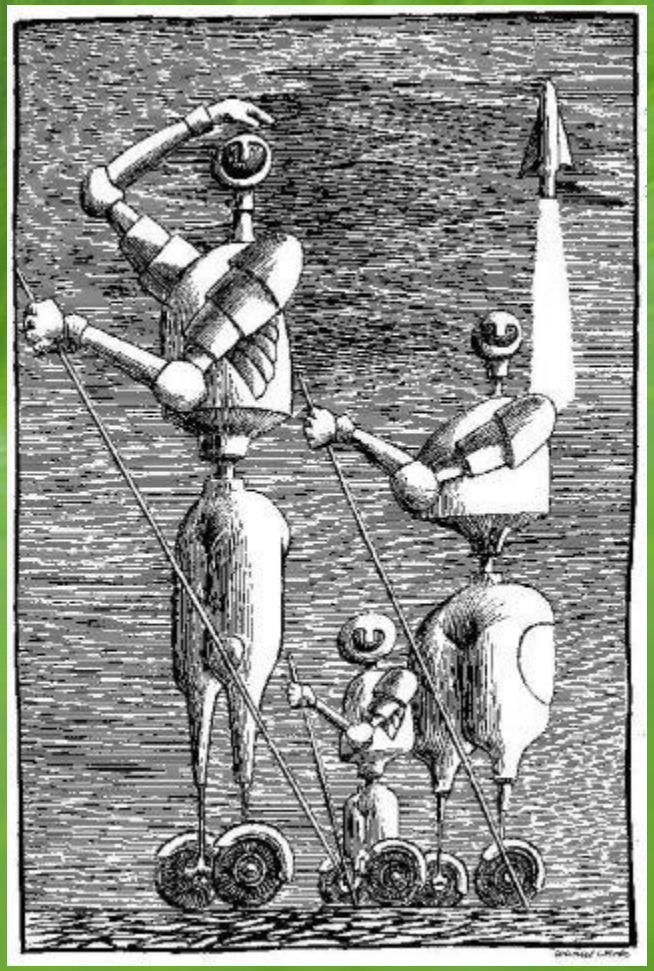
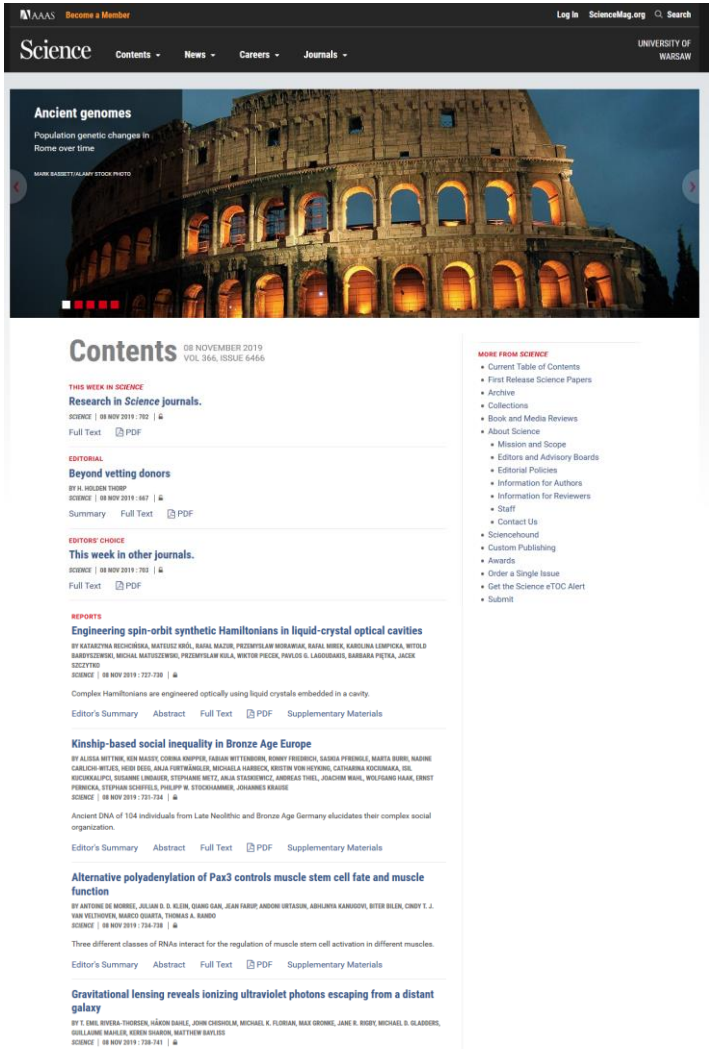
Dlaczego dioda świeci i jak zamienić ładunek elektryczny na foton?



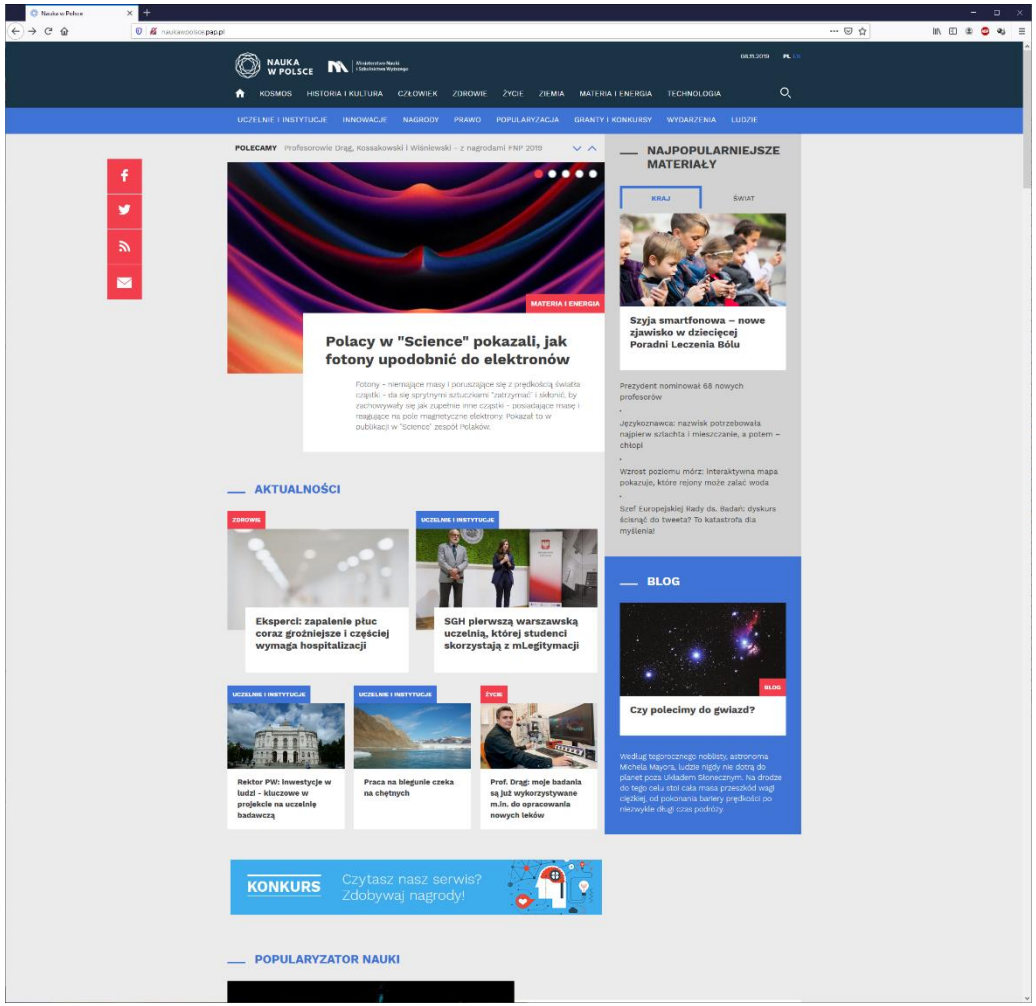
Jacek.Szczytko@fuw.edu.pl Wydział Fizyki UW

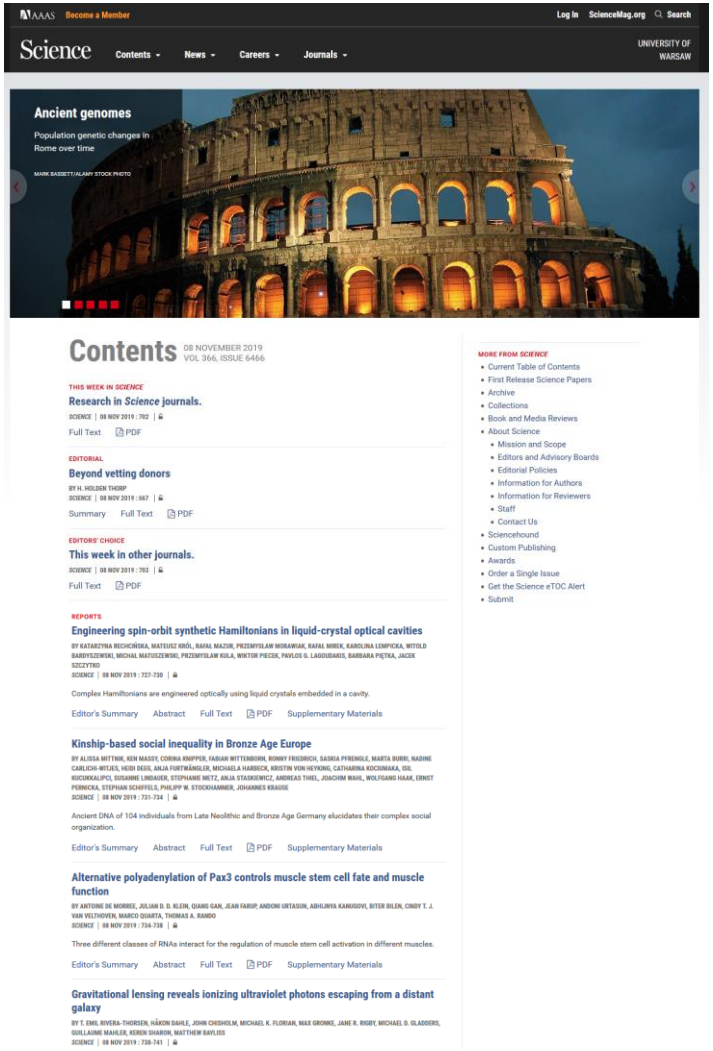
Vive la Science!



