MACROMOLECULES

lecture for physics and biophysics students

2018. winter semester – 5. November

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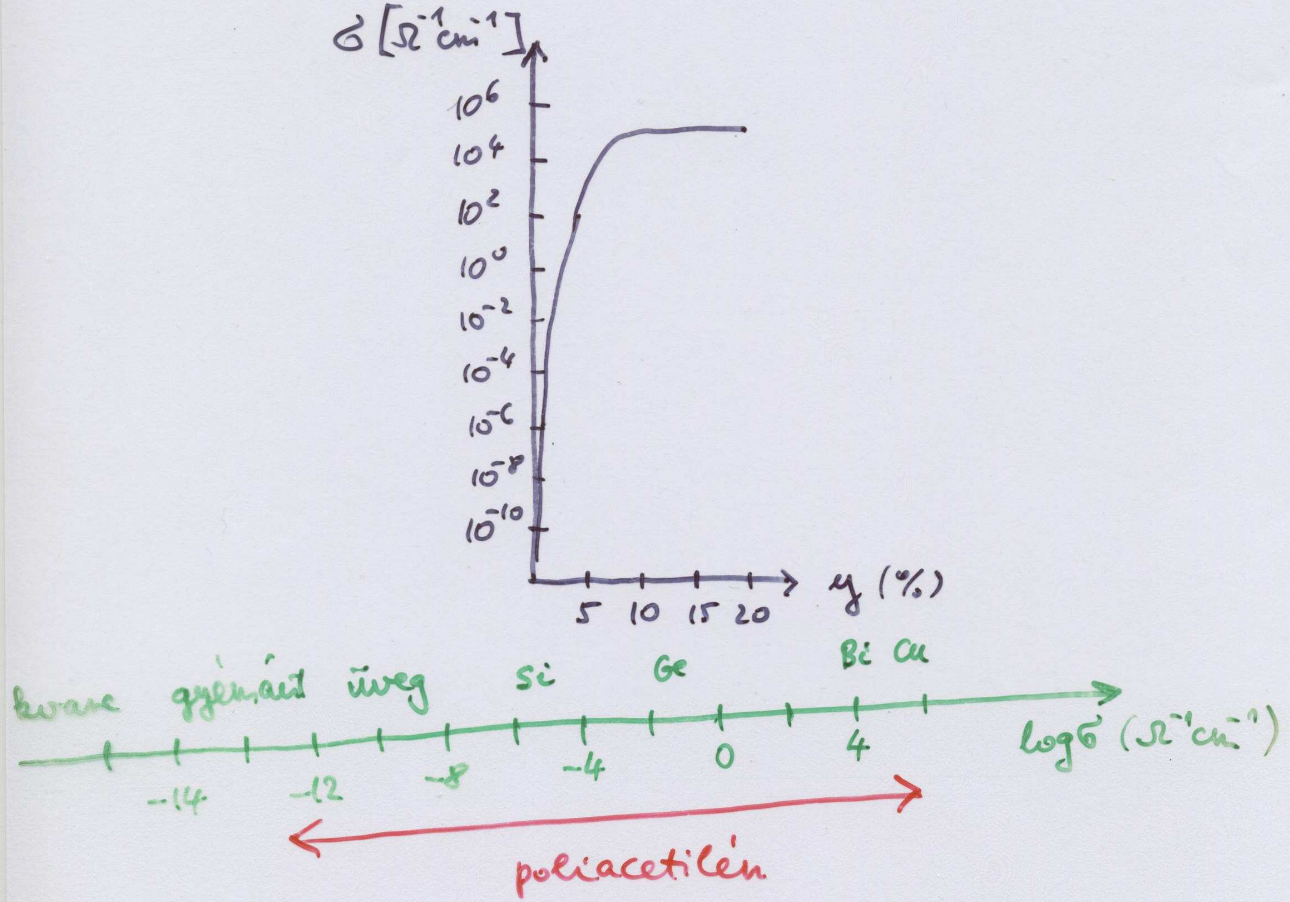
FÉLVEZETŐ → FÉM ÁTMENET

