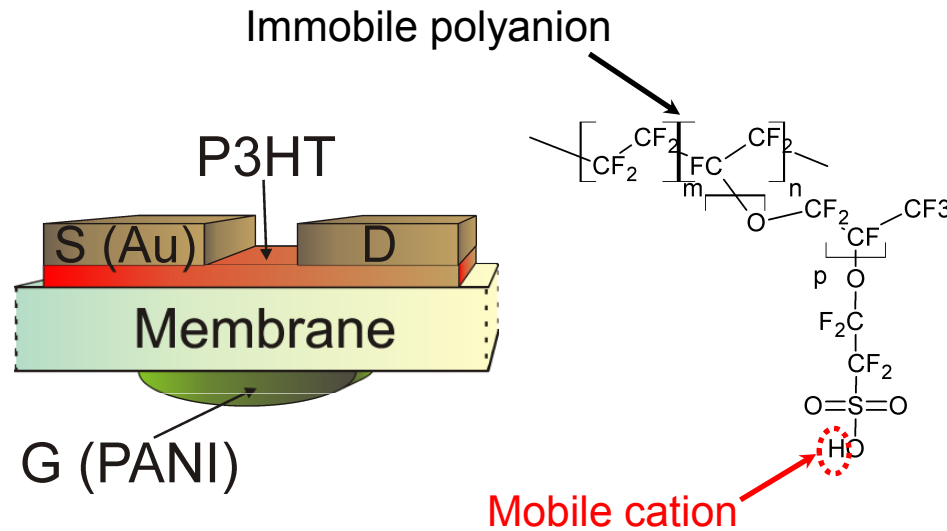
Polyanion
 Cation

Identical L and W



The MemFET

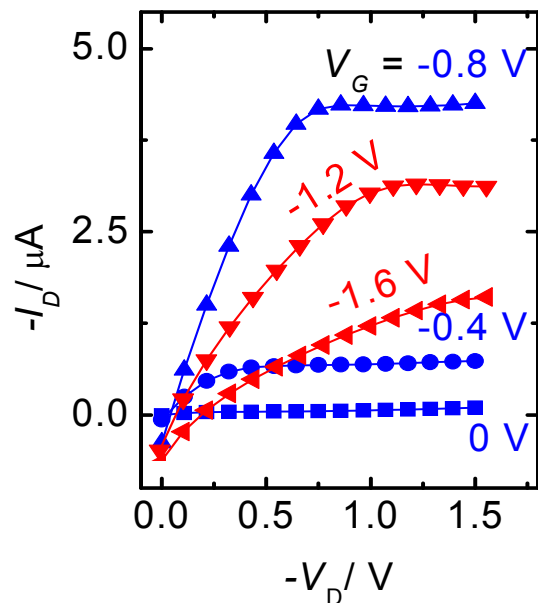
PTFE:PFSA (Nafion) polyelectrolyte membrane:



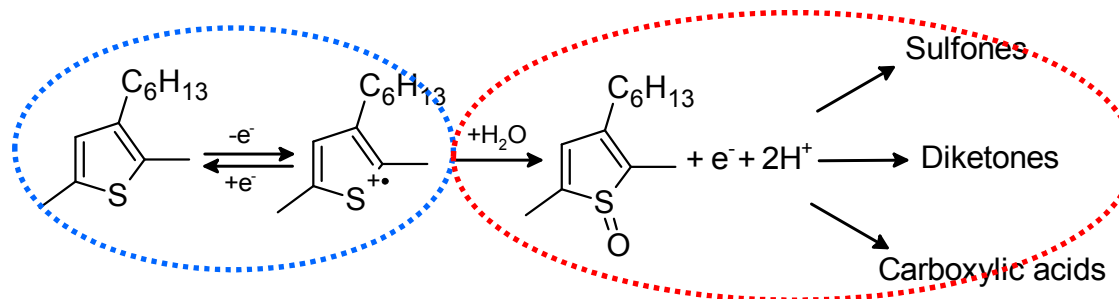
Membrane features:

