INSTITUTE OF ELECTRONIC STRUCTURE AND LASER

Electronic Plants as an innovative platform for reducing environmental health risk factors

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SDG3: Good health and well-being & related Targets

TARGET 3.1
REDUCE MATERNAL MORTALITY

TARGET 3.2
END ALL PREVENTABLE DEATHS UNDER 5 YEARS OF AGE

TARGET 3.3
FIGHT COMMUNICABLE DISEASES

TARGET 3.4
REDUCE MORTALITY FROM NON-COMMUNICABLE DISEASES AND PROMOTE MENTAL HEALTH

TARGET 3.5
PREVENT AND TREAT SUBSTANCE ABUSE

TARGET 3.6
REDUCE ROAD INJURIES AND DEATHS

TARGET 3.7
UNIVERSAL ACCESS TO SEXUAL AND REPRODUCTIVE CARE, FAMILY PLANNING AND EDUCATION

TARGET 3.8
ACHIEVE UNIVERSAL HEALTH COVERAGE

TARGET 3.9
REDUCE ILLNESSES AND DEATH FROM HAZARDOUS CHEMICALS AND POLLUTION

TARGET 3.A
IMPLEMENT THE WHO FRAMEWORK CONVENTION ON TOBACCO CONTROL

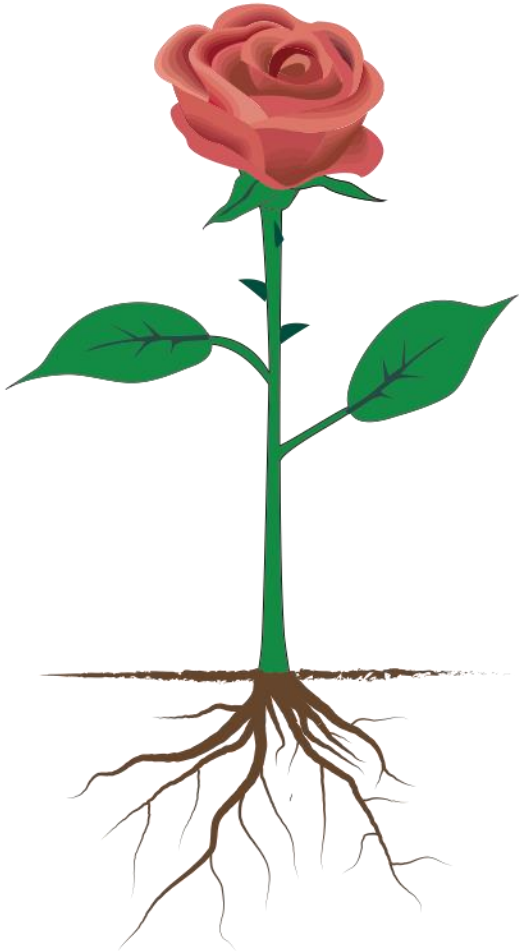
TARGET 3.B
SUPPORT RESEARCH, DEVELOPMENT AND UNIVERSAL ACCESS TO AFFORDABLE VACCINES AND MEDICINES

TARGET 3.C
INCREASE HEALTH FINANCING AND SUPPORT HEALTH WORKFORCE IN DEVELOPING COUNTRIES

TARGET 3.D
IMPROVE EARLY WARNING SYSTEMS FOR GLOBAL HEALTH RISKS

Plants as technological components

- Solar-powered
- Carbon negative
- Convert CO_2 into chemical energy
- Sense and adapt to various environmental stimuli
- Self-repair via tissue regeneration
- Produce useful materials (e.g. cellulose)



Plant-based biohybrid technological systems

Plant Nanobionics

Electronic Plants

Electronic Plants – The concept

Prof. Magnus Berggren

Prof. Eleni Stavrinidou

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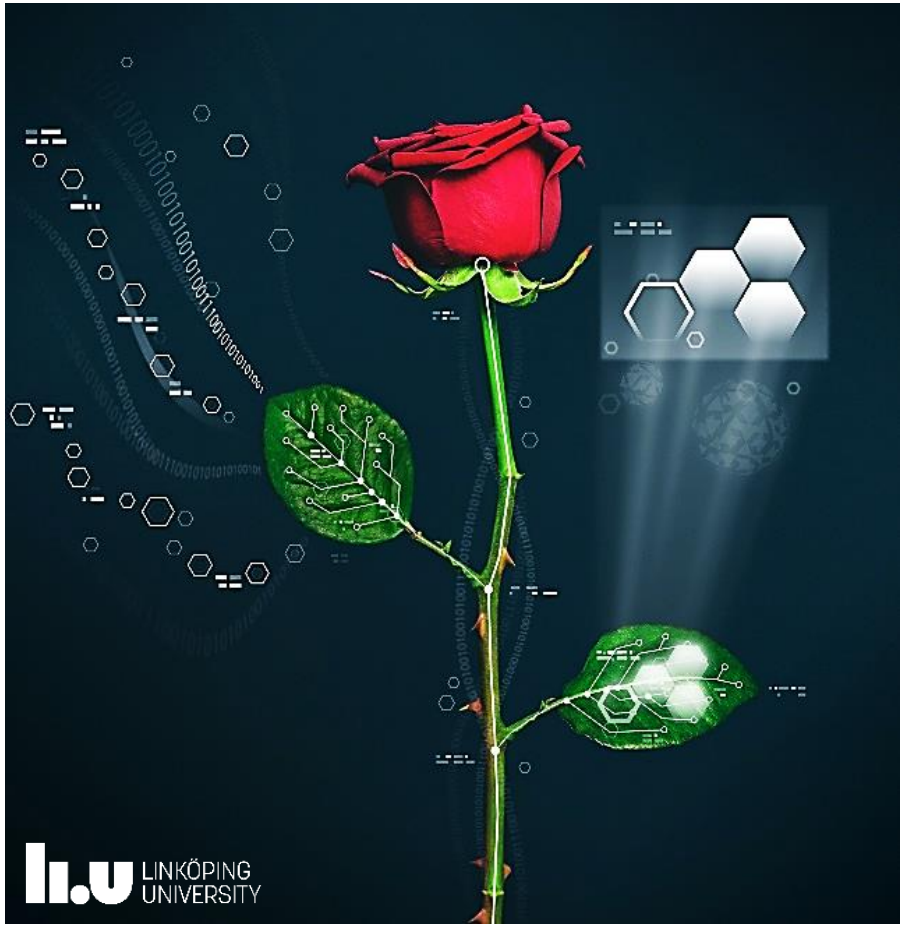