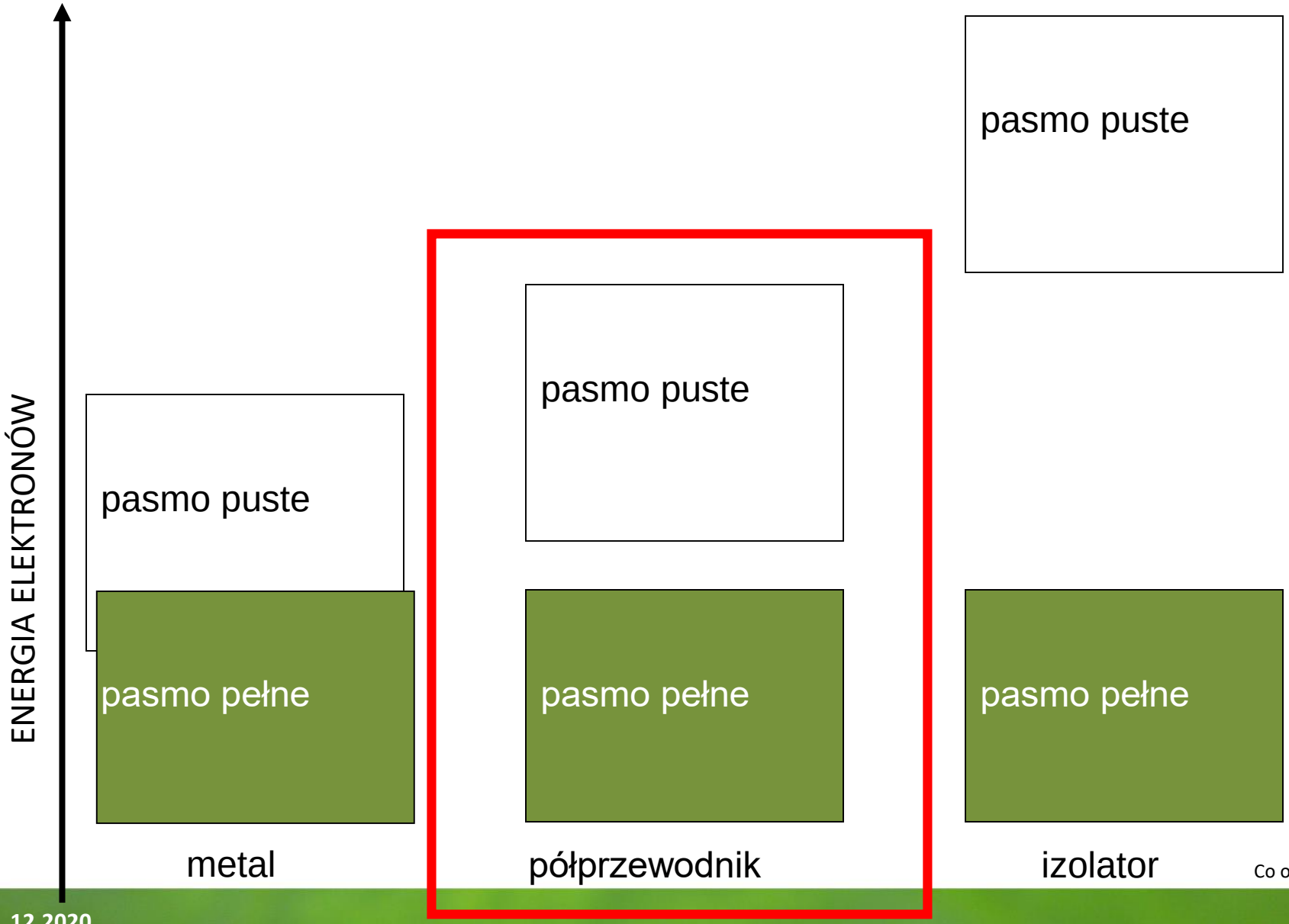
Vive la Science!

http://naukawpolsce.pap.pl/



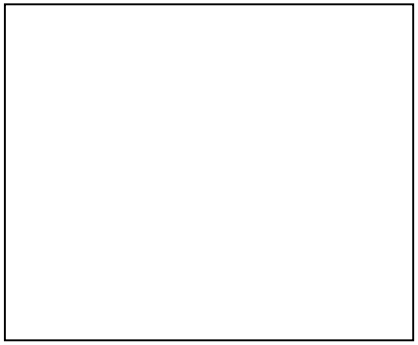


Teoria pasmowa ciał stałych.

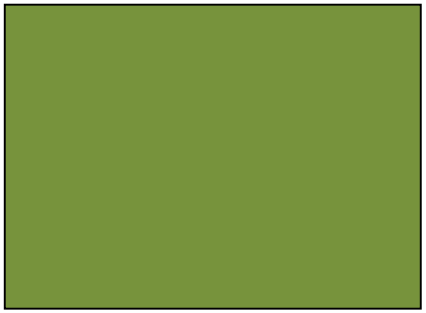


Co odróżnia pp i iz

Teoria pasmowa ciał stałych.



półprzewodnik typu p



półprzewodnik typu n

Teoria pasmowa ciał stałych.

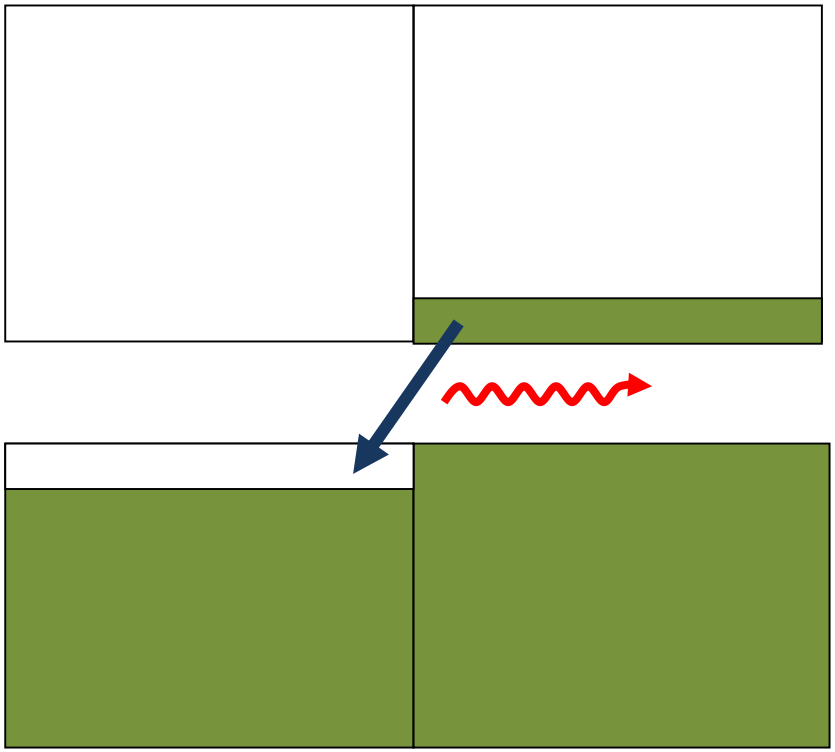
Dioda – czyli złącze *p-n*

typ p typ n

Flat band

Teoria pasmowa ciał stałych.

Dioda – czyli złącze *p-n*



Flat band

Przerwa energetyczna

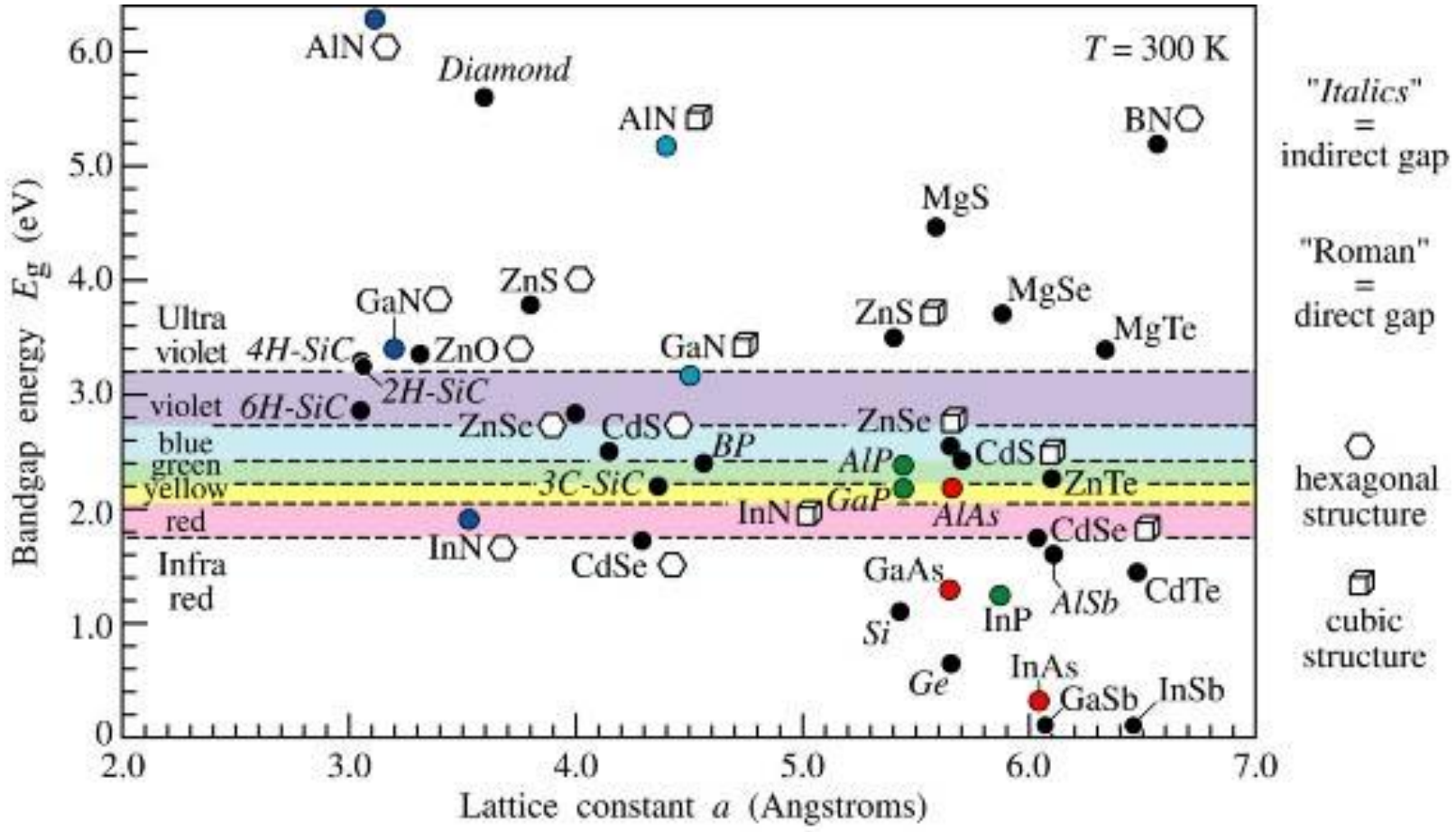
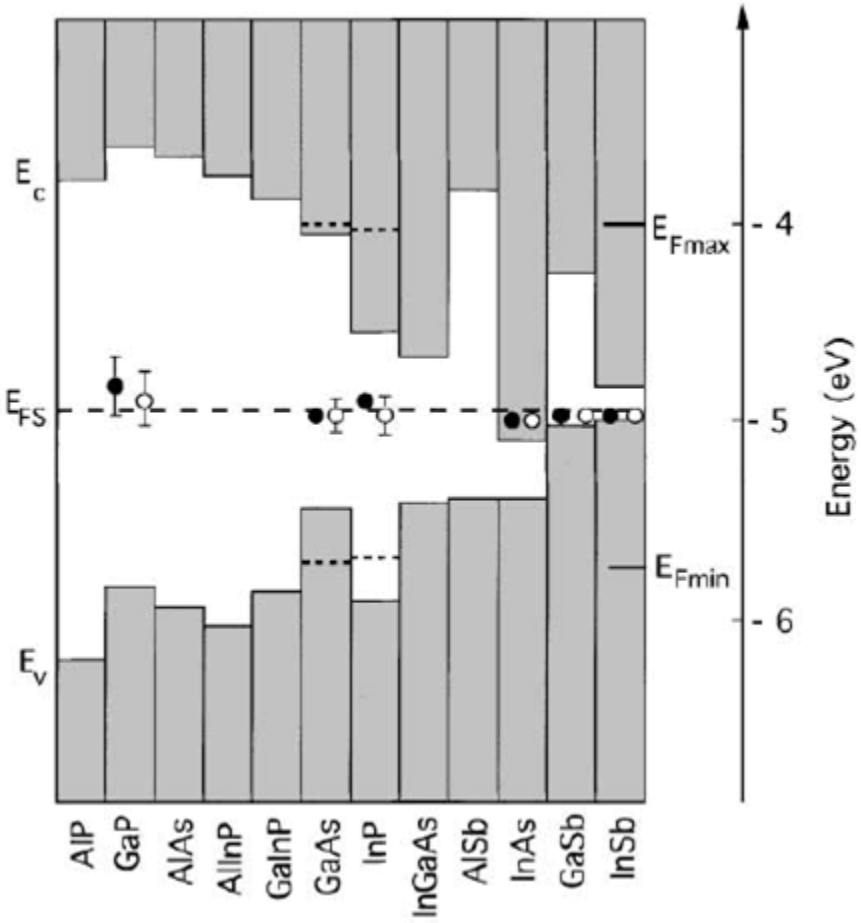