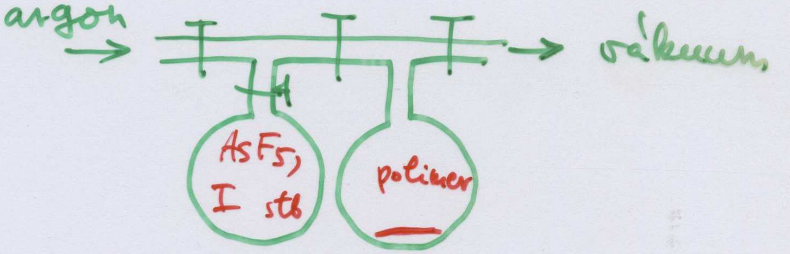
DÓPOLÁS (INTERKALÁLÁS) HATÁSÁRA

$(CH\,I_y)_x$, $(CH\,Br_y)_x$ $[CH(AsF_5)_y]_x$ stb

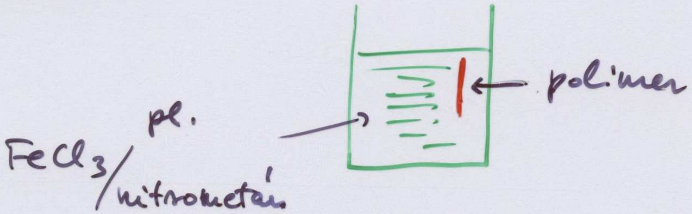


DÓPOLÁS

a) Gázfázisból

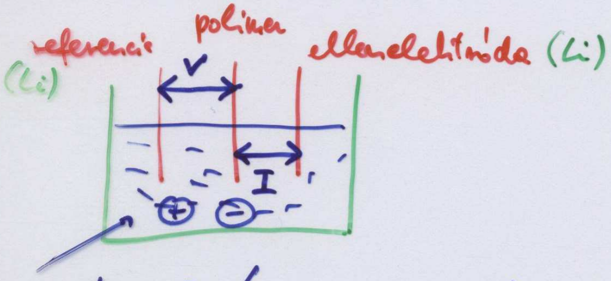


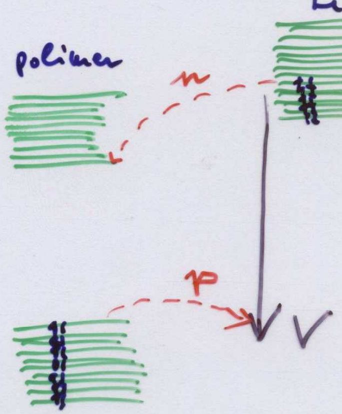
b) Folyadék fázisból



($FeCl_4^-$)

c) Elektrokémiai dópolás





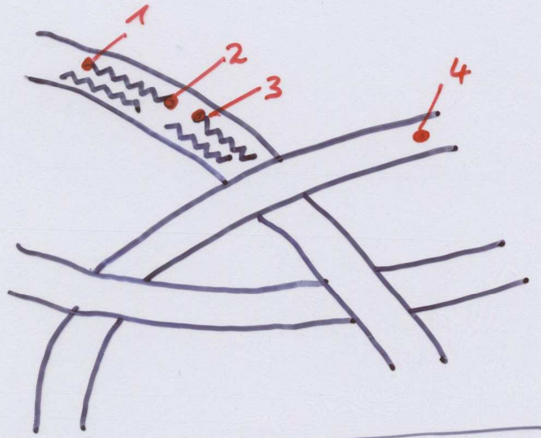
pl. $Li^+ClO_4^-$ / propilén-karbonát (n)

tetrabutil-ammónium (p)

Dópolt polimer: „piszkos fém"

T csökken → σ csökken

$\sigma(T)=\sigma_0 e^{-\left(T_0+\frac{T_1}{T}\right)}$ (Shen…



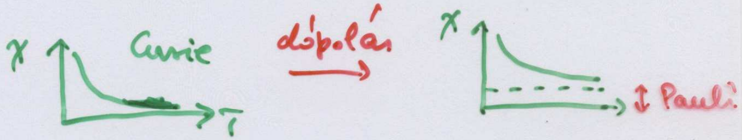
1–2 láncon belüli

2–3 láncok közötti

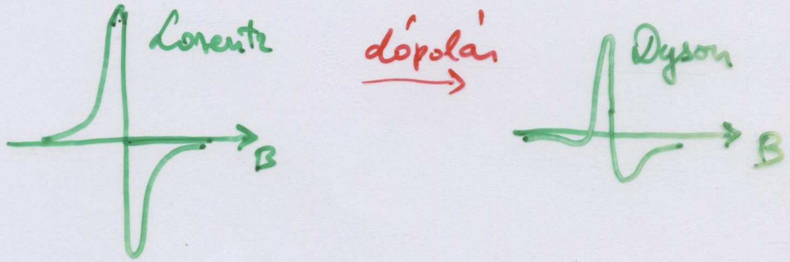
3–4 fibrillák közötti

- Termoelektromos erő (S)

- Mágneses szuszceptibilitás (χ)

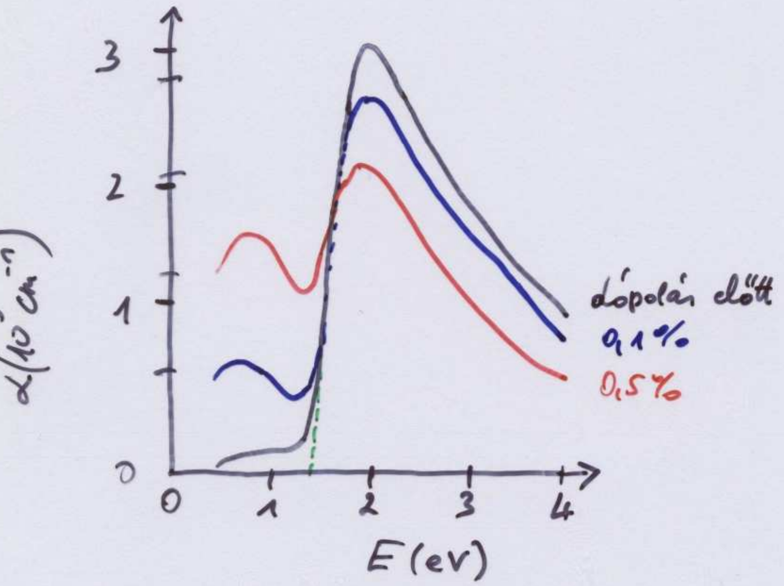


- ESR



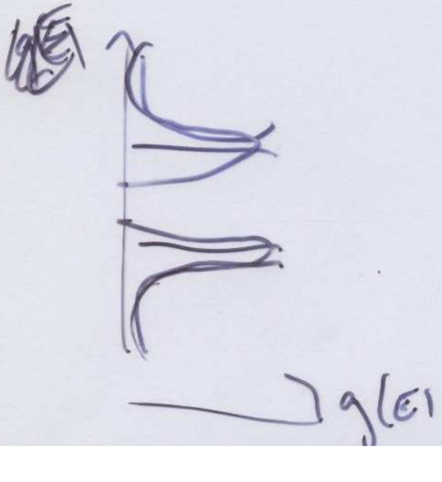
Az optikai abszorpció változása dópolás hatására