E. Stavrinidou et al. *Sci.Adv.* **1**, e1501136 (2015)

HyPhOE

H2020 – FET open:
Hybrid Electronics based on Photosynthetic Organisms

European Commission | Horizon 2020 European Union funding for Research & Innovation

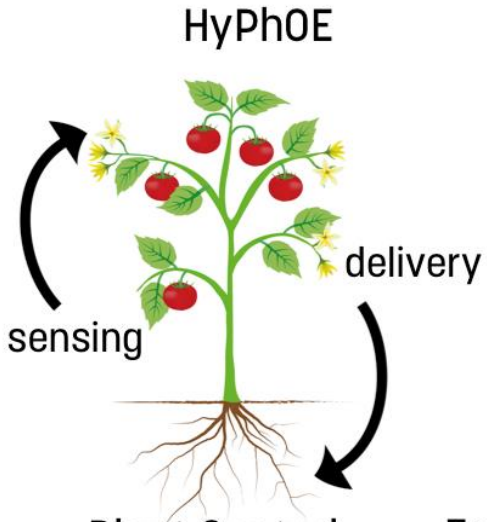
Electronic Plants – Applications

Prof. Magnus Berggren

Prof. Eleni Stavrinidou

LINKÖPING UNIVERSITY

Energy Systems



Plant Control

Environmental Monitoring

HyPhOE

H2020 – FET open:
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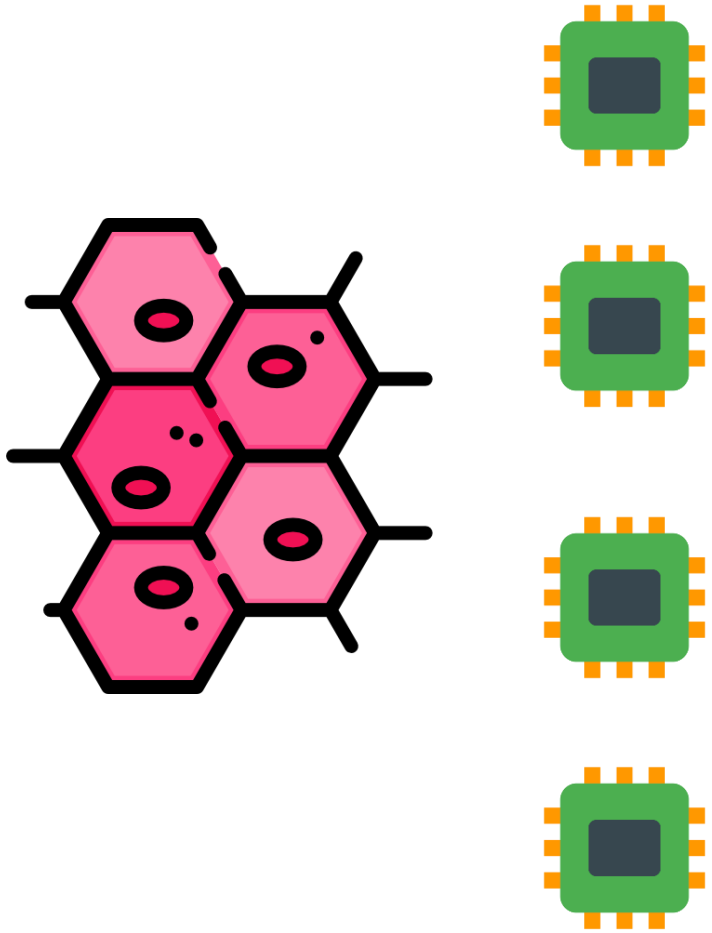
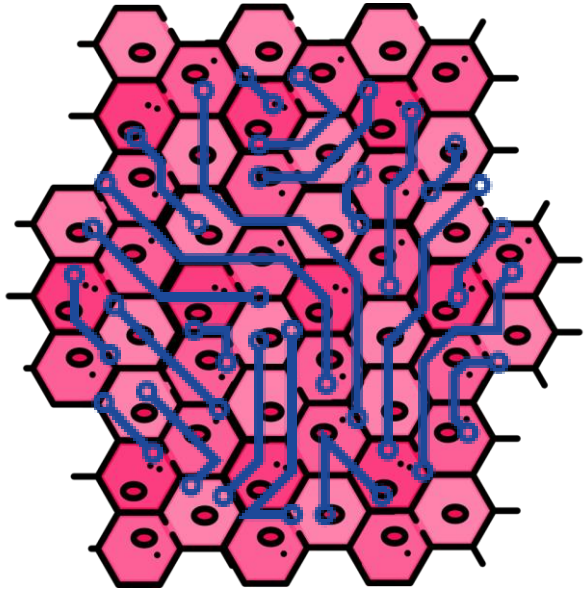
Electronic functionalization of tissue