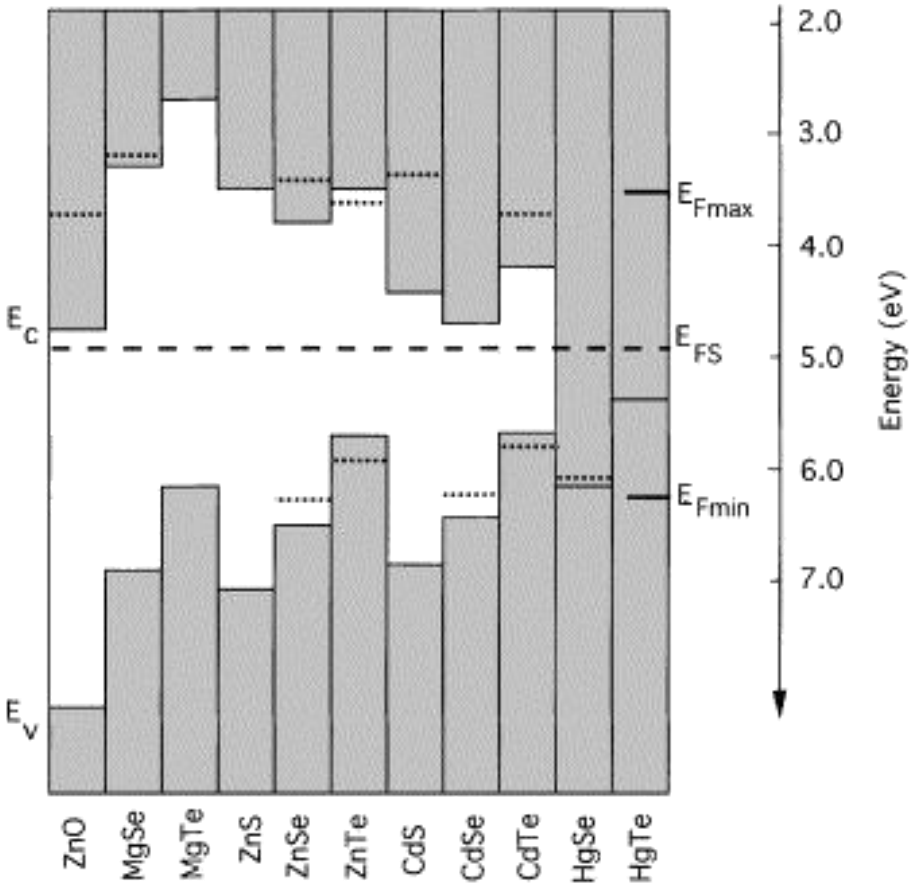
Fig. 11.4. Room-temperature bandgap energy versus lattice constant of common elemental and binary compound semiconductors.

http://www.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap11/F11-04-R.jpg

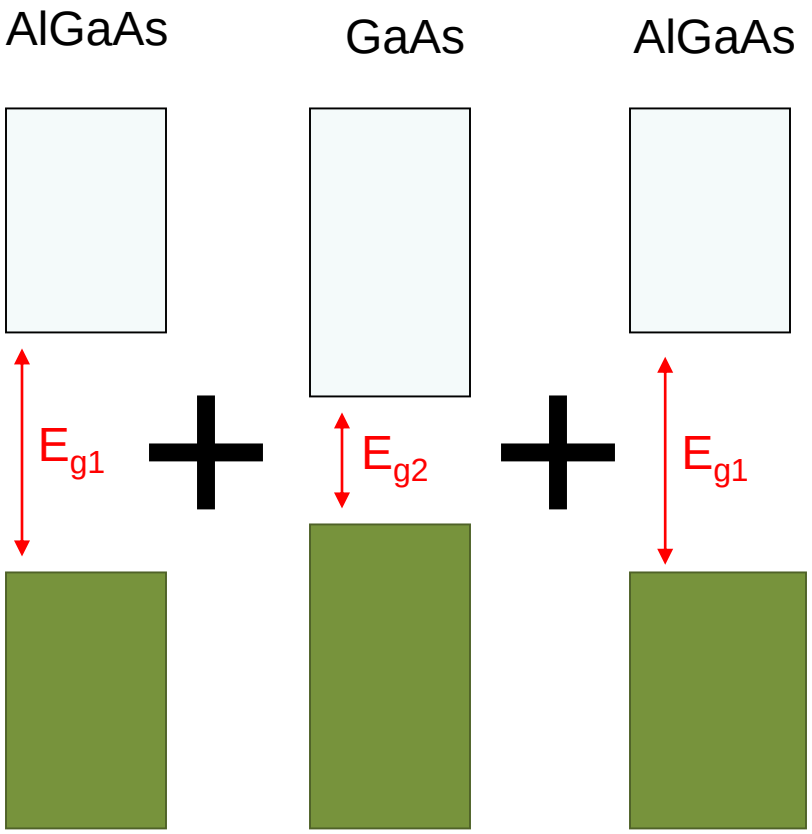
Bandgap engineering

Valence band offset





Studnia Kwantowa



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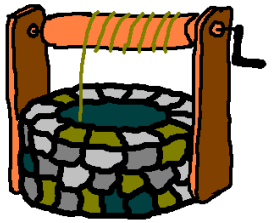

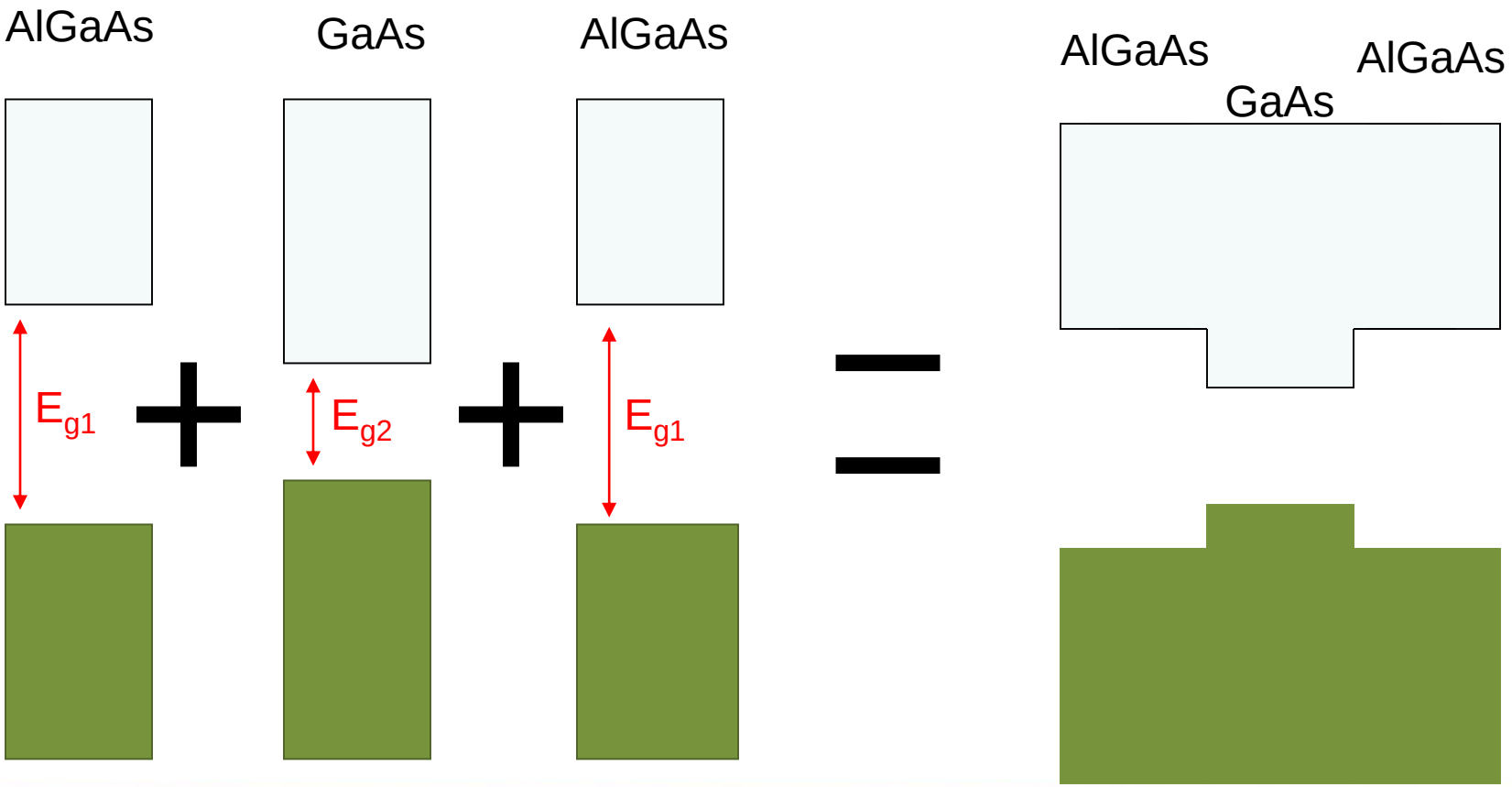

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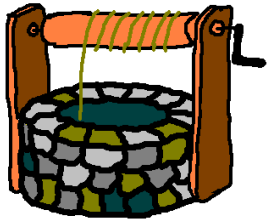