$I \sim e^{-\alpha r}$



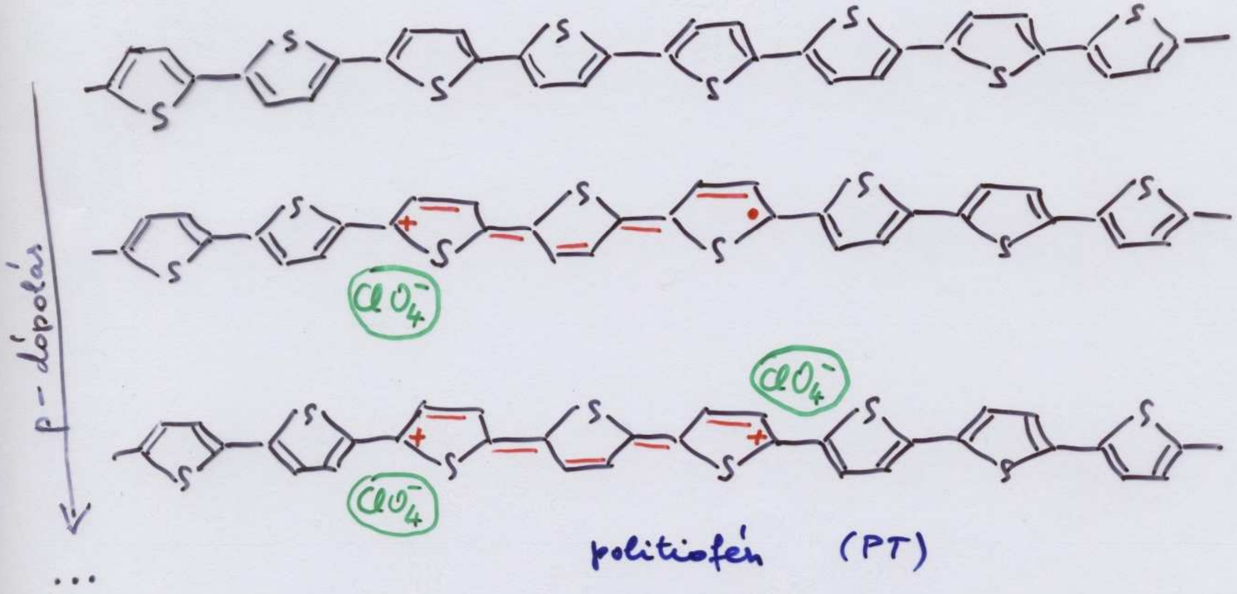
trans-$(CH)_x$

(Surah

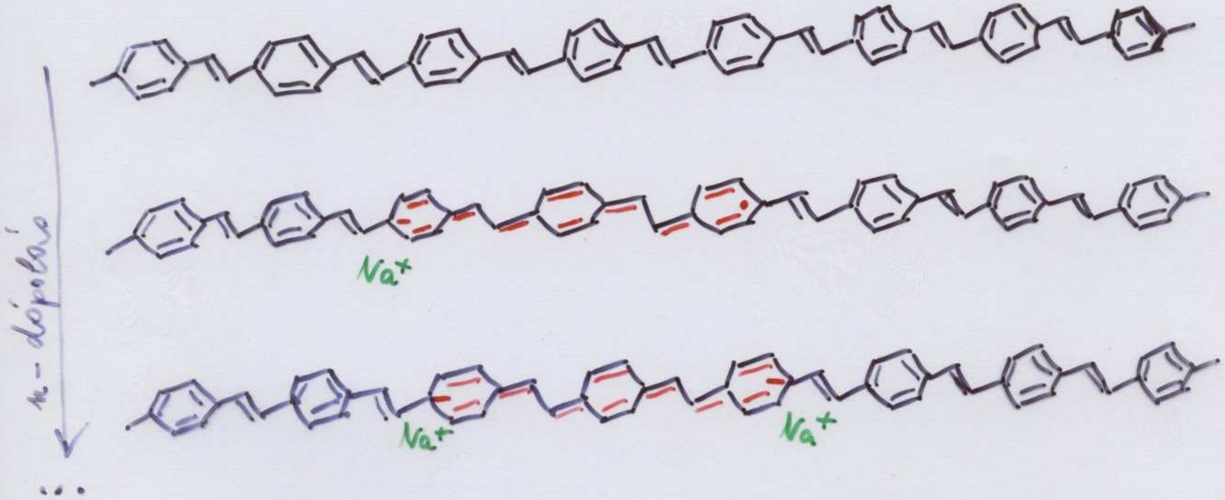


POLARONOK, BIPOLARONOK ...

(gyök-ionok)