Electronic/biological interface



Hybrid electronic-biological structures

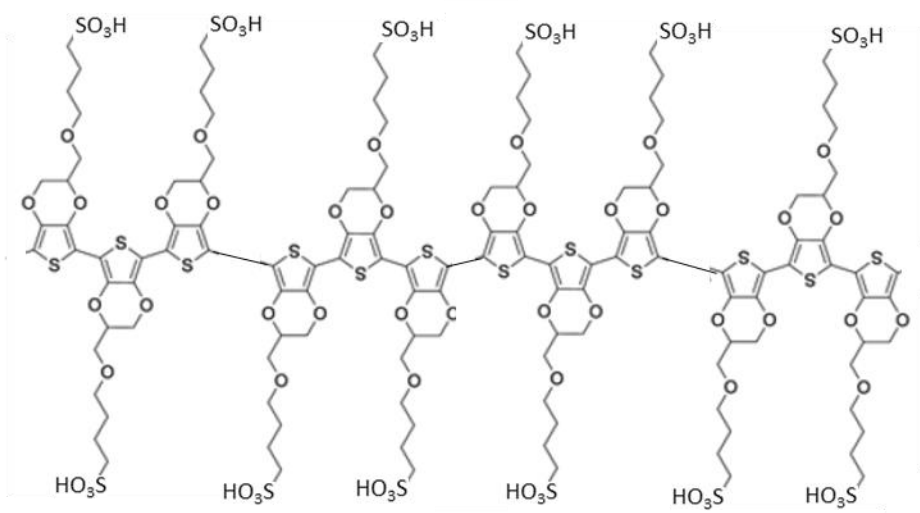


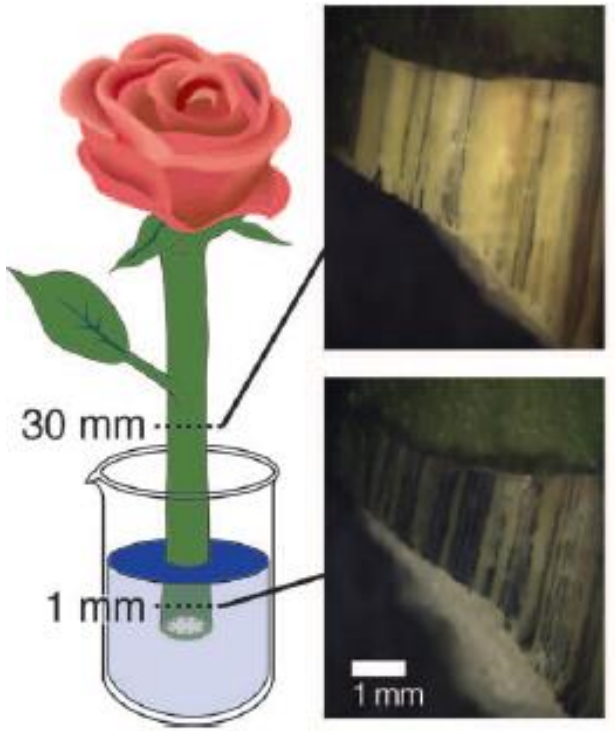
Biological tissue acts as template for the fabrication of electronic devices and circuits

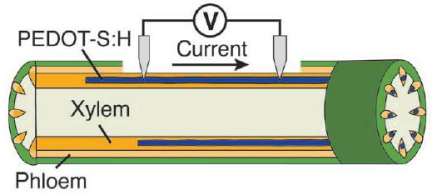
Electronic functionalization of tissue – Materials

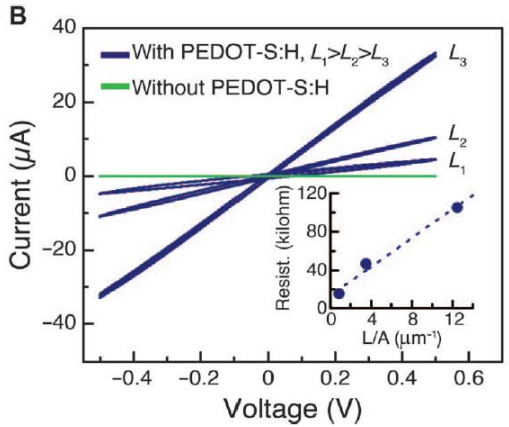
Organic Conducting Polymers

PEDOT:S-H







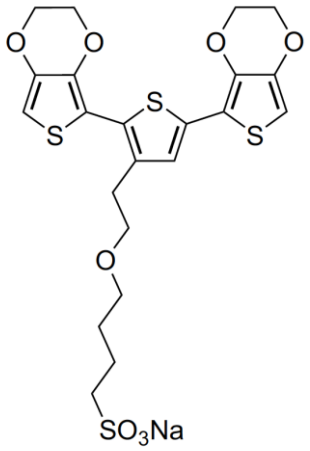


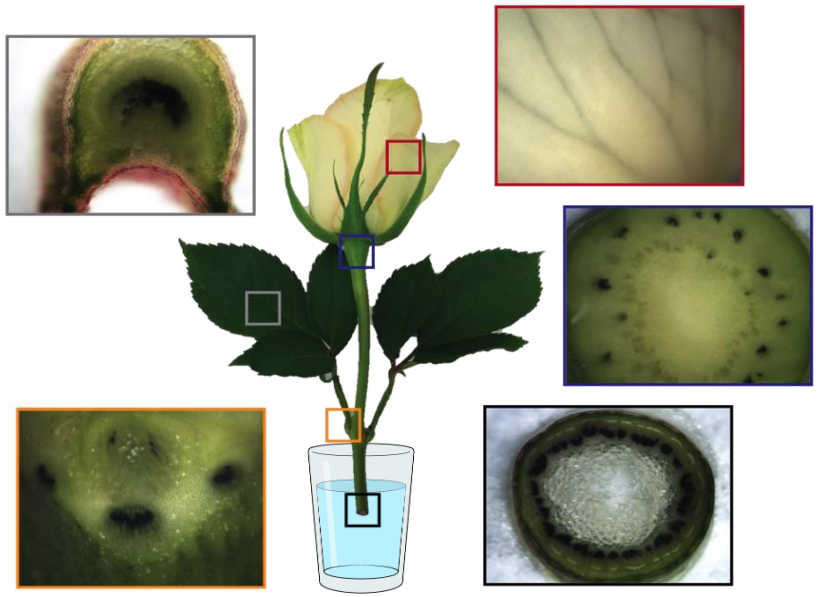
- Conducting wires are formed in the stem, along the xylem vascular channels
- Limited distribution of the polymer within the plant

