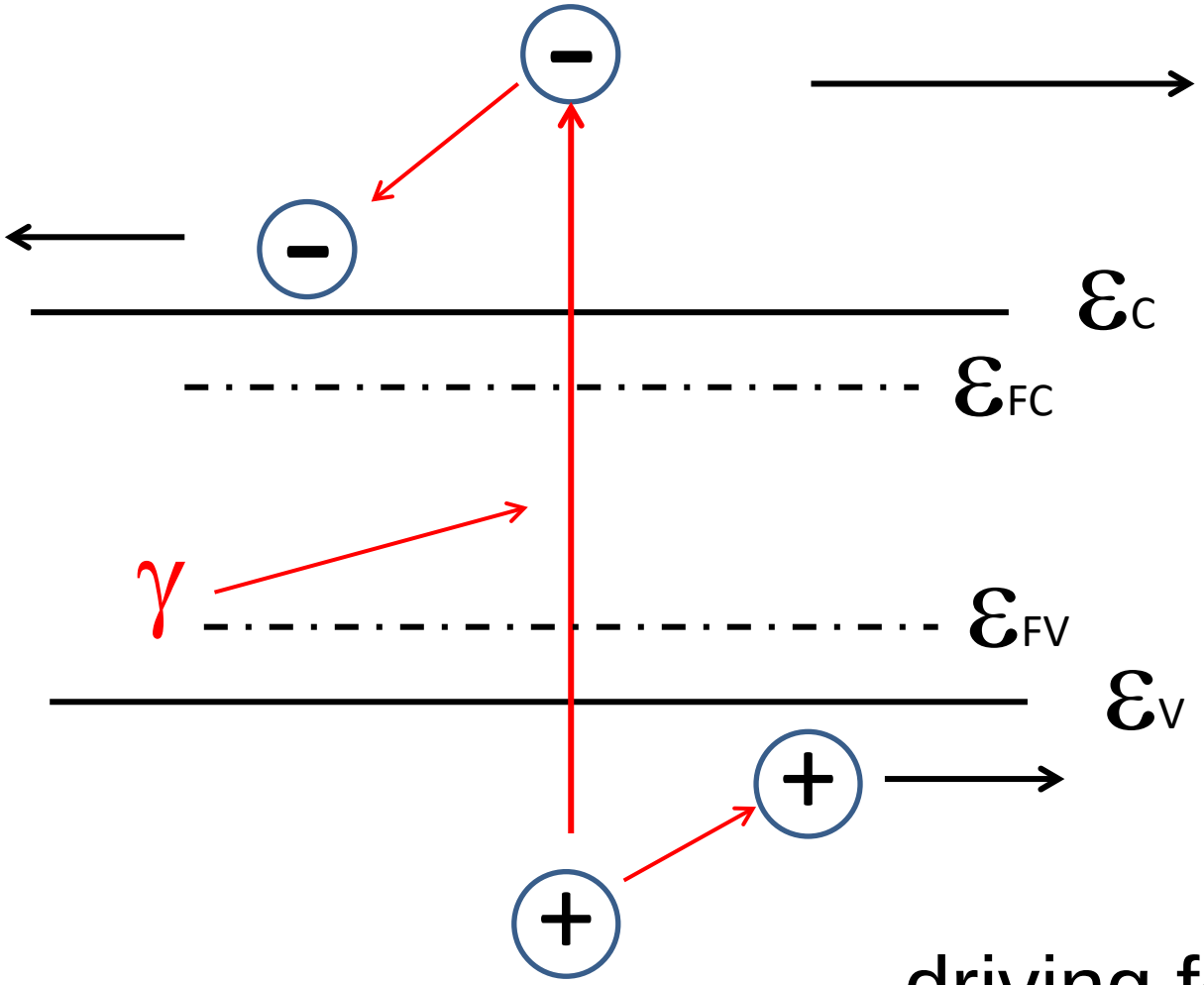
Selectivity is the Essence of Solar Cells

Peter Würfel
Karlsruhe Institute of Technology

Solar cells must produce current



driving forces ?