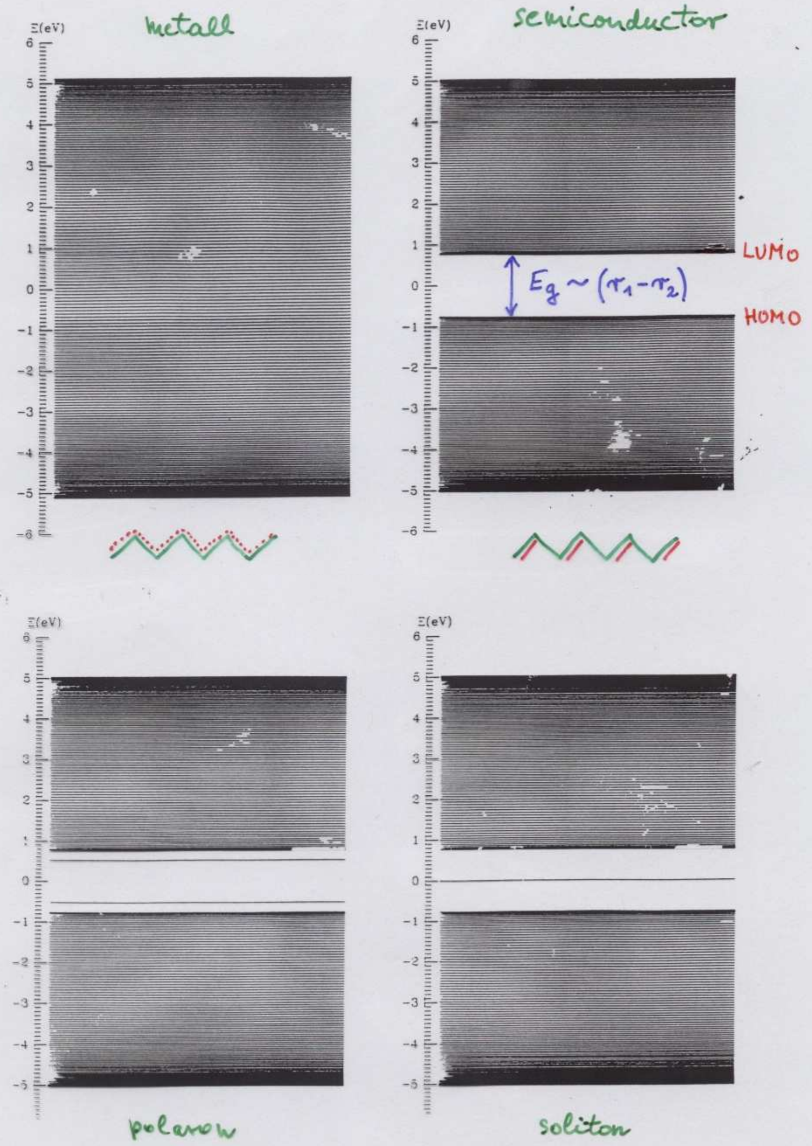


politiofén (PT)



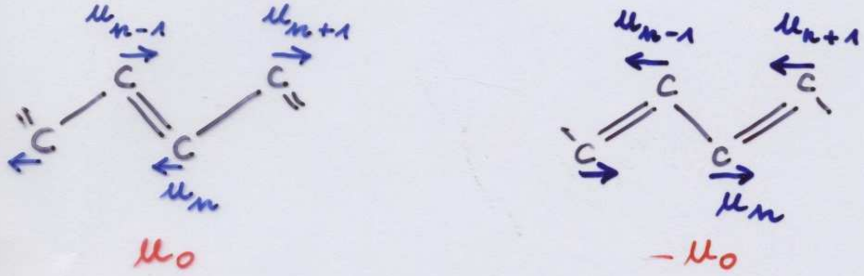
poli-parafenilén-vinilén (PPV)

C_{200}

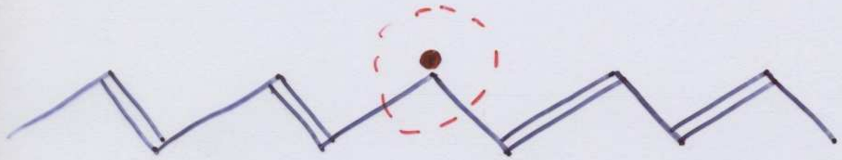


The energy levels for a linear chain of 200 C-atoms, calculated by LHS – model.

SZOLITON (transz-poliacetilénben)

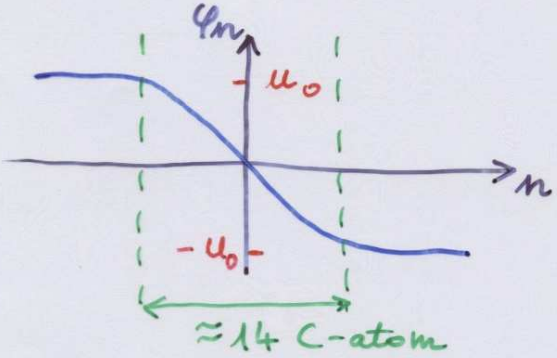


degenerált alapállapot!