E. Stavrinidou et. al, *Sci. Adv.* **1**, e1501136 (2015)

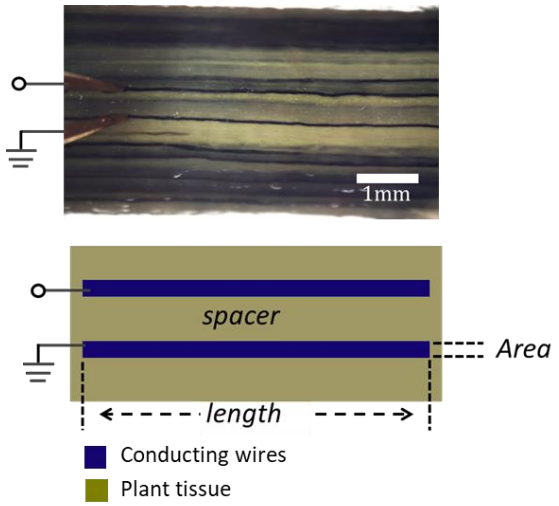
Electronic functionalization of tissue – Materials

ETES





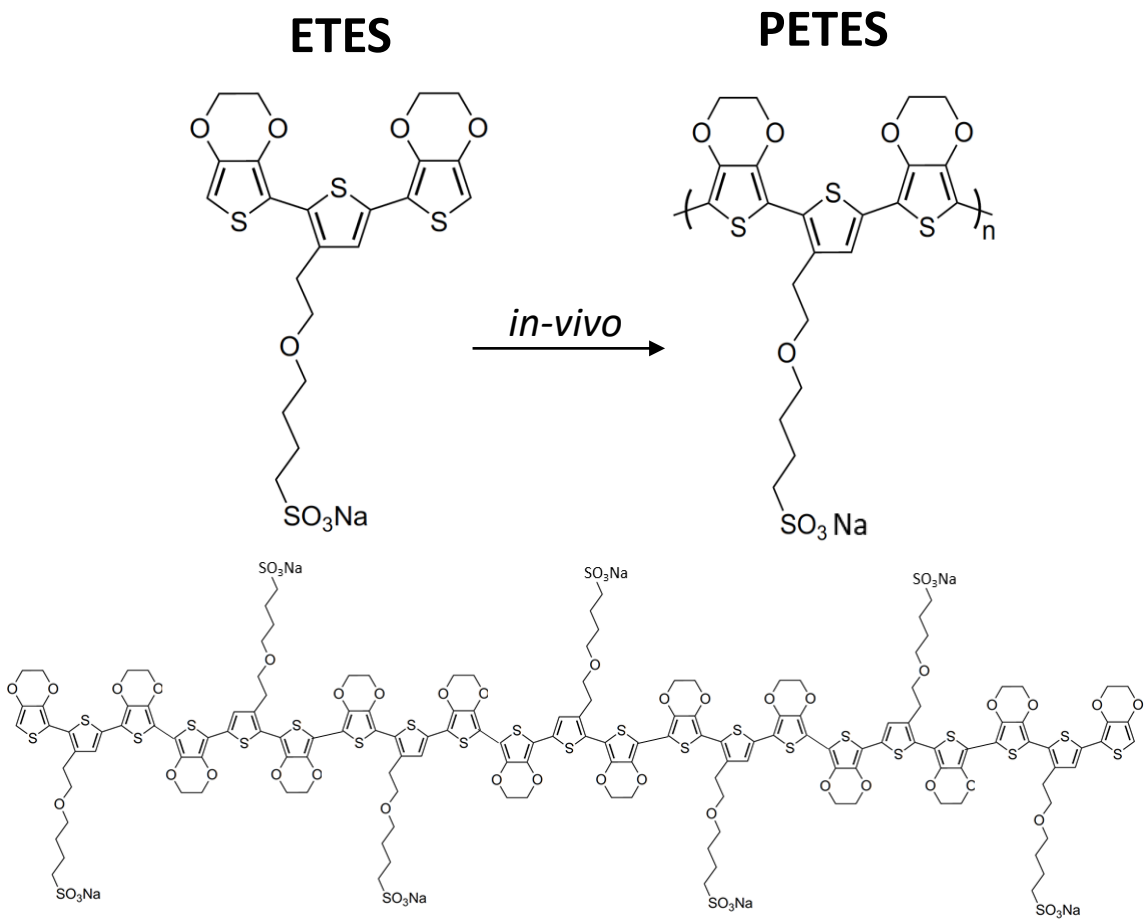
Supercapacitor

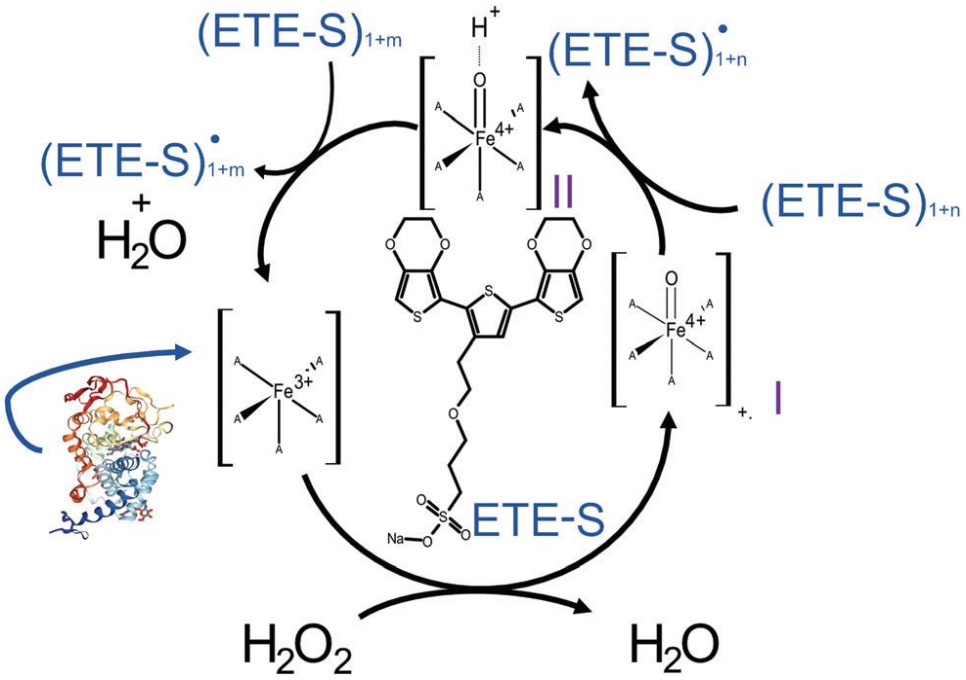


ETES travels along the xylem vascular system of the rose cutting, and forms long-range conducting wires in every part of it