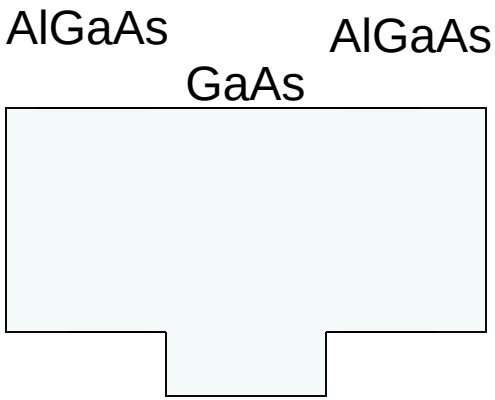

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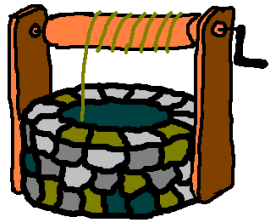
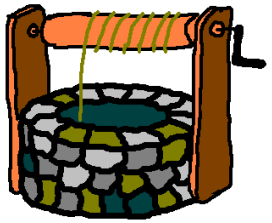
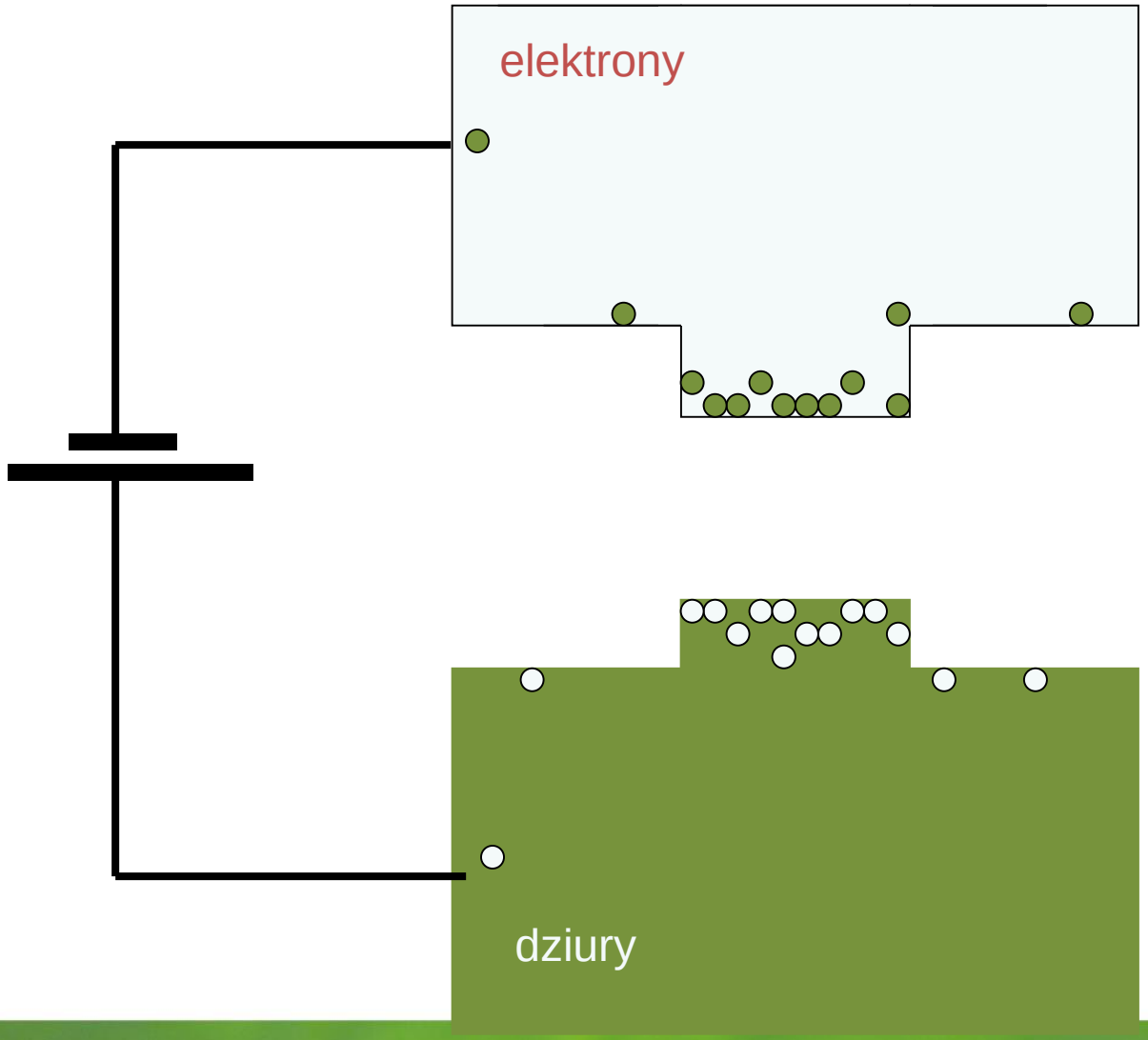
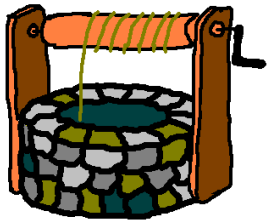


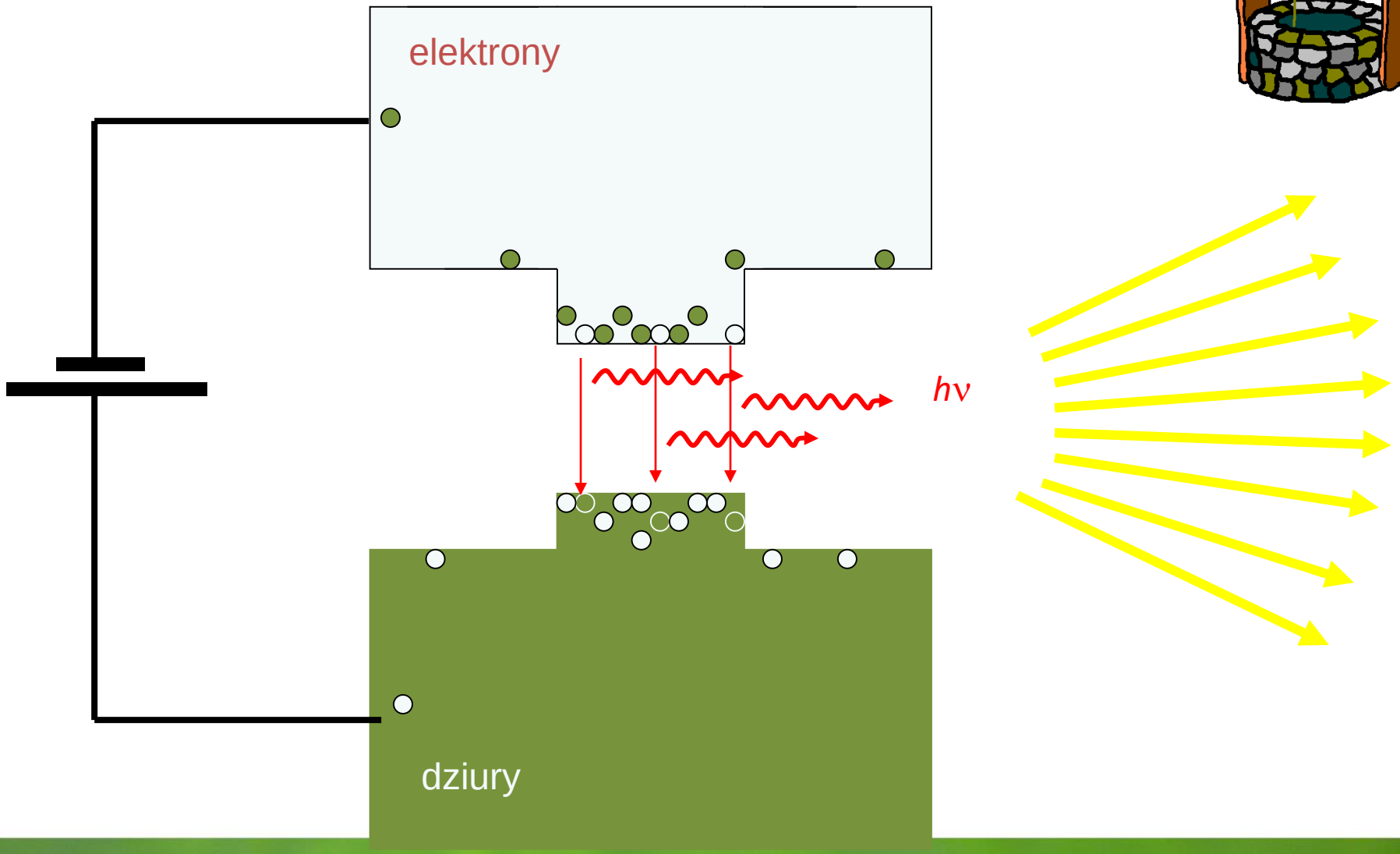
Studnia Kwantowa





Studnia Kwantowa





Jak zbudowany jest laser?

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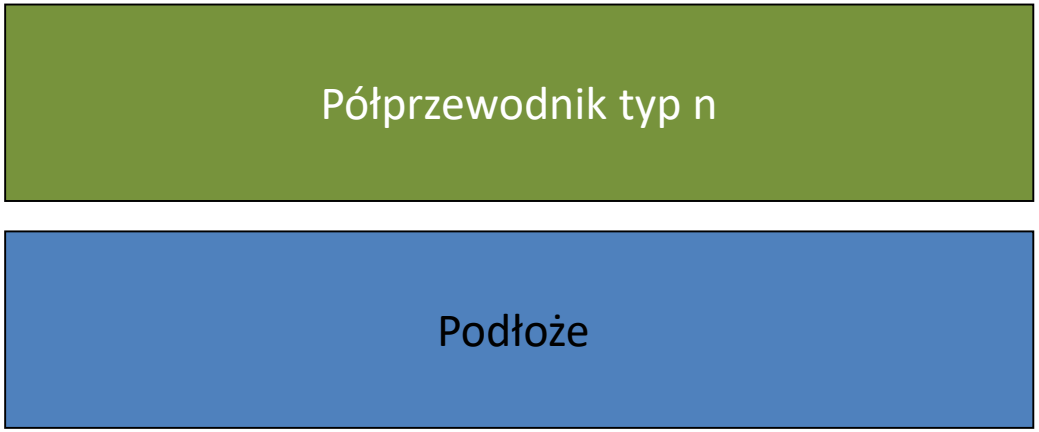