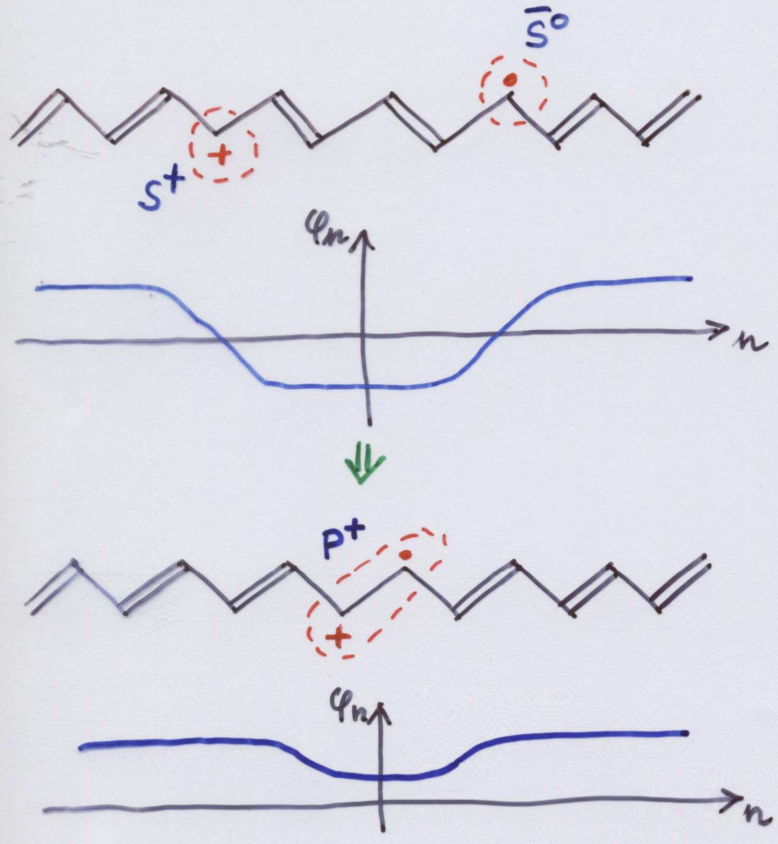
(semleges) szoliton

rendparaméter: $\varphi_n = (-1)^n \cdot u_n$

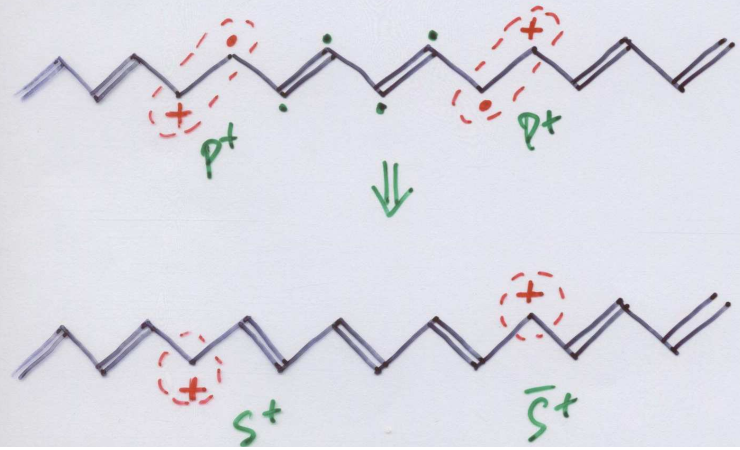


E_{c-t} < E_{t-c}

cisz-poliacetilén: nem degenerált!