E. Stavrinidou et. al, *PNAS* **114**, 2807 (2017)

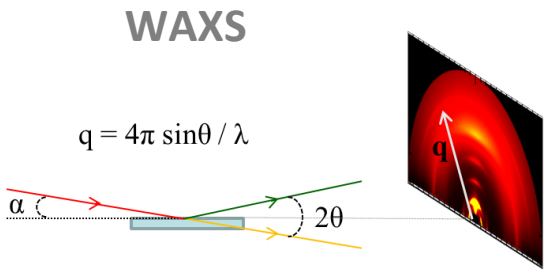
Electronic functionalization of tissue – The mechanism

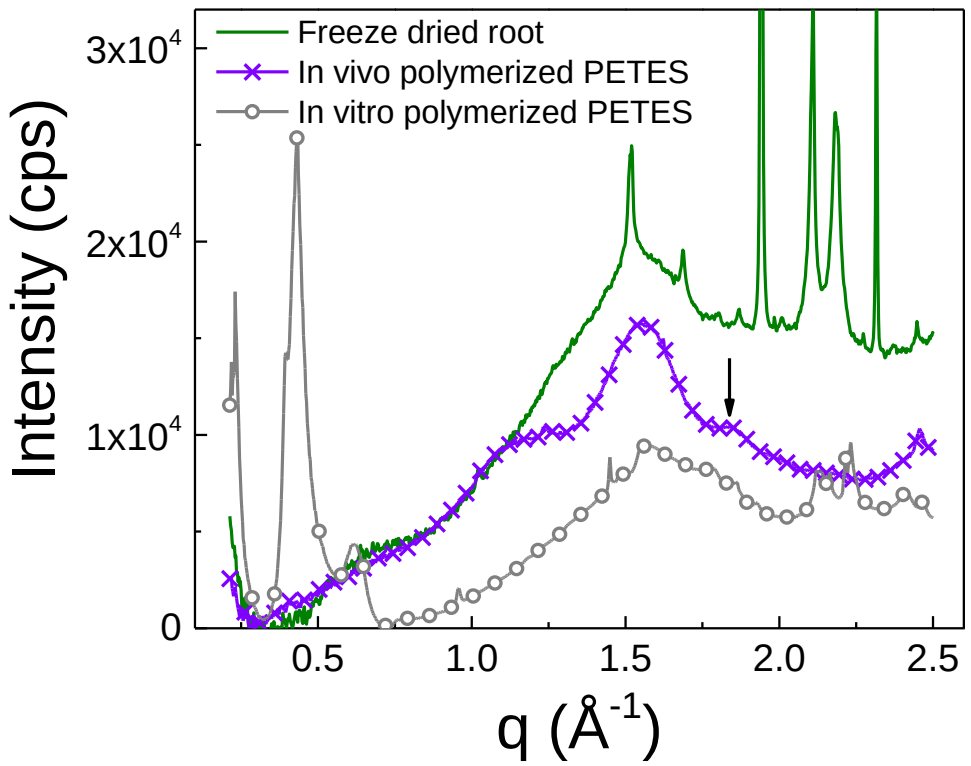


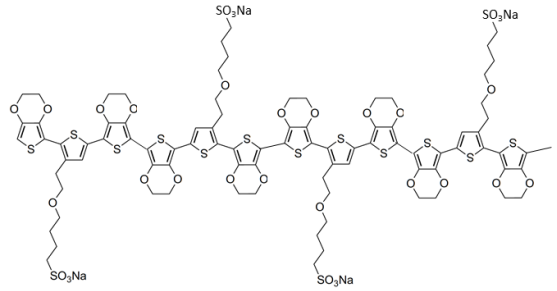


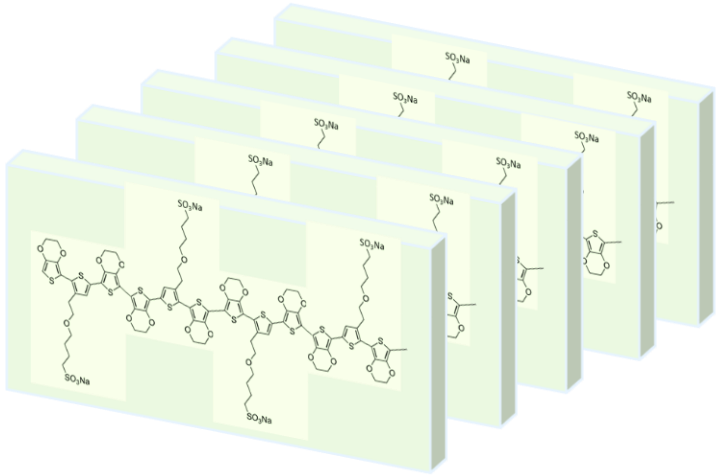
PETES is formed on the cell walls
➡ **True bio-hybrid system**