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

Hydrous Electrolytes Cause Degradation by Oxidation

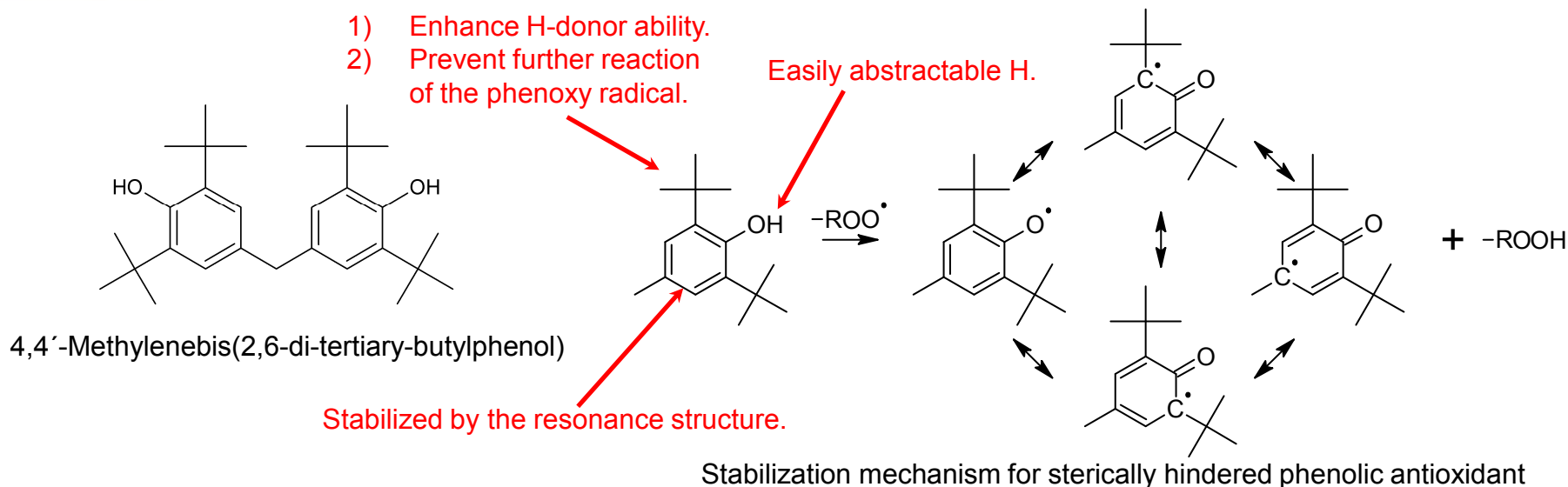


Proposed degradation mechanism for P3HT



Water electrolysis bad for OFETs!

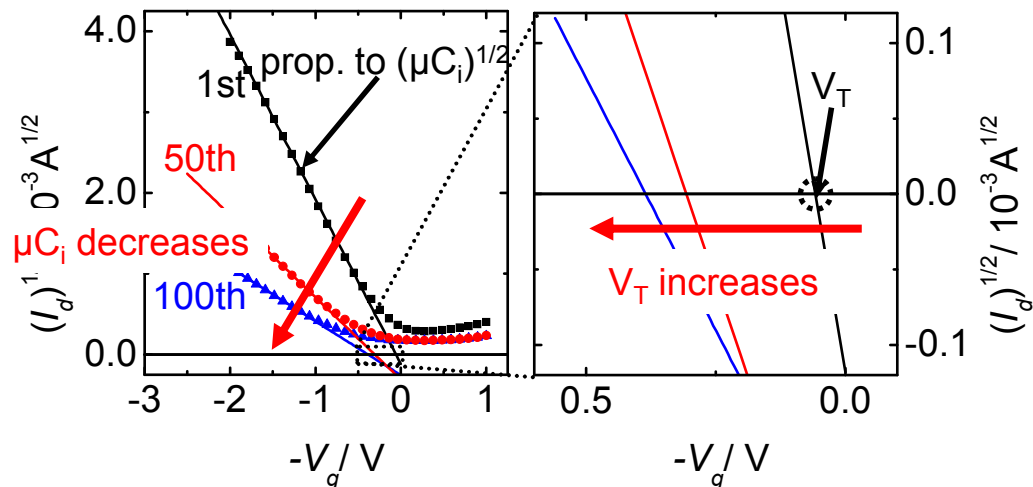
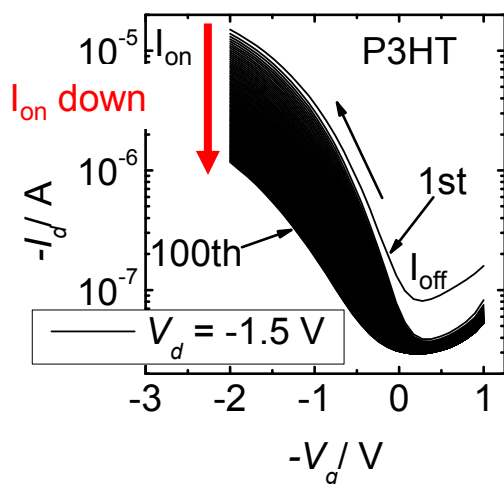
Sterically Hindered Phenolic Antioxidants