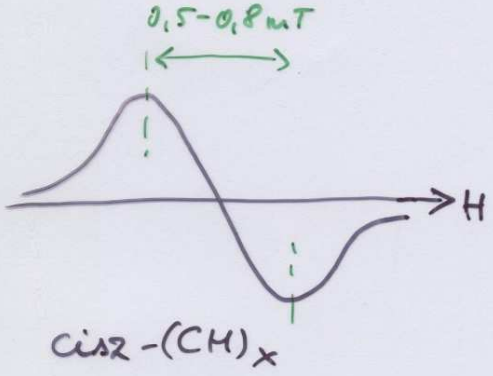


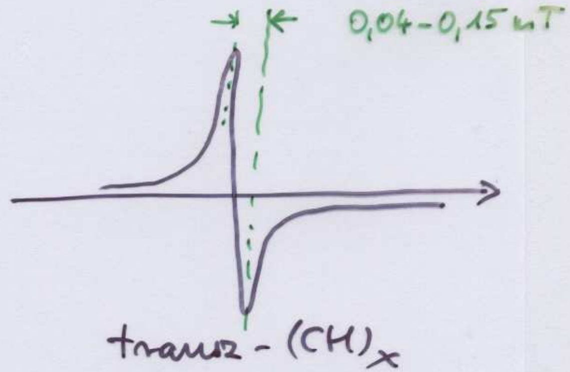
$$S^+ + \bar{S}^0 \rightarrow P^+$$



$$P^+ + P^+ \rightarrow S^+ + \bar{S}^+$$

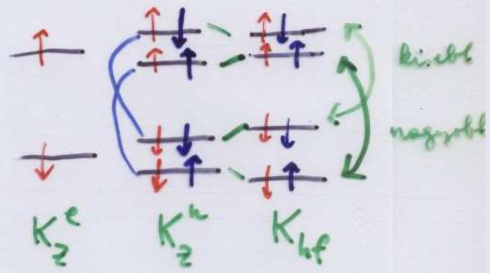
Szolitonok $(CH)_x$ -ben , ESR

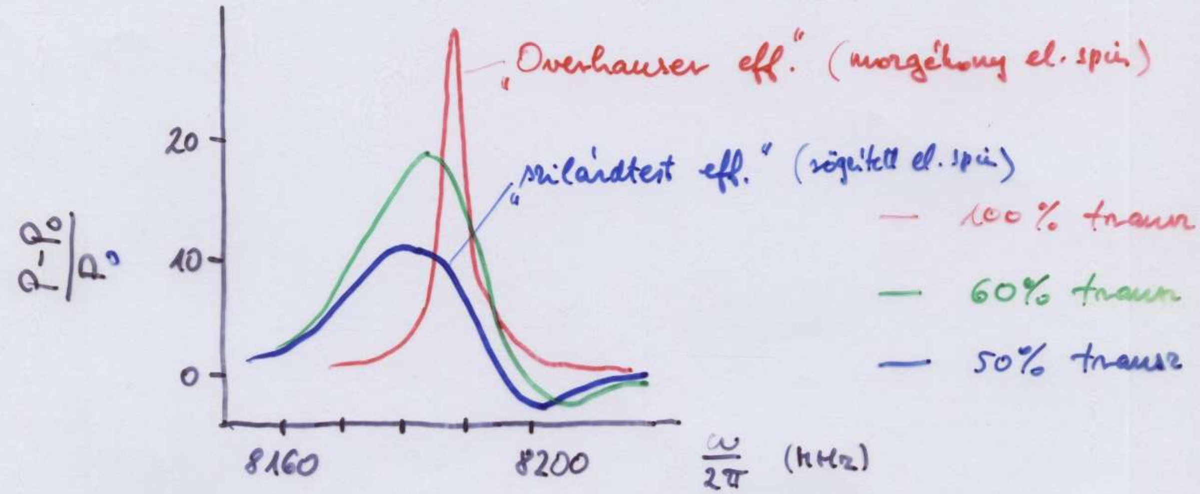




Dynamic Nuclear Polarization

ESR-jel telítése → NMR intenzitás változása



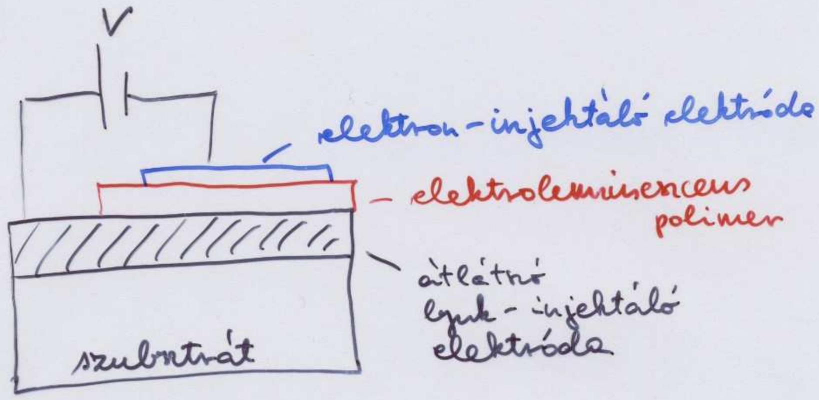


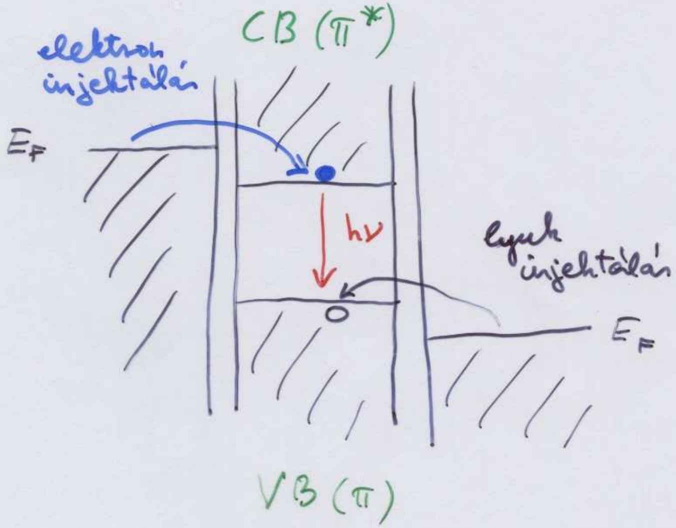
Konjugált polimerek alkalmazási lehetőségei

- elektromos (hajlékony vezető, antisztatikus fólia ...) MISFET ...
- elektrokémiai (gomb-akku)
- optikai (termokróm, LED ...)
- nemlineáris optikai („fotonika", hiperpolarizálhatóság ...)
- „egzotikus" pl. molekuláris elektronikai

O - L E D

Organic Light Emitting Device





31. Addition of 1 weight % core material to a mantle source will have no effect on the isotopes of Sr, Nd, Pb, and oxygen, which are well correlated with Os isotopes in most OIBs [for example, Hawaii (18, 19)]. Core-mantle interaction would also buffer the f_{O_2} of OIBs to the iron-wustite buffer, which is three to four orders of magnitude lower than f_{O_2}'s actually measured in OIBs [*Basaltic Volcanism Study Project* (Pergamon Press, New York, 1981)].
32. K. Righter, M. J. Drake, G. Yaxley, *Phys. Earth Planet. Int.* **100**, 115 (1997).
33. J. Myers and H. Eugster, *Contrib. Mineral. Petrol.* **82**, 75 (1983).
34. T. Meisel, R. J. Walker, J. W. Morgan, *Nature* **383**, 517 (1996); H. K. Brueckner *et al.*, *J. Geophys. Res.* **100**, 22283 (1995); L. Reisberg and J.-P. Lorand, *Nature* **376**, 159 (1995); J. W. Morgan, G. A. Wandless, R. K. Petrie, A. J. Irving, *Tectonophysics* **75**, 47 (1981).
35. T. H. Green, *Chem. Geol.* **117**, 1 (1994).
36. We thank C. J. Capobianco, J. Chesley, M. J. Drake, S. Shirey, and P. Warren for discussions; P. Liermann and J. Ganguly for providing samples of Buell Park garnet; and J. Wang for expert assistance with the ion microprobe. This research is supported by NSF grants EAR-9706024 and EAR-9628092.

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Integrated Optoelectronic Devices Based on Conjugated Polymers

Henning Sirringhaus,* Nir Tessler, Richard H. Friend*

An all-polymer semiconductor integrated device is demonstrated with a high-mobility conjugated polymer field-effect transistor (FET) driving a polymer light-emitting diode (LED) of similar size. The FET uses regioregular poly(hexylthiophene). Its performance approaches that of inorganic amorphous silicon FETs, with field-effect mobilities of 0.05 to 0.1 square centimeters per volt second and ON-OFF current ratios of $>10^6$. The high mobility is attributed to the formation of extended polaron states as a result of local self-organization, in contrast to the variable-range hopping of self-localized polarons found in more disordered polymers. The FET-LED device represents a step toward all-polymer optoelectronic integrated circuits such as active-matrix polymer LED displays.