Electronic functionalization of tissue – Bio-hybrids







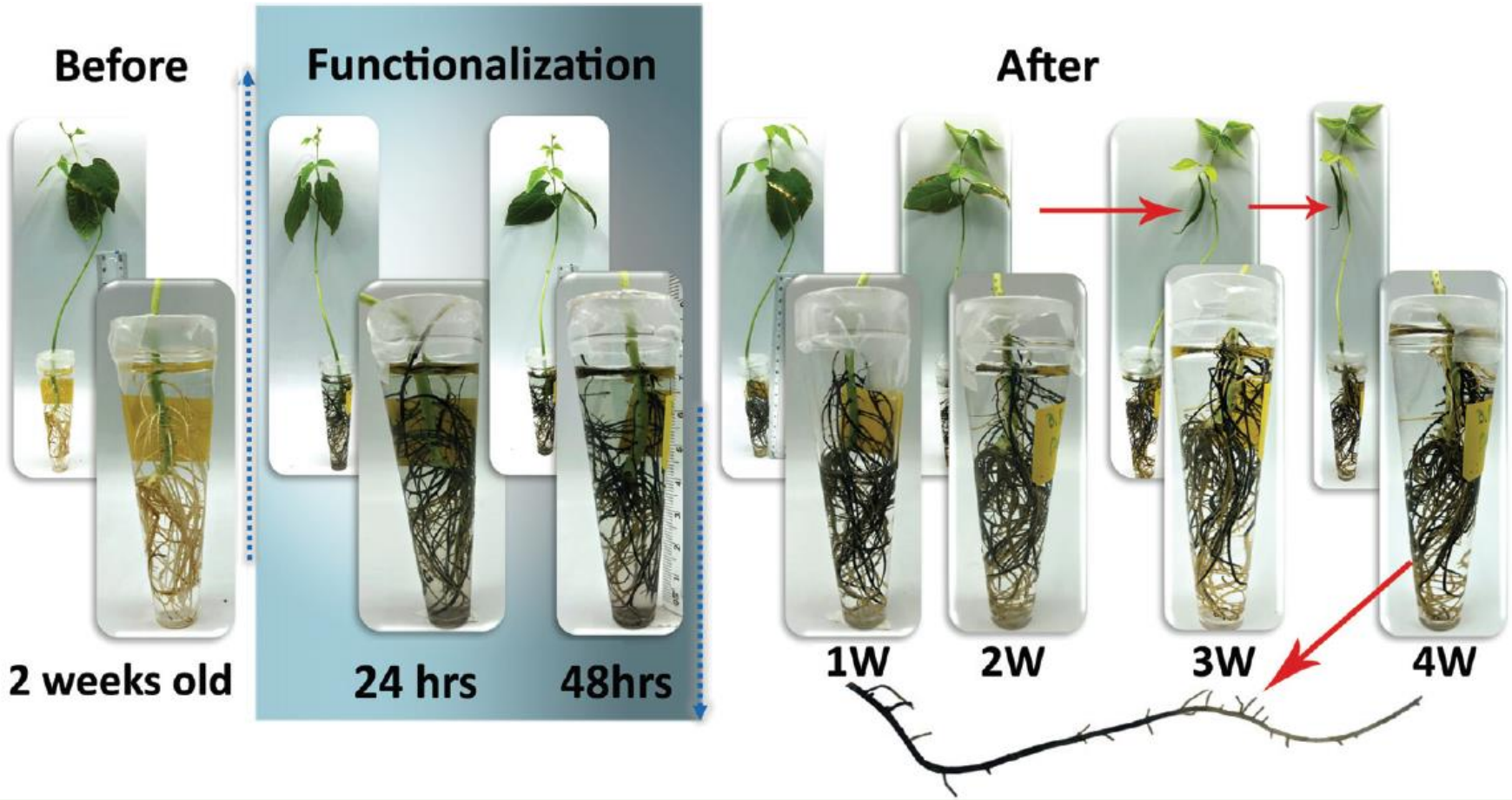


PETES is organized/ordered on the cell walls

➡ **True bio-hybrid system**

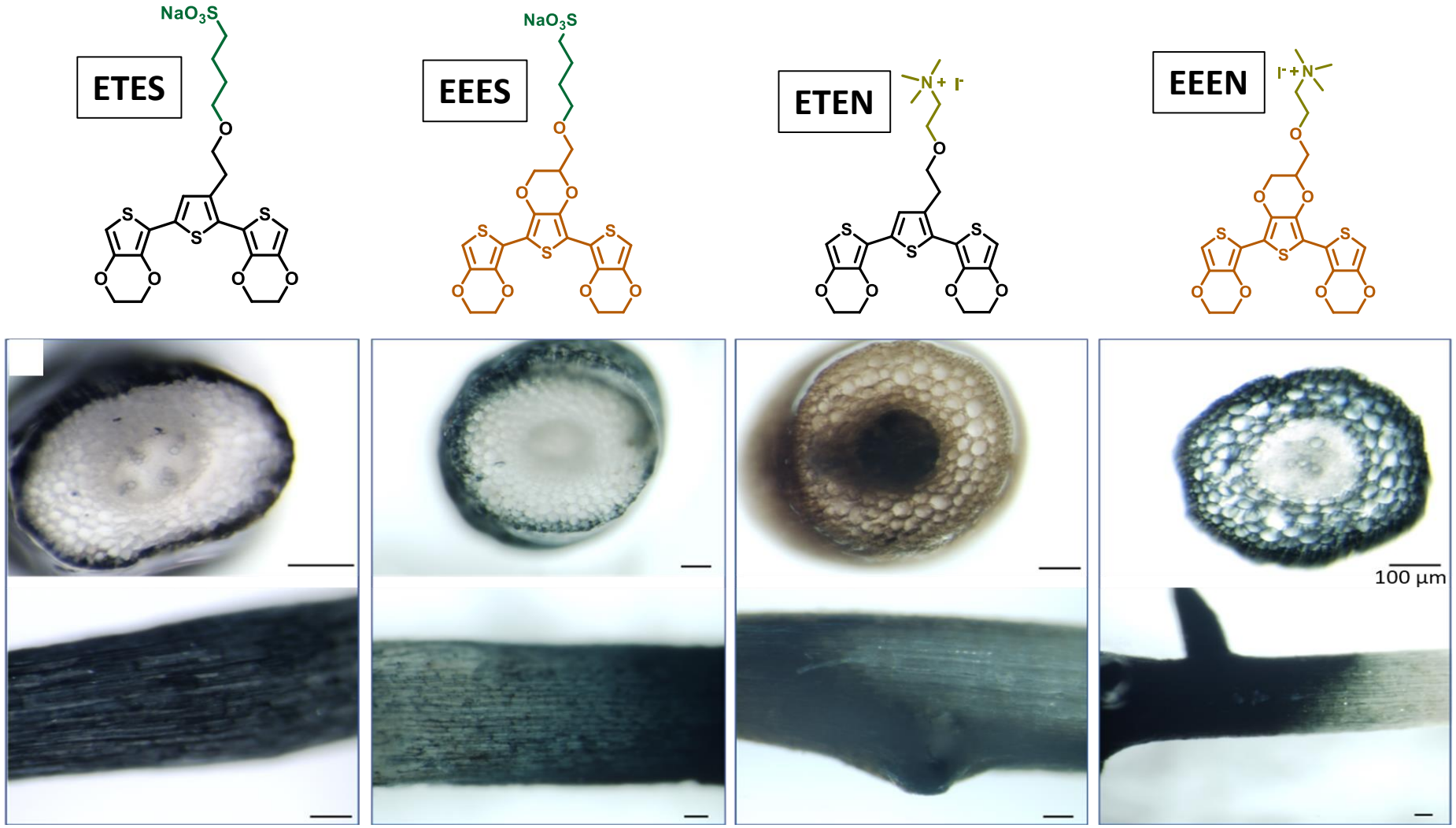
D. Parker et. al, Materials Horizons, 8, 3295 (2021), *Materials Horizons* 2021 Outstanding Paper Award

Plant growth after electronic functionalization