electrons have many handles at which forces can attack

charge : - grad $(-e\varphi)$ electrical potential

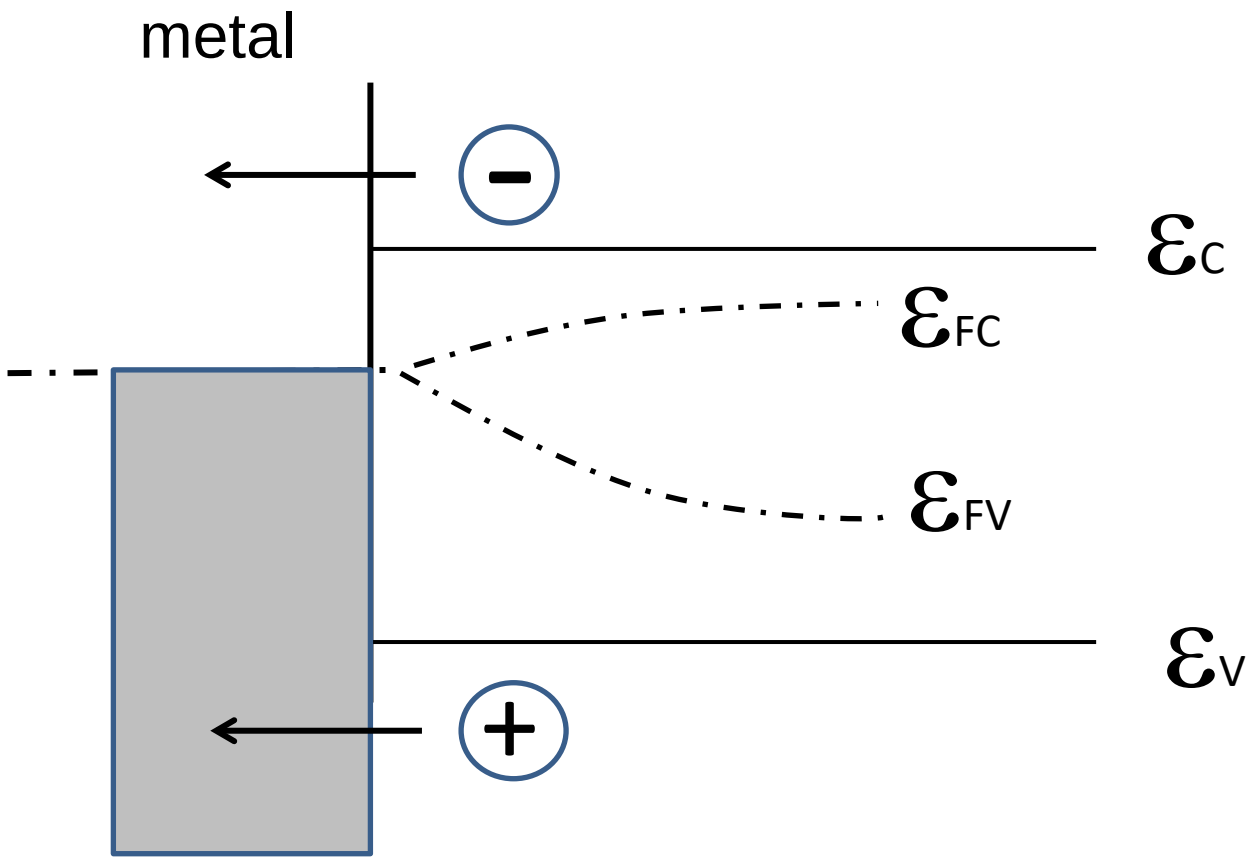
mass: - grad $m\Psi$ gravitational potential

particle: - grad μ chemical potential

resulting force: electrochemical potential

$$-\text{ grad } (\mu - e\varphi) = -\text{ grad } \eta = -\text{ grad } \varepsilon_F$$