Solution-processible conjugated polymers are among the most promising candidates for a cheap electronic and optoelectronic technology on plastic substrates. Polymer LEDs exceeding peak brightnesses of 10^6 cd m^{-2} (*1*) and high-resolution video polymer LED displays (*2*) have been demonstrated. One of the main obstacles to all-polymer optoelectronic circuits is the lack of a polymer FET with sufficiently high mobility and ON-OFF ratio to achieve reasonable switching speeds in logic circuits (*3*) and to drive polymer LEDs.

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Conjugated polymer FETs (*4*) typically show field-effect mobilities of $\mu_{FET} = 10^{-6}$ to 10^{-4} cm^2 V^{-1} s^{-1}, limited by variable-range hopping between disordered polymer chains and ON-OFF current ratios of $<10^4$ (*5*). This is much too low for logic and display applications, and therefore all previous approaches to drive polymer LEDs have used polycrystalline (*2*) or amorphous silicon (a-Si) (*6*) technology. Recently, a polymer FET with a mobility of 0.01 to 0.04 cm^2 V^{-1} s^{-1} and an ON-OFF ratio of 10^2 to 10^4 using regioregular poly(hexylthiophene) (P3HT) was described (*7*). The high mobility is related to structural order in the polymer film induced by the regioregular head-to-tail (HT) coupling of the hexyl side chains. However, a clear understanding of the transport mechanism giving rise to the relatively high mobilities is still lacking.

Here, we report a considerably improved P3HT FET reaching mobilities of 0.05 to 0.1 cm^2 V^{-1} s^{-1} and ON-OFF ratios of $>10^6$, the performance of which starts to rival that of inorganic a-Si FETs and enables us to demonstrate integrated optoelectronic polymer devices. As an example, we have chosen a simple pixel-like configuration in which the FET supplies the current to a polymer LED. This allows us to assess the prospects of active-matrix addressing in all-polymer LED displays.

To construct the multilayer device (Fig. 1A), we first fabricated the FET by spin-coating a film of P3HT (500 to 700 Å) (*8*) onto a highly doped n^+-Si wafer with a 2300 Å SiO_2 gate oxide (capacitance C_i = 15 nF cm^{-2}). Au source-drain contacts were deposited onto the P3HT through a shadow mask. Then, a layer of SiO_x was thermally evaporated through another, mechanically aligned, shadow mask to define the active LED area on the finger-shaped Au FET drain electrode acting as the hole-injecting anode of the LED. A single layer of poly[2-methoxy-5-(2′-ethyl-hexyloxy)-*p*-phenylene-vinylene] (MEH-PPV) was spin-coated on top. Evaporation of a semitransparent Ca-Ag cathode completed the device. No photolithographic steps were involved. The device

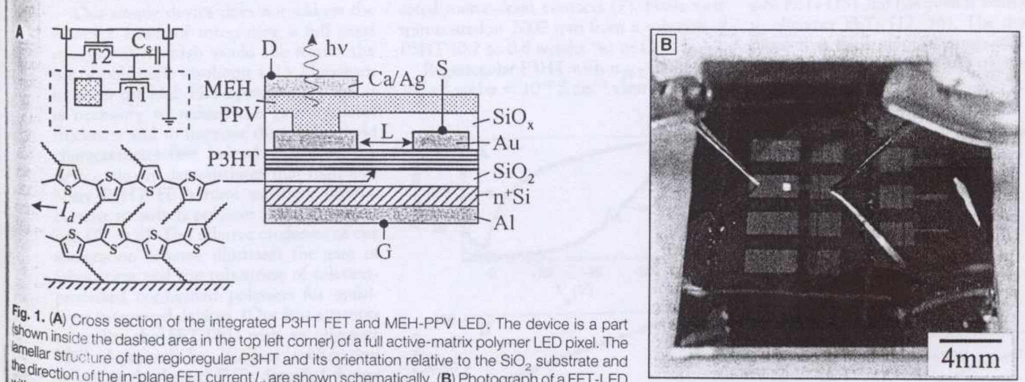
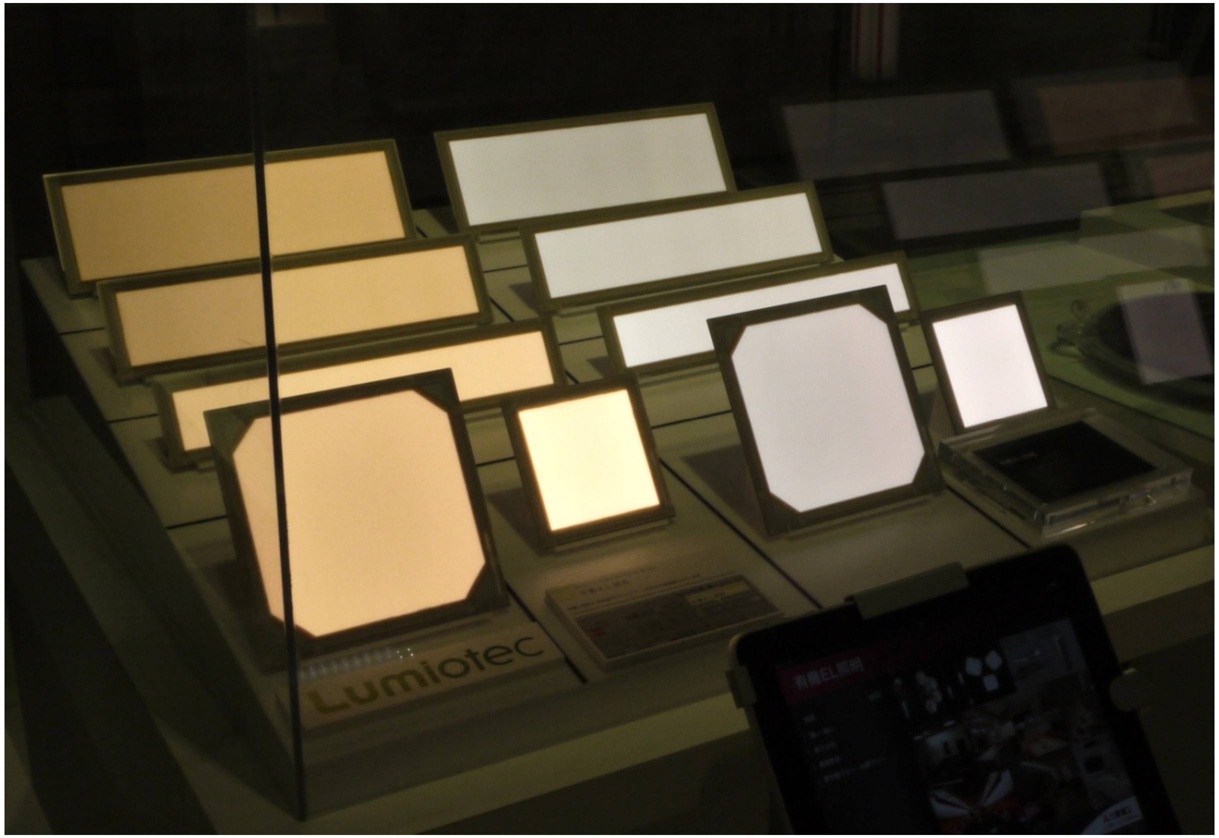