After functionalization of the whole root, the roots continue to grow and develop new lateral roots. At week 3, bean pods are visible!

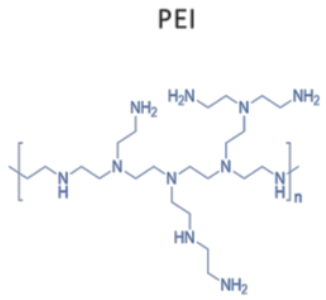
New materials for e-plants

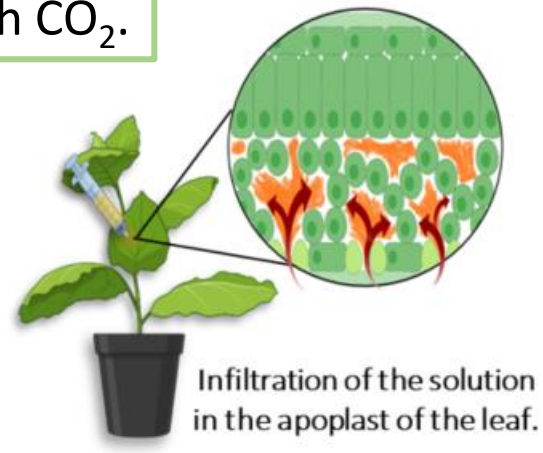


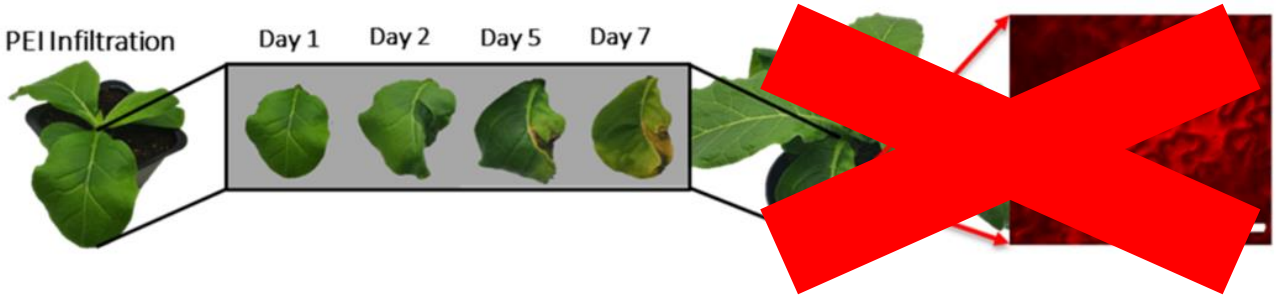
Mantione et. al, ACS Appl. Electron. Mater., **2**, 4065 (2020)