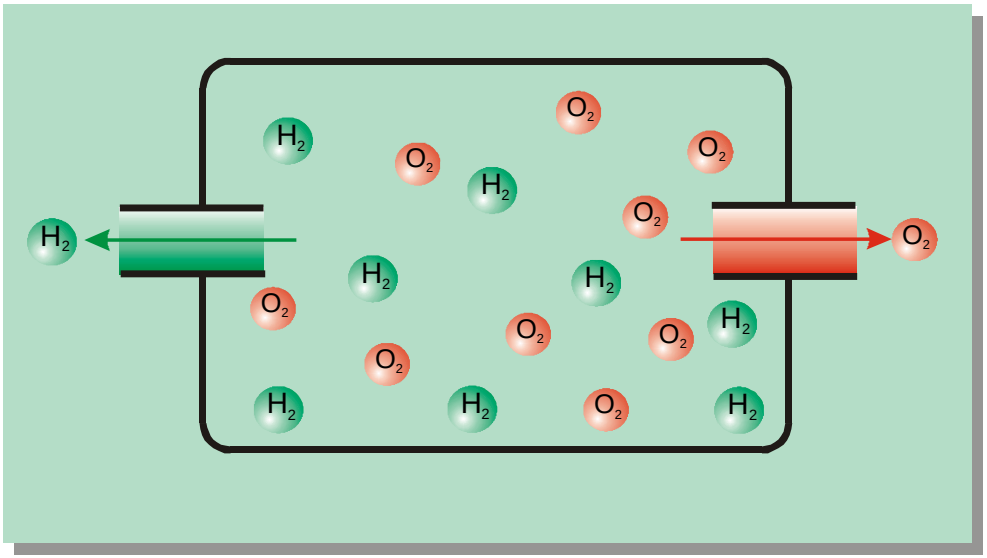
driving forces are not selective



metal contacts are not selective

Separation of hydrogen and oxygen with selective membranes

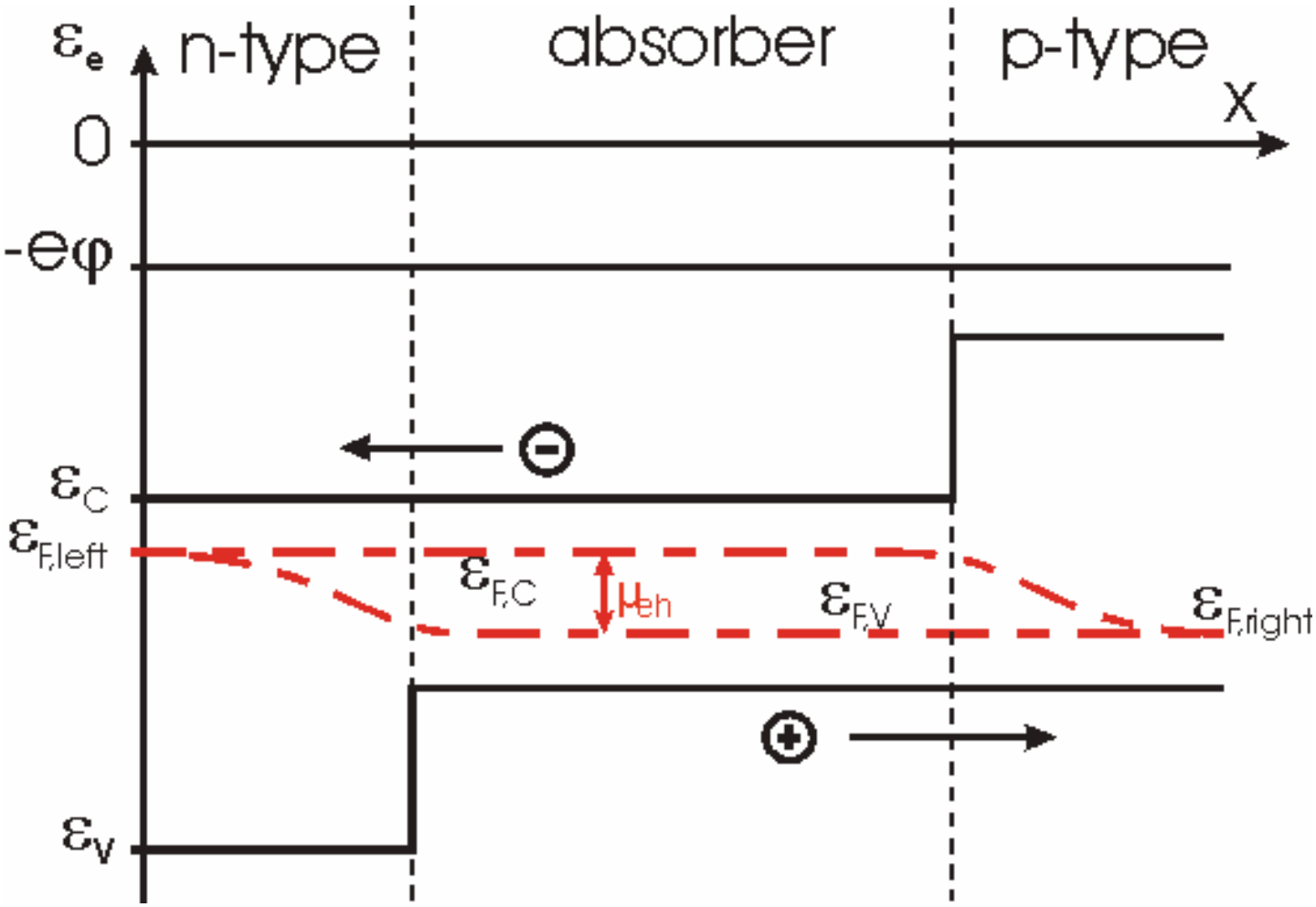