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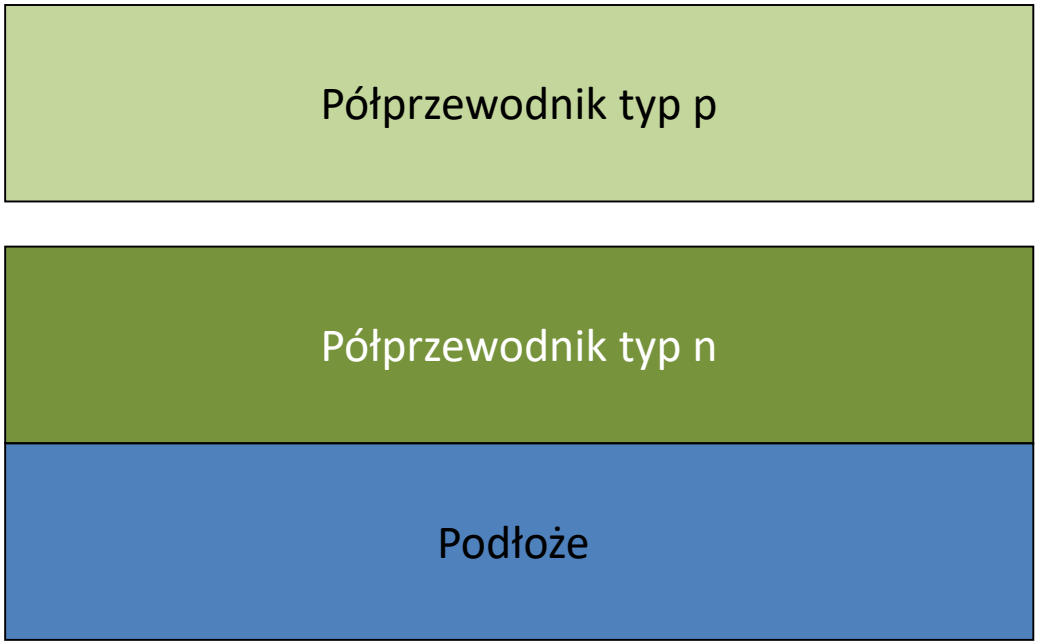
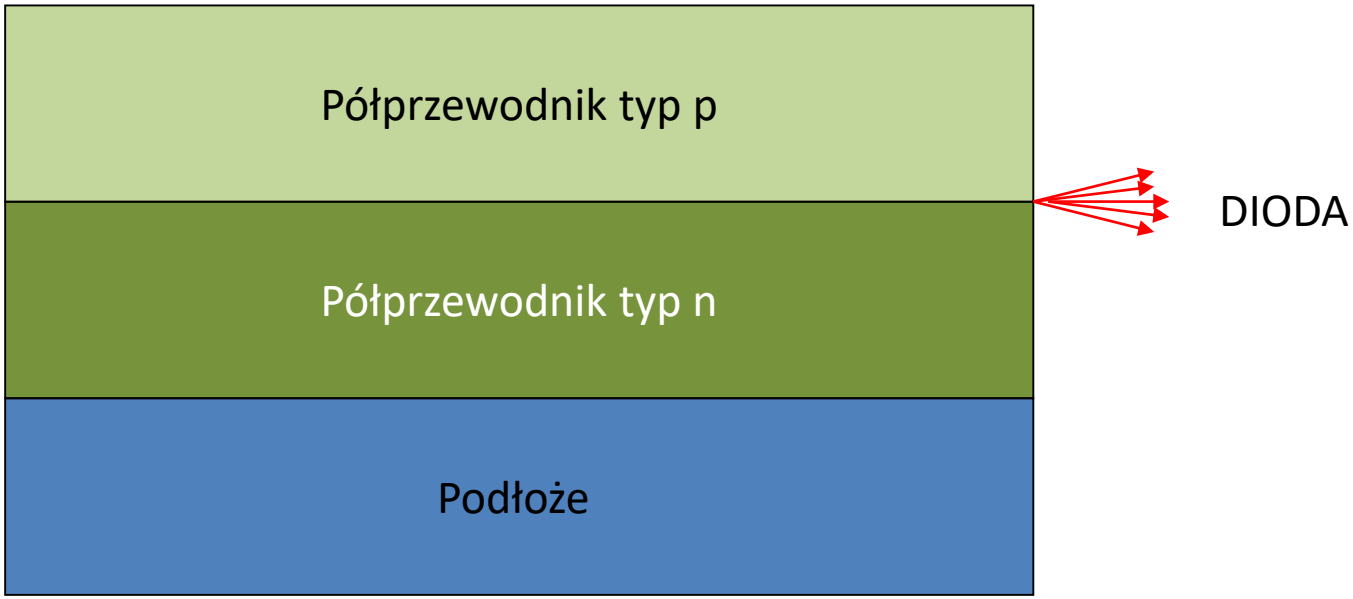


Jak zbudowany jest laser?



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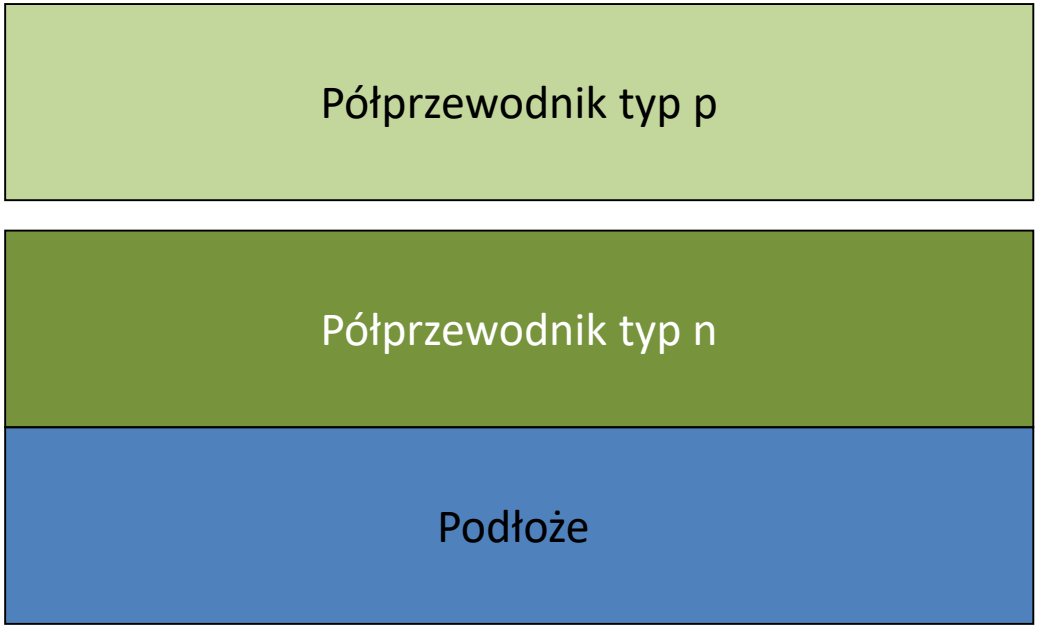

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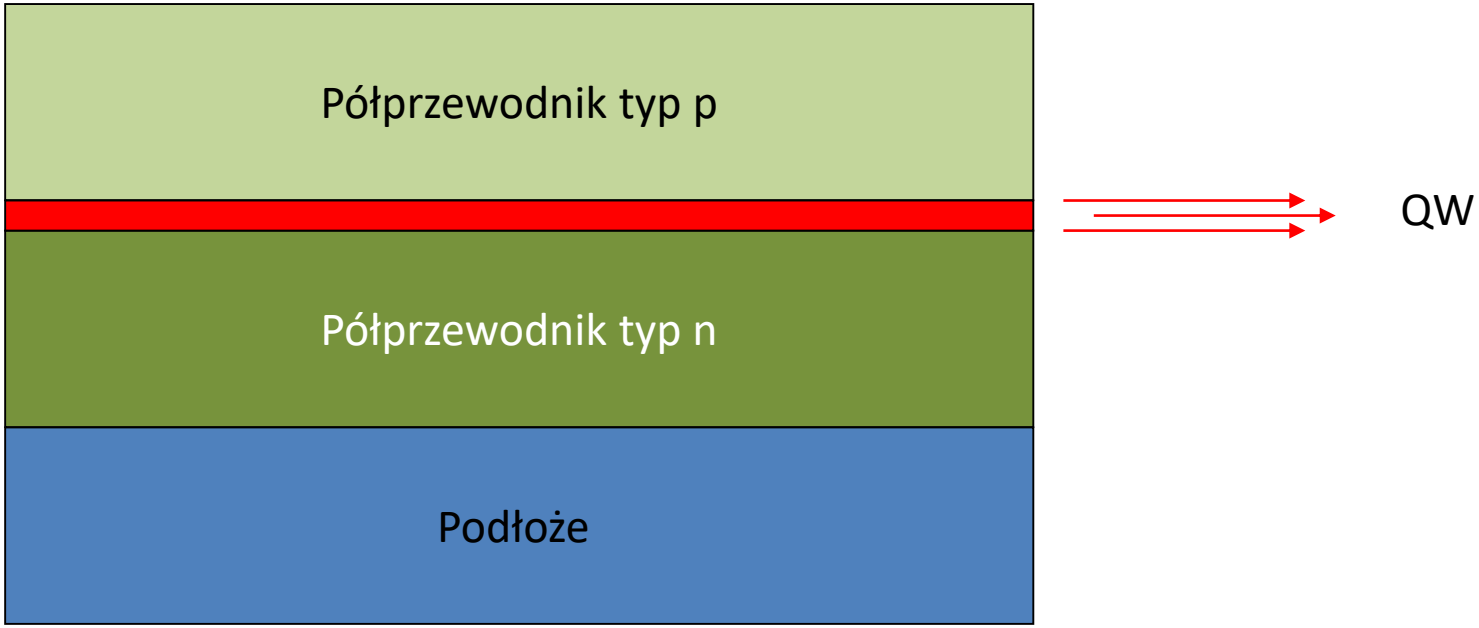

Trochę historii

- 1907 – żółta elektroluminescencja SiC (Henry Joseph Round)
- 1936 – elektroluminescencja ZnS, George Destriau
- Lata ‘50 pierwsze diody świecące (w podczerwieni) z GaAs – akronim Light Emitting Diode (LED),
- **MASER** (Microwave Amplification by the Stimulated Emission of Radiation) Charles H. Townes in 1954.
- 1960 **LASER** (rubin, Theodore Maiman) 1961 He-Ne (Ali Javan, William Bennet, and Donald Herriot)

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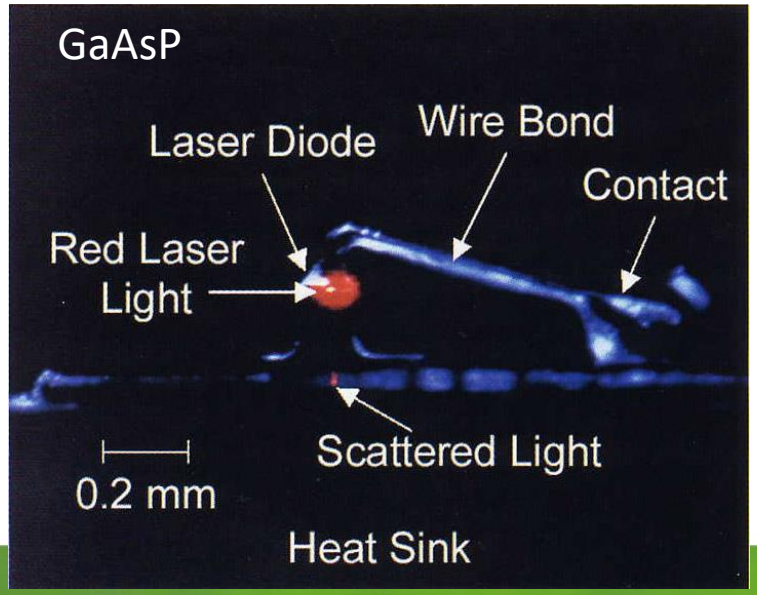

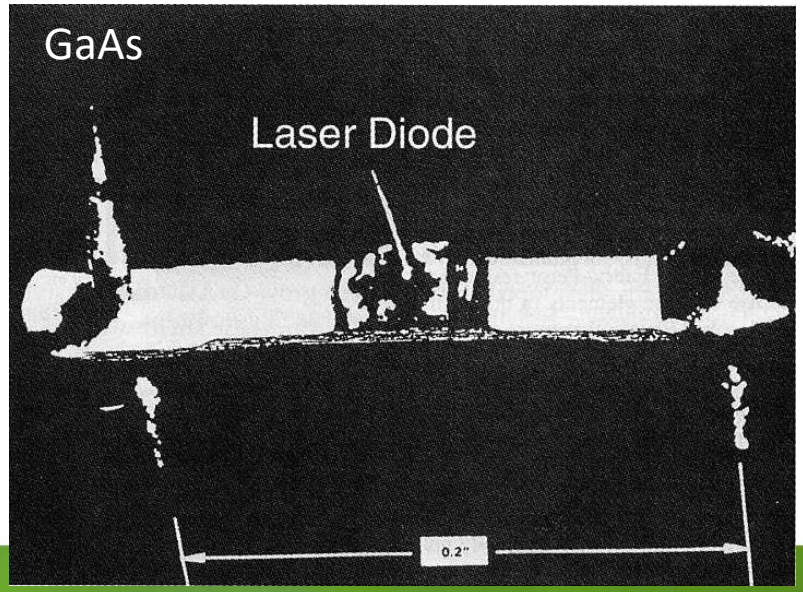

http://www.rpi.edu/~schubert/

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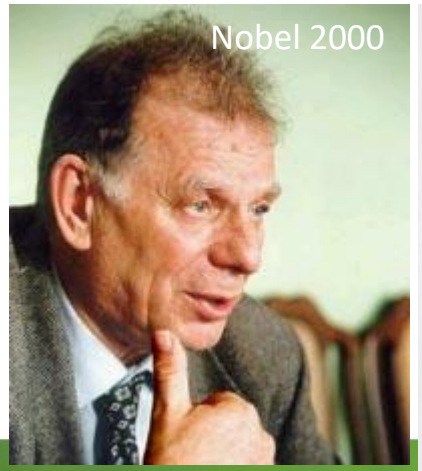