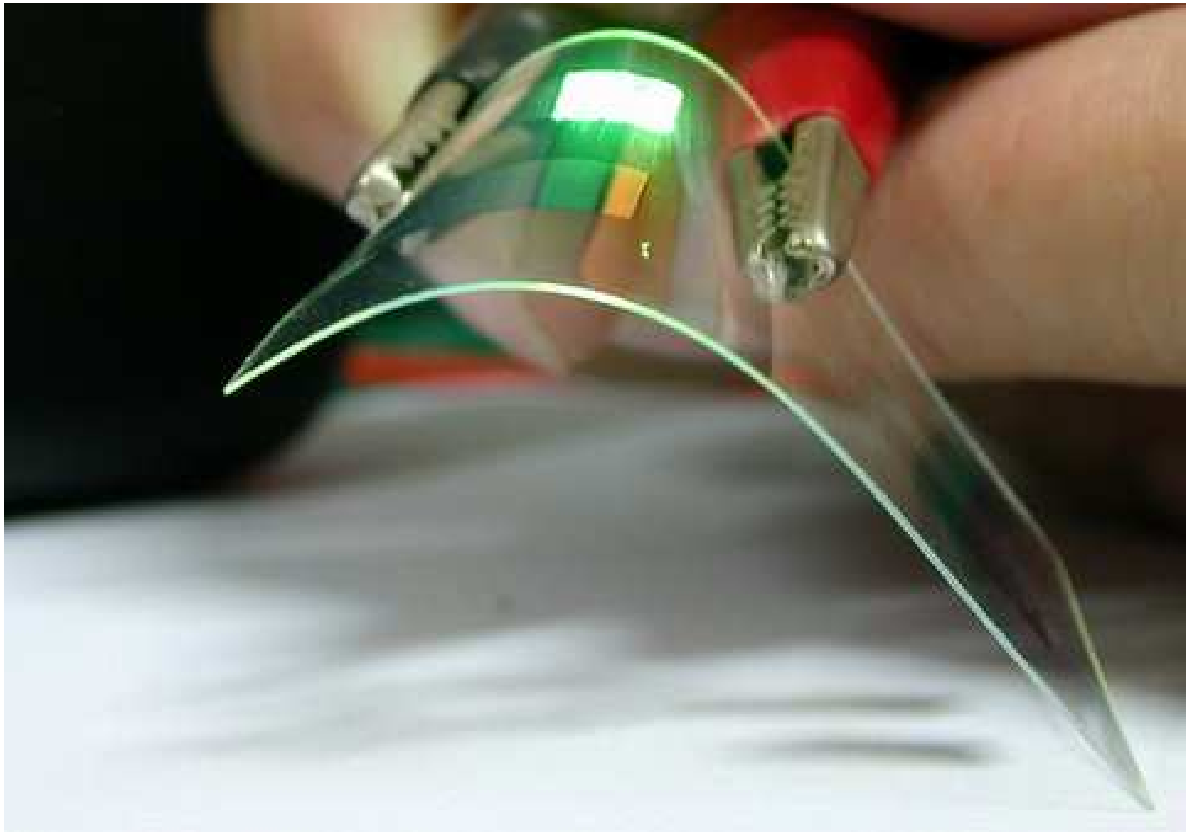
Fig. 1. (**A**) Cross section of the integrated P3HT FET and MEH-PPV LED. The device is a part (shown inside the dashed area in the top left corner) of a full active-matrix polymer LED pixel. The lamellar structure of the regioregular P3HT and its orientation relative to the SiO_2 substrate and the direction of the in-plane FET current I_d are shown schematically. (**B**) Photograph of a FET-LED with one of the four "pixels" switched on. The MEH-PPV layer (orange) was made to cover the substrate only partially in order to make the underlying (blueish) P3HT layer visible.

Prototype OLED lighting panels



from Wikipedia

Demonstration of a flexible OLED device



from Wikipedia

LG OLED TV

from Wikipedia

Sony XEL-1, the world's first OLED TV

from Wikipedia

3.8 cm (1.5 in) OLED display from a Creative ZEN V media player

from Wikipedia

Demonstration of a 4.1" prototype OLED flexible display from Sony

from Wikipedia