$\leftarrow H_2$ $O_2 \rightarrow$



driving force: pressure gradient, gradient of chemical potentials

Separation of electrons and holes

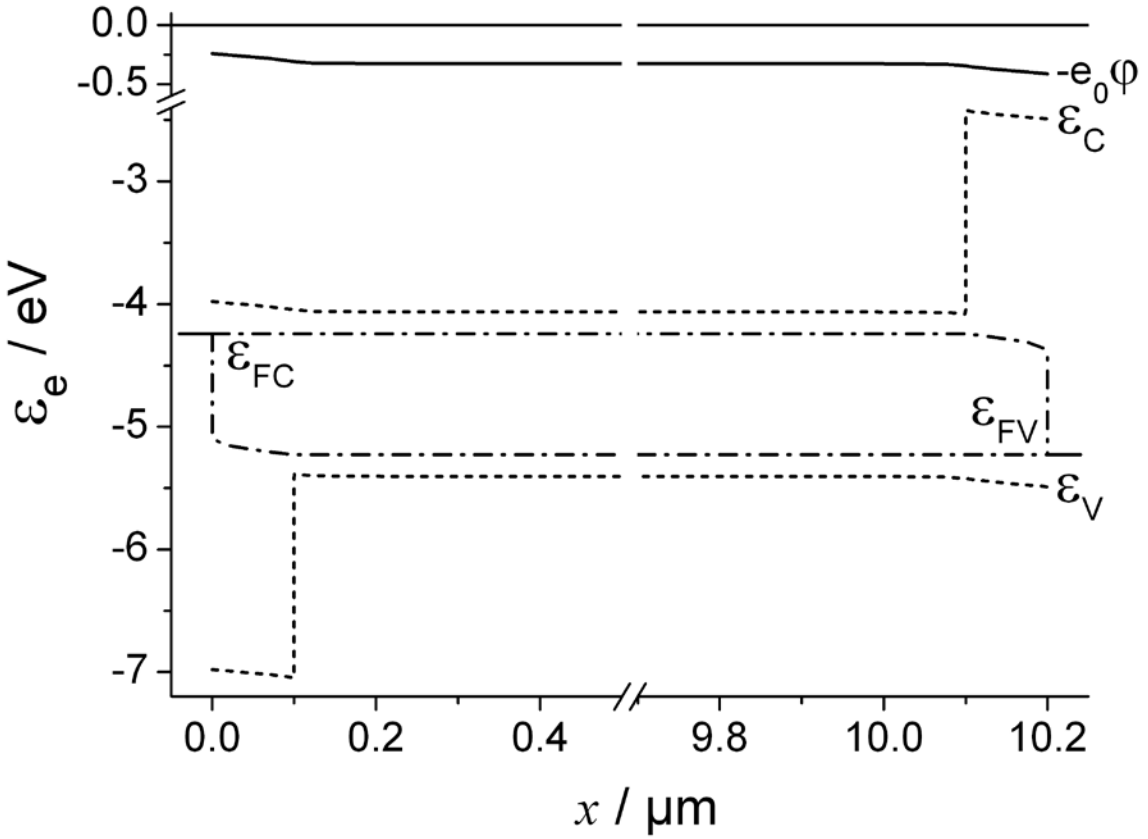
by selective conductivities in front of metal contacts