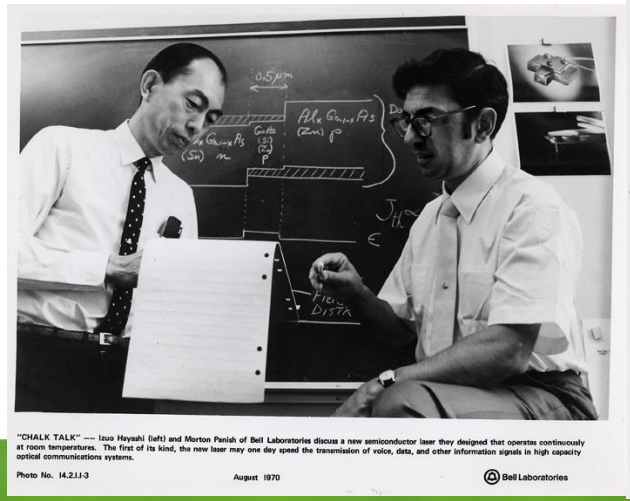

"CHALK TALK" — Izuo Hayashi (left) and Morton Panish of Bell Laboratories discuss a new semiconductor laser they designed that operates continuously at room temperatures. The first of its kind, the new laser may one day speed the transmission of voice, data, and other information signals in high capacity optical communications systems.

Photo No. 14.2.1.1-3 August 1970 Bell Laboratories

HONEST, ABE — IT'S A LASER! This new semiconductor laser, designed by Bell Laboratories scientists Izuo Hayashi, Morton Panish, P. W. Foy and S. Sumski, is about 15 thousandths of an inch long by three thousandths of an inch wide. A power source no larger than a dry cell battery will operate this laser — the first of its kind to run continuously at room temperature.

Photo No. 14.2.1.1-2 August 1970 Bell Laboratories

http://www.rpi.edu/~schubert/

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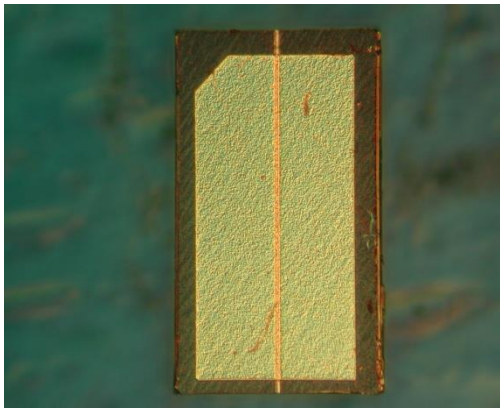
- Lata ’60 pierwsze diody świecące na czerwono z GaAsP/GaAs, a później GaAsP/GaP
- 1970 pierwszy laser cw RT (Zhores Alferov ZSRR, Hayashi and Panish, Bell Labs)
- Połowa lat ’70 diody z GaP (zielone). **Czerwone + Zielone = Żółte**
- Połowa lat ’80 diody z GaAlAsP (bardzo wydajne).
- Połowa lat ’90 diody z InGaAlP (jeszcze bardziej wydajne) czerwone, pomarańczowe, zielone i żółte.

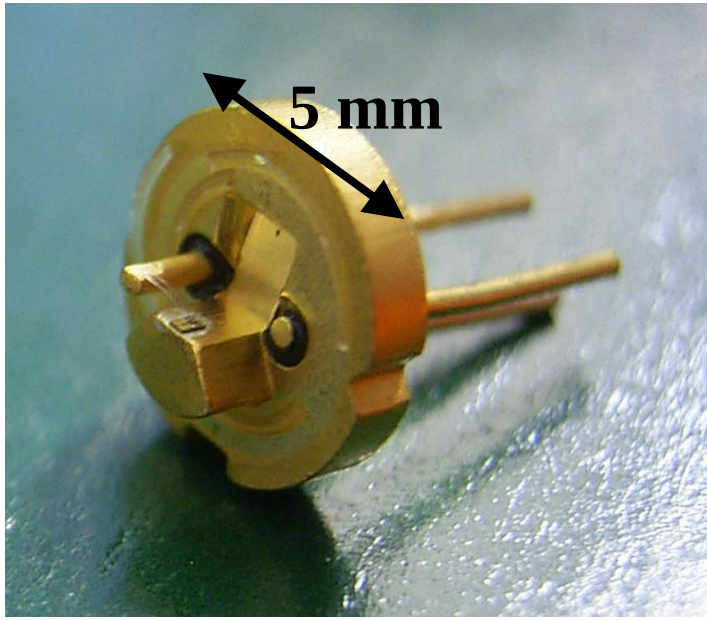
Trochę historii

1977 – pierwsza rozmowa telefoniczna transmitowana światłowodem
1982 – Phillips and Sony rozpoczynają produkcje odtwarzaczy CD
1996-97 – technologia DVD

Left: first CD-player (1982)

Obecnie ponad 60% rynku laserów półprzewodnikowych to :
Lasery telekomunikacyjne: 1.55 µm
Lasery CD, DVD 790, 640 nm





Czesław Skierbiszewski *UNIPRESS*

Przerwa energetyczna

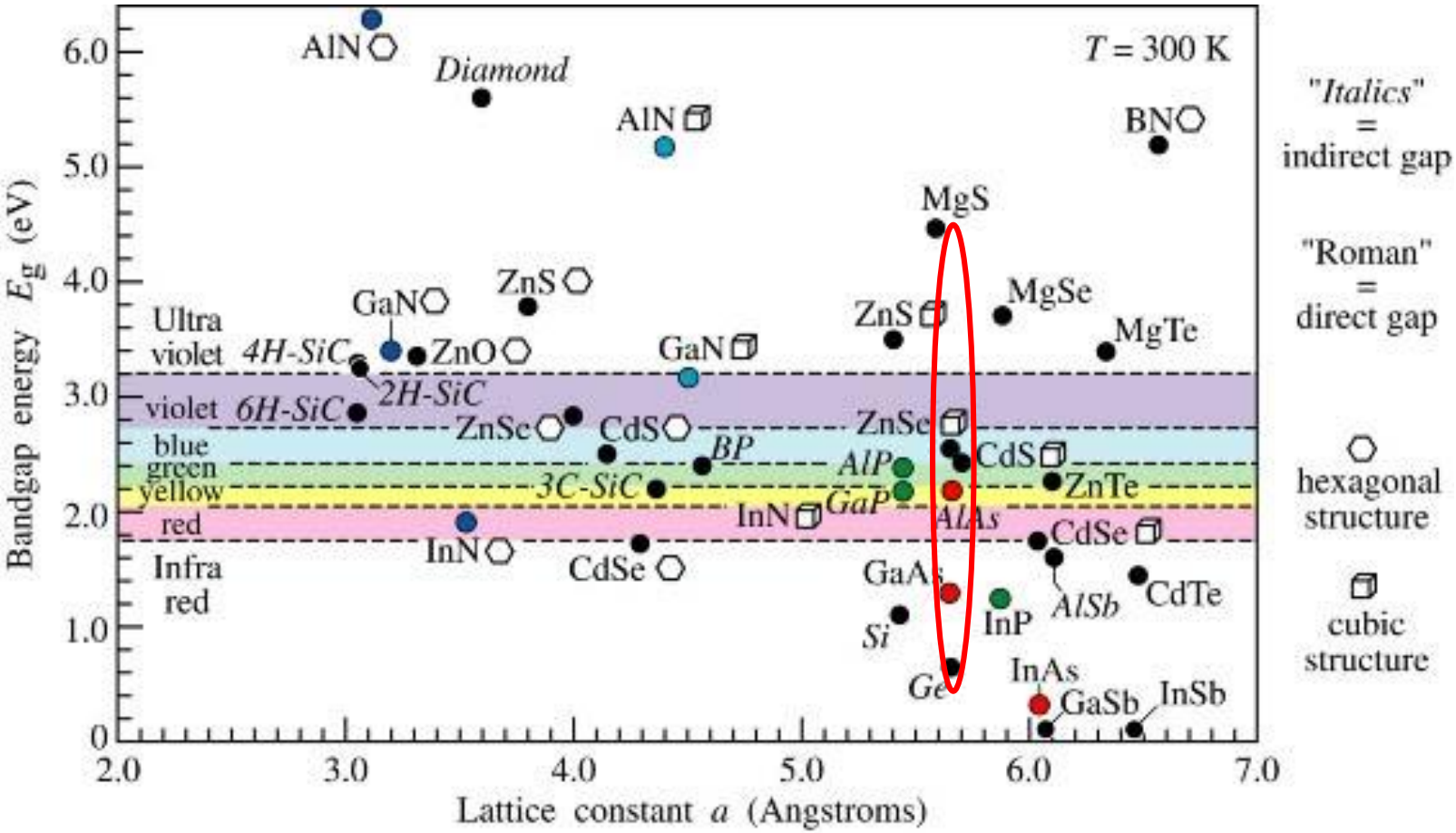


Fig. 11.4. Room-temperature bandgap energy versus lattice constant of common elemental and binary compound semiconductors.

http://www.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap11/F11-04-R.jpg

Obiecujący materiał

1272 Appl. Phys. Lett. 59 (11), 9 September 1991 0003-6951/91/361272-03$02.00

Blue-green laser diodes

M. A. Haase, J. Qiu, J. M. DePuydt, and H. Cheng
3M Company, 201-1N-35 3M Center, St. Paul, Minnesota 55144

Lifetime 100h

(Received 17 May 1991; accepted for publication 13 June 1991)

The first laser diodes fabricated from wide-band-gap II-VI semiconductors are demonstrated. These devices emit coherent light at a wavelength of 490 nm from a ZnSe-based single-quantum-well structure under pulsed current injection at 77 K. This is the shortest wavelength ever generated by a semiconductor laser diode.

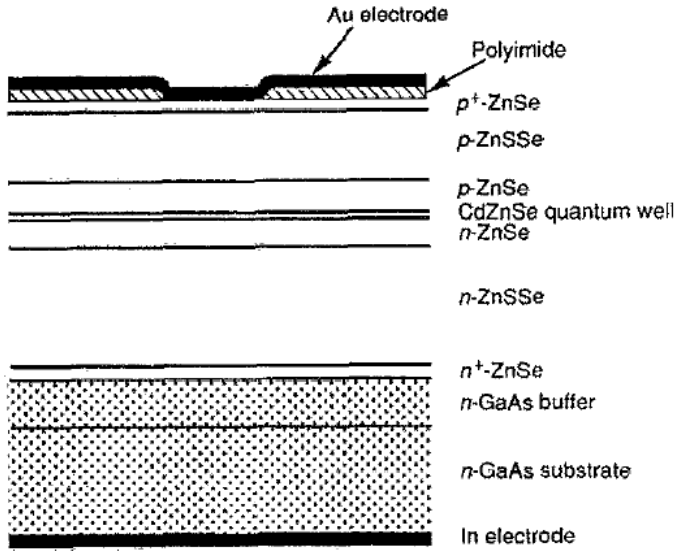


FIG. 1. A cross section of a blue-green laser diode.