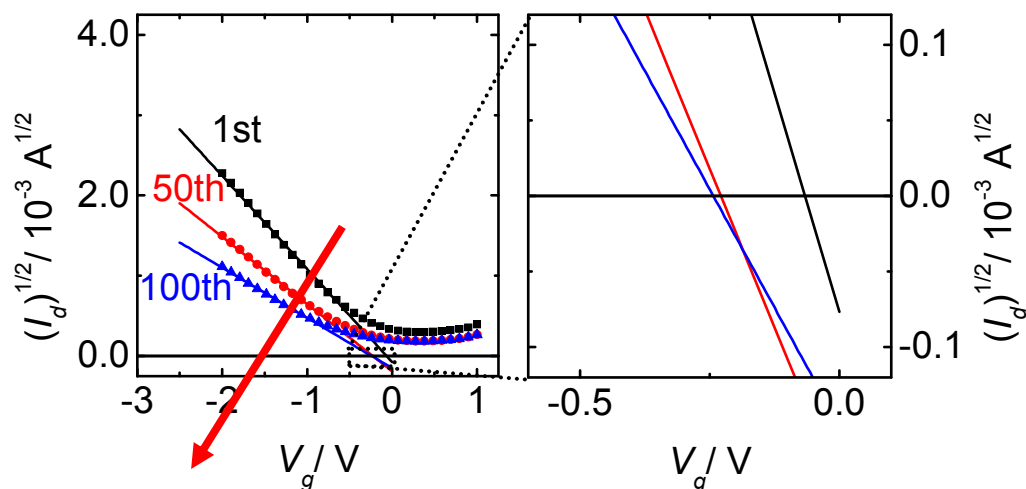
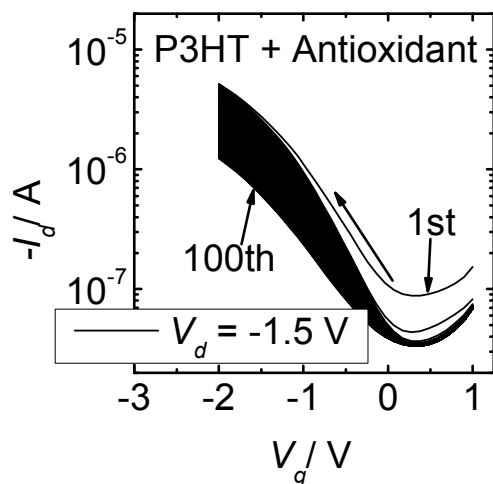
Sterically Hindered Phenolic Antioxidants: Well known for protecting polyolefins against degradation [1].

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

Sterically Hindered Phenolic Antioxidants



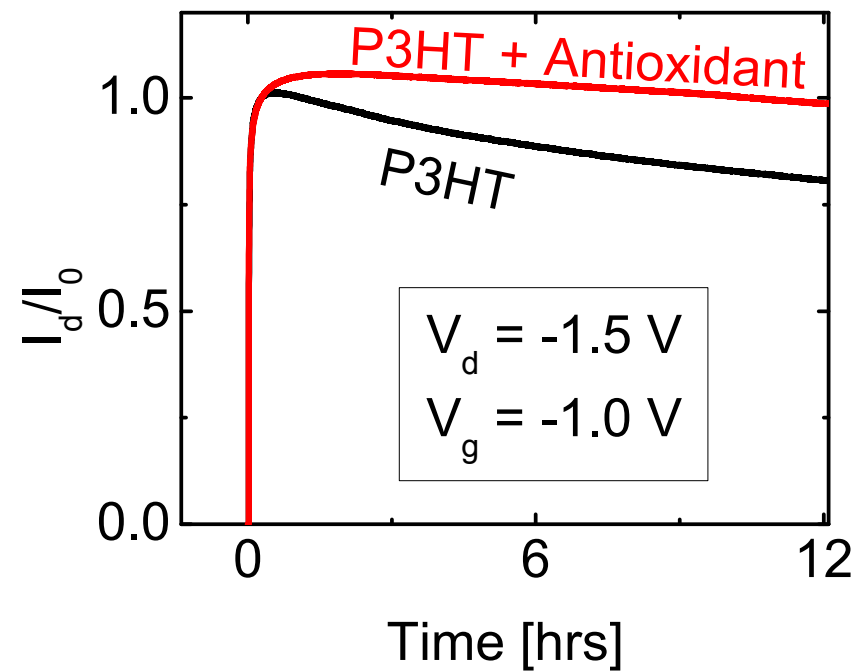
Note! V_T increases \rightarrow More electric potential required to *turn on* the transistor \leftrightarrow **Disrupted conjugation!**



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.



Collaborators:

H. Aarnio, C.-J. Wikman, Prof. C.-E. Wilén and Prof. K. Österbacka.

Financial Support:

- Academy of Finland through the National Center of Excellence.
- Finnish Funding Agency for Technology and Innovation through the FLEXSENS project.
- Åbo Akademi Foundation.

Thank You!



UNIVERSITY OF HELSINKI



ÅBO AKADEMI