optimal hetero- structure (E_G = 1,34 eV)

full area contacts at maximum power

U. Wuerfel, A. Cuevas and P. Wuerfel, J. Photovoltaics **5,** 461 (2015)



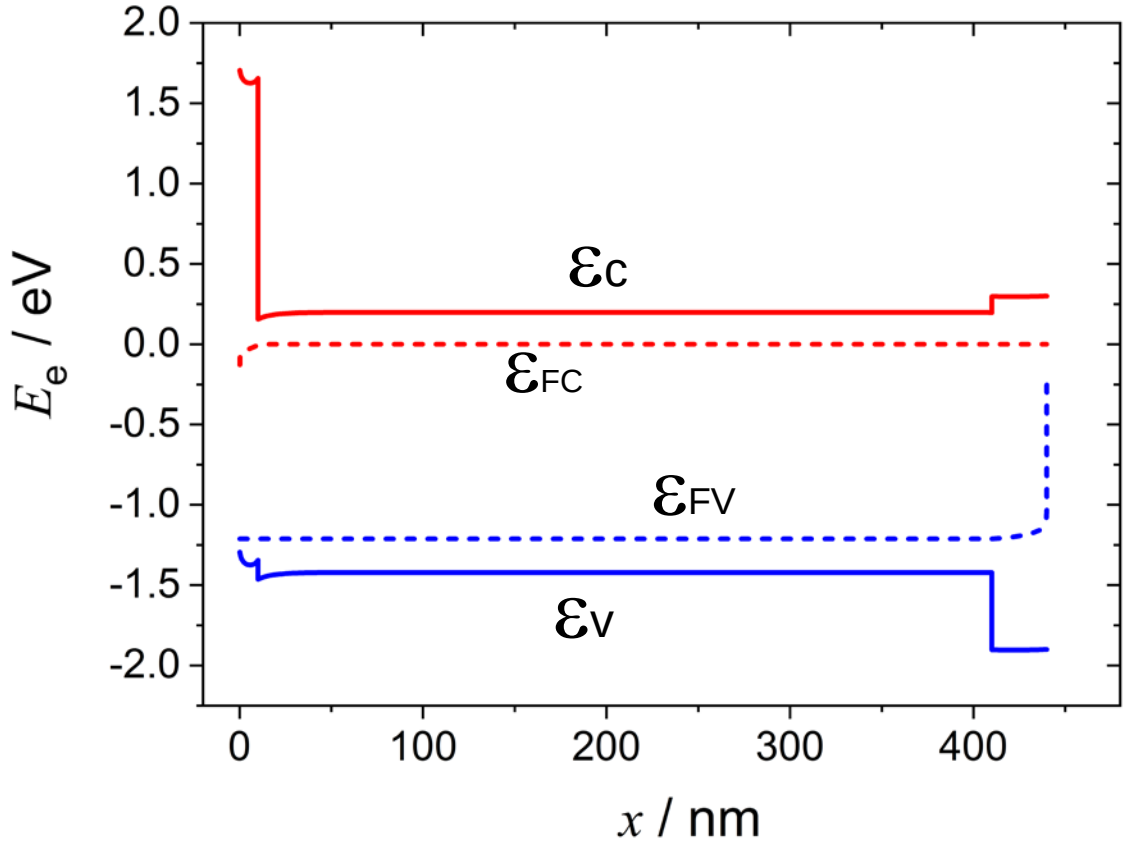
electrons and holes move against the field at max. power !!

V_b = 697 mV, V_{mpp} = 987 mV

η = 33,7 %

realisation in organic solar cells

PTAA / perovskite / C60



simulation by U. Wuerfel, Fraunhofer ISE