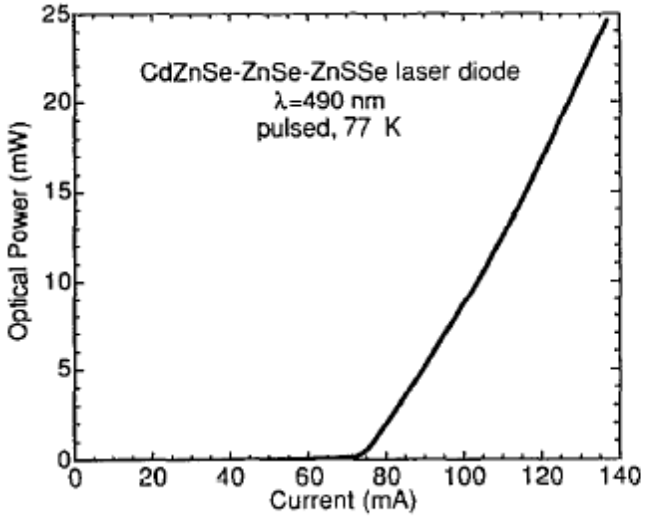


FIG. 2. The *L-I* characteristic of a blue-green laser diode. This gain-guided device is 20 μm wide and 1160 μm long.

Obiecujący materiał

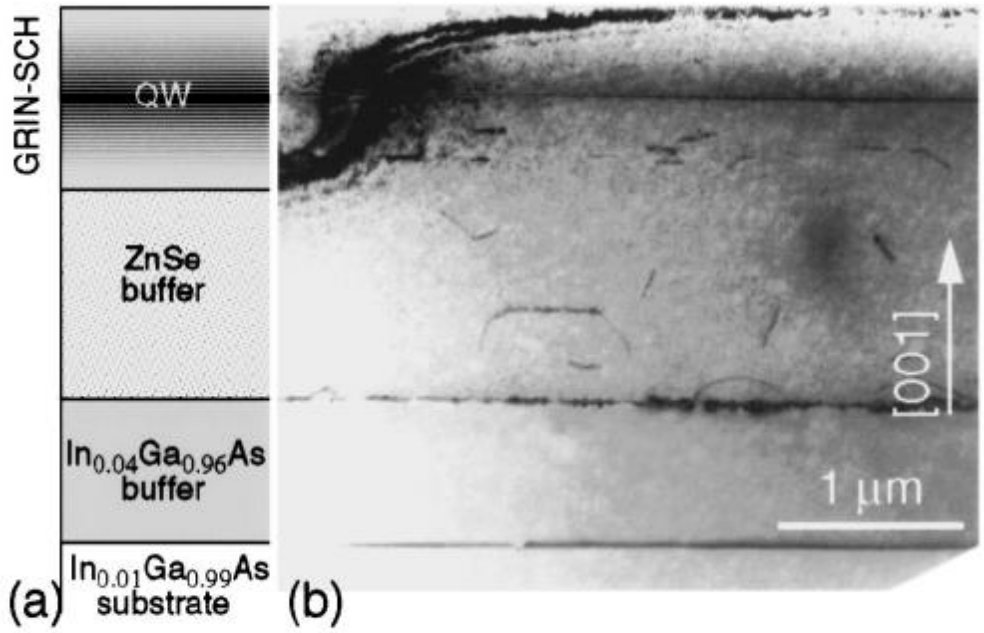


FIG. 1. (a) Schema of the structure; (b) bright field TEM image in the cross section of No. 372 near the [110] zone axis.

JOURNAL OF APPLIED PHYSICS VOLUME 83, NUMBER 4 15 FEBRUARY 1998

Transmission electron microscopy and cathodoluminescence studies of extended defects in electron-beam-pumped $Zn_{1-x}Cd_xSe$/ZnSe blue-green lasers

Jean-Marc Bonard[a),b)] and Jean-Daniel Ganière
Département de Physique, Institut de Micro-et Optoélectronique, Ecole Polytechnique Fédérale, CH-1015 Lausanne, Switzerland

Lia Vanzetti,[c)] Jens J. Paggel,[d)] Lucia Sorba,[e)] and Alfonso Franciosi[f)]
Laboratorio Nazionale TASC-INFM, Area di Ricerca, Padriciano 99, I-34012 Trieste, Italy

Denis Hervé[g)] and Engin Molva
Département Optronique, LETI (CEA-Technologies Avancées) 17 rue des Martyrs, F-38054 Grenoble Cédex 9, France

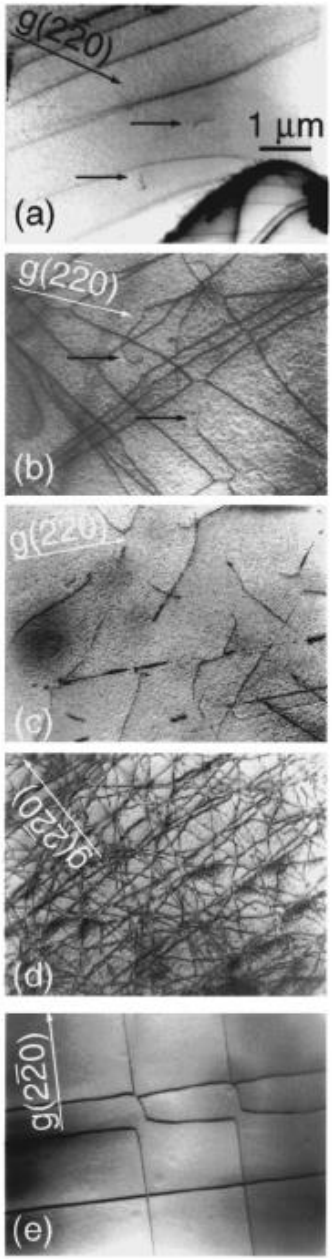


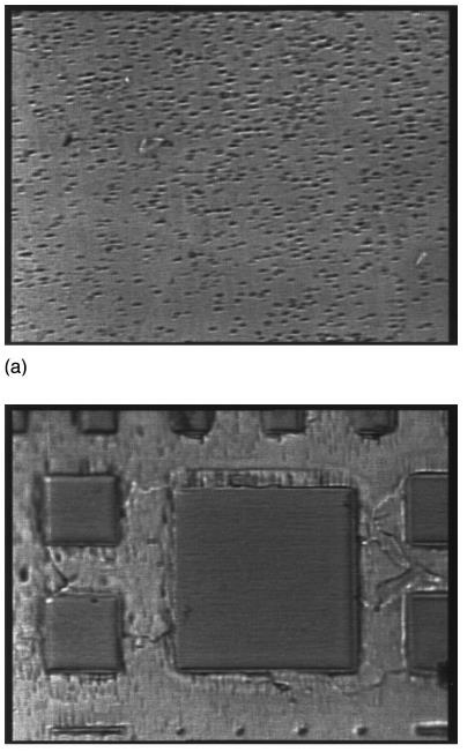
FIG. 3. Bright field TEM images of No. 372 in plan view taken with g =(220) two beam diffraction conditions near the [001] zone axis: (a) top GRIN layer (thickness of the foil: ~400 nm); (b) whole GRINSCH (~800 nm); (c) ZnSe buffer (GRINSCH removed); (d) ZnSe buffer with III-V/II-VI interface (GRINSCH removed); (e) InGaAs buffer and substrate-buffer interface (GRINSCH and ZnSe buffer removed).

Obiecujący materiał

JOURNAL OF APPLIED PHYSICS VOLUME 91, NUMBER 6 15 MARCH 2002

Patterned heteroepitaxial processing applied to ZnSe and $ZnS_{0.02}Se_{0.98}$ on GaAs (001)

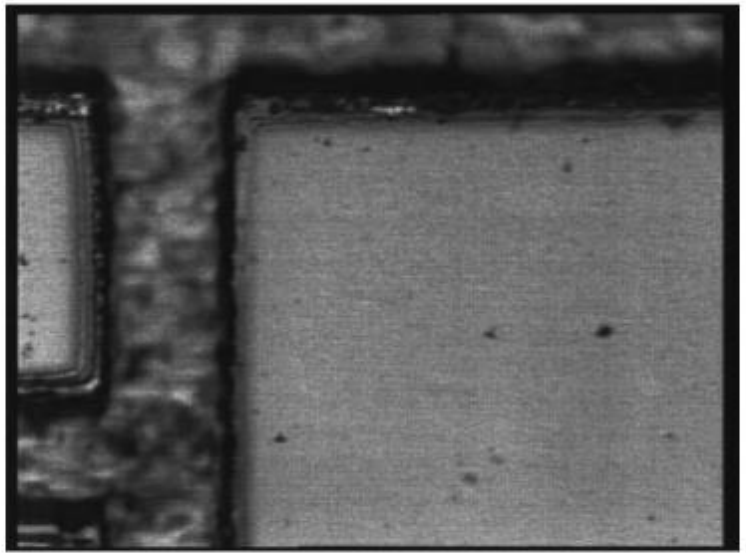
X. G. Zhang, A. Rodriguez, P. Li, F. C. Jain, and J. E. Ayers[a)]
Electrical and Computer Engineering Department, University of Connecticut, 260 Glenbrook Road, Storrs, Connecticut 06269-2157



(a)

(b)

FIG. 1. The etch pit morphology of: (a) a 6000 Å thick as-grown ZnSe layer on GaAs and (b) a PHP prepared layer consisting of 6000 Å thick ZnSe mesas on GaAs. Both pieces were from the same ZnSe/GaAs wafer.



(d)

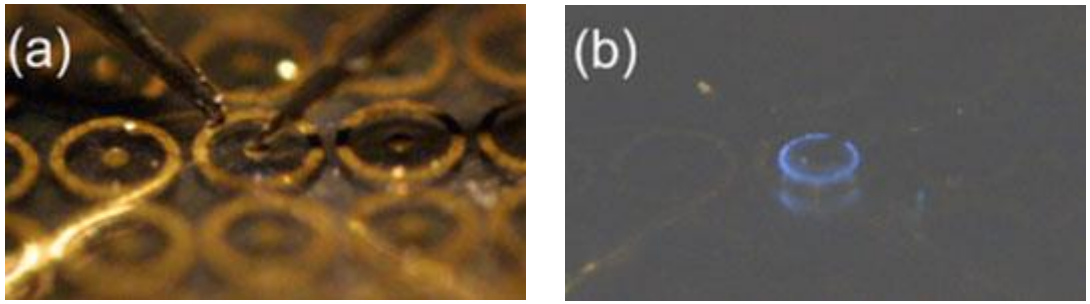
FIG. 5. The etch pit morphology of $ZnS_{0.02}Se_{0.98}$ on GaAs: (a) a 2900 Å thick as-grown and (b) a 2900 Å thick PHP prepared (both pieces were from the same wafer); (c) a 6000 Å thick as-grown and (d) a 6000 Å thick PHP prepared layer [both (c) and (d) were from the same wafer].