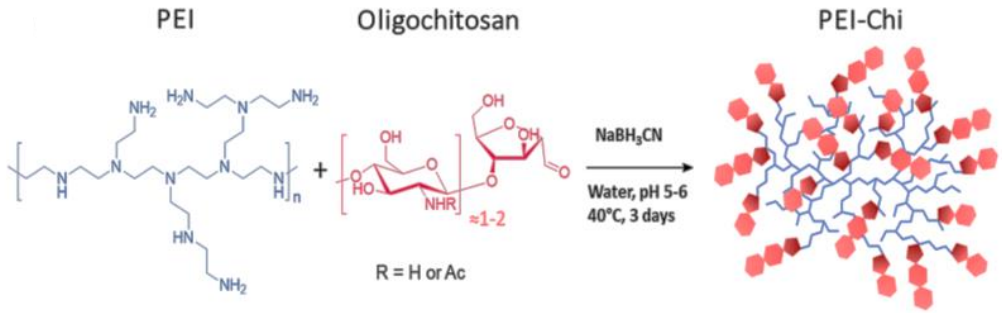
e-plants as CO_2 sensors for environmental monitoring

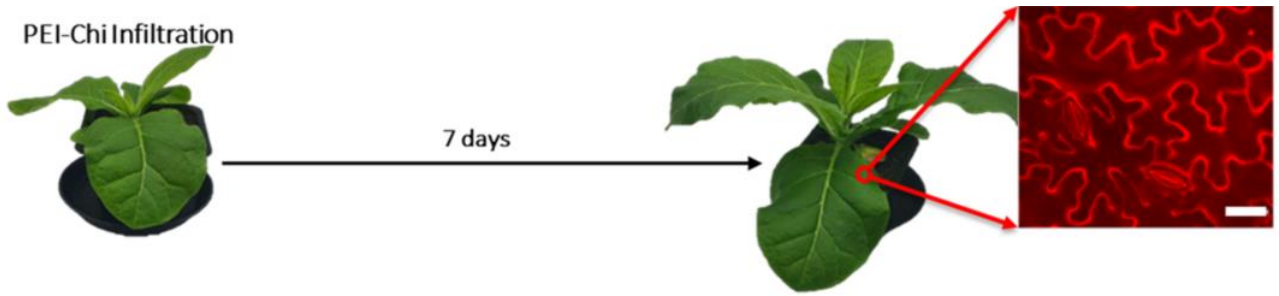
Amines react easily with CO_2.





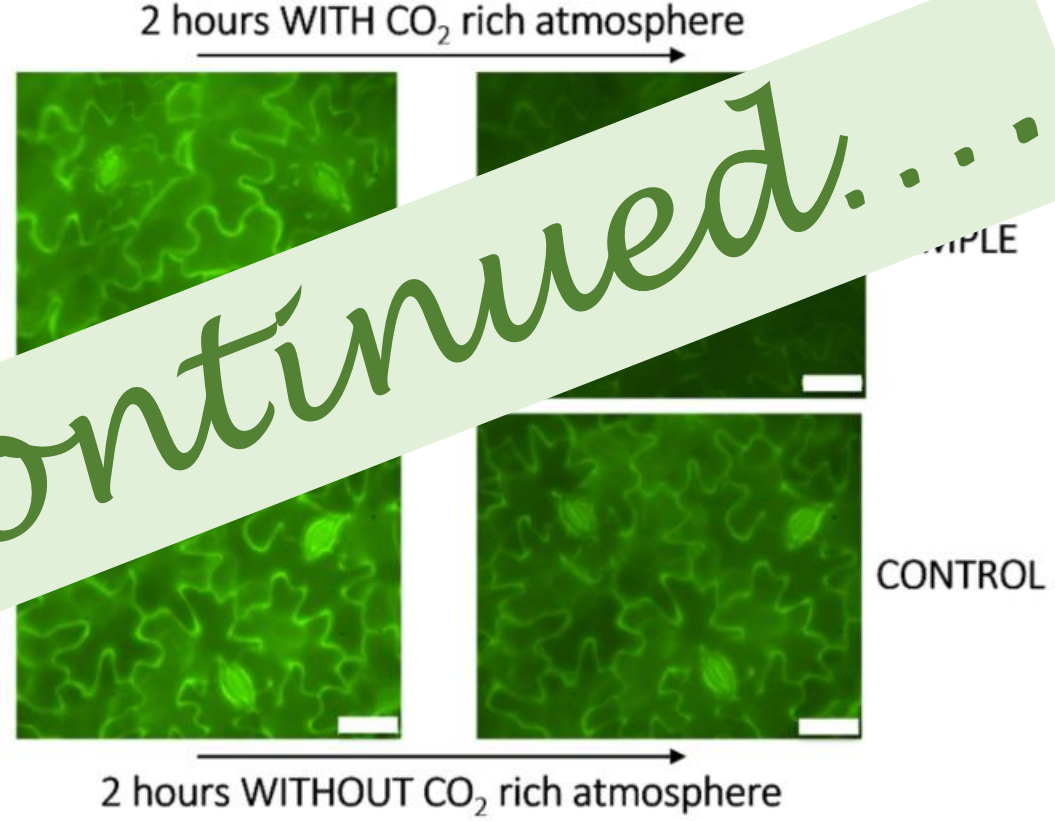






Manuscript under preparation

e-plants as CO_2 sensors for environmental monitoring



To be continued...

PEI-Chi infiltrated in tobacco leaves is capable of uptaking CO_2 in vivo

Manuscript under preparation

Bordeaux INP ENSCBP

LCPO Laboratoire de Chimie des Polymères Organiques

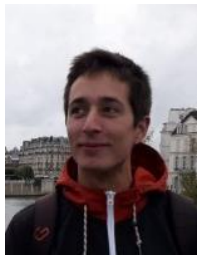
thank you

LINKÖPING UNIVERSITY

Dr. Daniele Mantione

Dr. Emin Istif

Prof. Eleni Stavrinidou



Dr. Lorenzo Vallan

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Gwennael Dufil

Daniela Parker

Cyril Routier

Funding:

European Commission | Horizon 2020 European Union funding for Research & Innovation

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