Obiecujący materiał

May 19, 2005

World's First Blue LED Made with Zinc Oxide

A Japanese team led by Professor Masashi Kawasaki of the Tohoku University Institute for Materials Research announced it had successfully developed the world's first blue light-emitting diode (LED) made with low-cost zinc oxide in December 2004.



http://www.jetro.go.jp/en/market/trend/topic/2005_05_led.html

Przerwa energetyczna

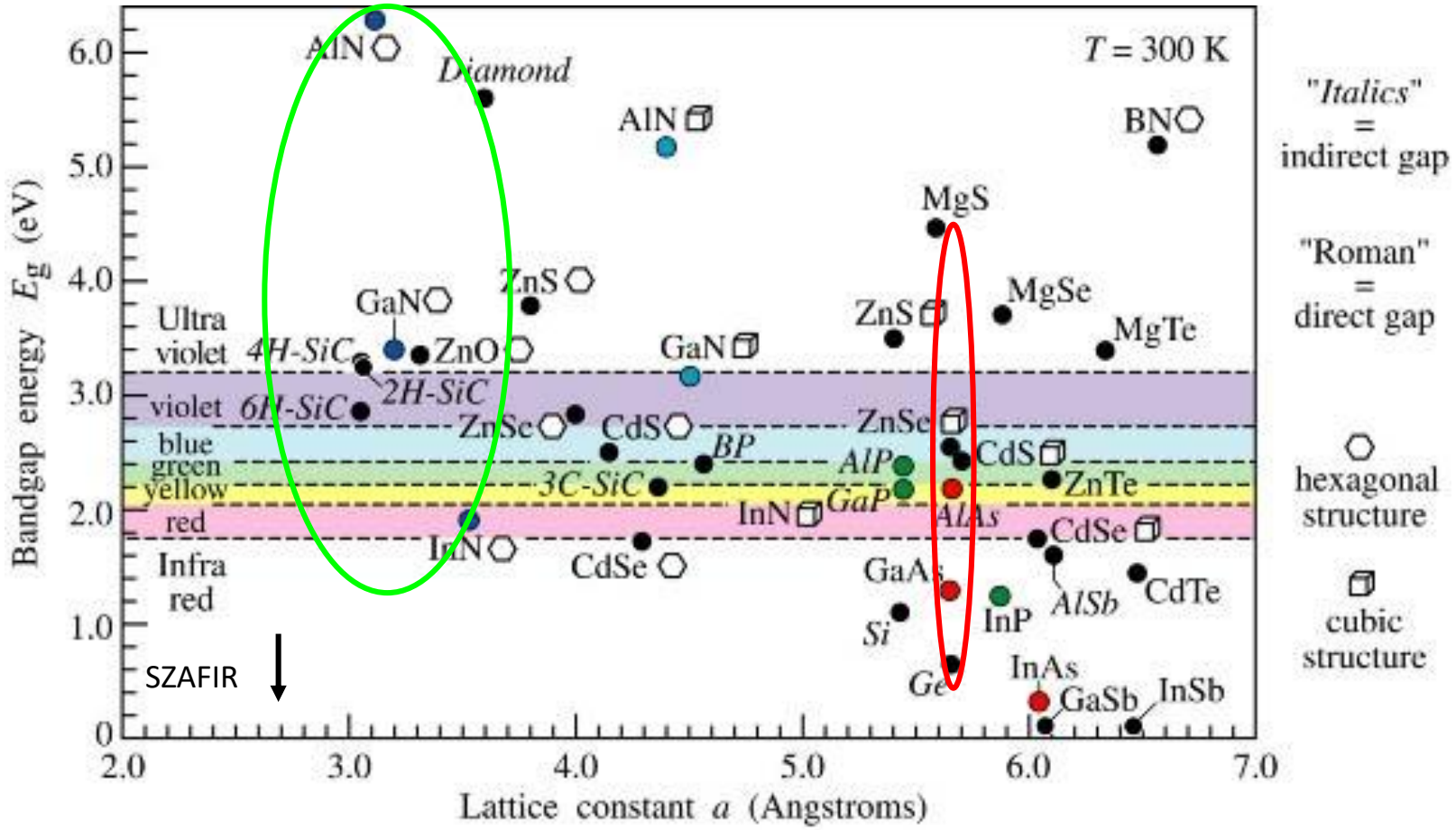
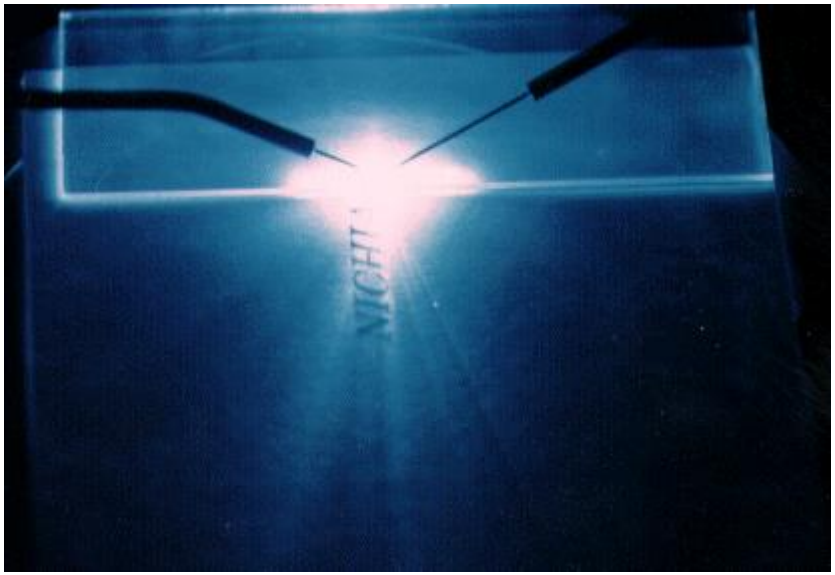


Fig. 11.4. Room-temperature bandgap energy versus lattice constant of common elemental and binary compound semiconductors.

http://www.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap11/F11-04-R.jpg

Trochę historii

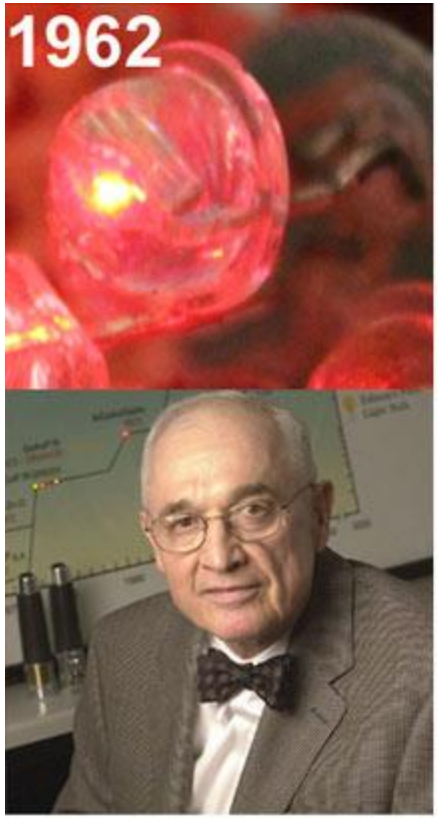
- Połowa lat ’90 diody z InGaAlP (jeszcze bardziej wydajne) czerwone, pomarańczowe, zielone i żółte.
- 1993 Niebieskie diody Nichia (Nakamura)
- 1996 Niebieski laser Nichia (Nakamura) RT, pulsed 215 mW



Nichia Chemical Industries

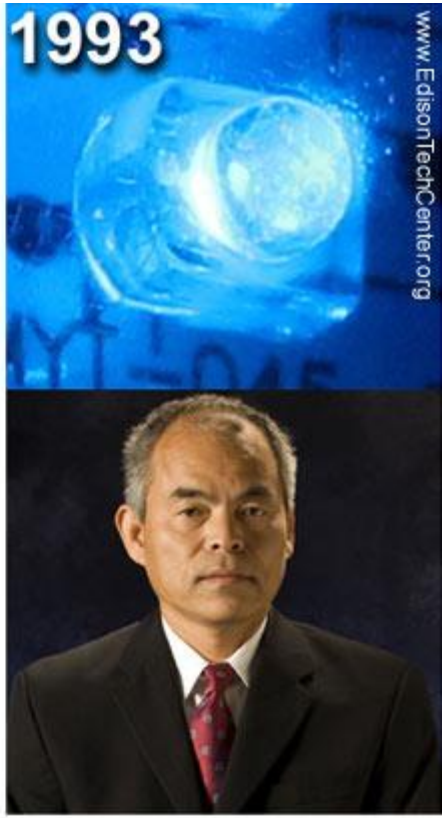
http://nsr.mij.mrs.org/news/flash.html

Trzy kolory



Nick Holonyak
Syracuse, NY

George Craford
St. Louis, MI



Shuji Nakamura
Tokushima, Japan

http://www.edisontechcenter.org/LED.html

Trzy kolory

The Nobel Prize in Physics 2014
Isamu Akasaki, Hiroshi Amano, Shuji Nakamura

The Nobel Prize in Physics 2014

Photo: Yasuo Nakamura/Meijo University

Isamu Akasaki

Prize share: 1/3

Photo: Nagoya University

Hiroshi Amano

Prize share: 1/3

Photo: Randall Lamb, UCSB

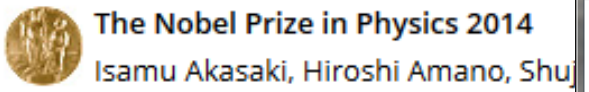
Shuji Nakamura

Prize share: 1/3

The Nobel Prize in Physics 2014 was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura *"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"*.

http://www.nobelprize.org/nobel_prizes/physics/laureates/2014/

Trzy kolory



Dr Szczytko: odkrycia noblis...

naukawpolsce.pap.pl/aktualnosci/news,402184,dr-szczytko-odkrycia-nol

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PL EN 8 października 2014

pap Nauka w Polsce
serwis PAP poświęcony polskiej nauce

Szukaj
Wyszukiwanie zaawansowane

Ministerstwo Nauki i Szkolnictwa Wyższego

Historia i kultura Kosmos Przyroda Społeczeństwo Technologie Uczelnie Nauki medyczne

Najnowsze i z archeologią" w Muzeum w Gliwicach | Nobel z fizyki dla twórców niebieskiej diody | Prof. Suski: tegoroczni nobliści dali początek r

Strona główna • Aktualności • Technologie

A A A

Dr Szczytko: odkrycia noblistów ważne również dla polskiej nauki

08.10.2014 TECHNOLOGIE, NAGRODY NOBLA 2014

Poleć Władysław Marek Saj to poleca.

Fot. Fotolia

Rewolucyjne odkrycie dzisiejszych noblistów było bardzo ważne też dla rodzimej nauki. Spowodowało, że badania nad azotkiem galu, prowadzone też przez polskich naukowców, nagle znalazły się w centrum światowej nauki - ocenił dr Jacek Szczytko z Uniwersytetu Warszawskiego.

We wtorek w Sztokholmie Komitet Noblowski ogłosił, że Isamu Akasaki, Hiroshi Amano i Shuji Nakamura za wynalezienie wydajnej diody emitującej niebieskie światło otrzymają Nagrodę Nobla z fizyki. Pierwszym krokiem do tego celu było uzyskanie wysokiej jakości kryształów azotku galu na szafirowym podłożu, co umożliwiło zbudowanie pierwszej niebieskiej diody.

"To było przełomowe odkrycie i bardzo ważne z punktu widzenia polskiej nauki. W Polsce nie mogliśmy się zajmować materiałami, którymi zajmuje się cały świat. Nakłady na naukę nie pozwalały na konkurowanie z instytucjami, których budżet był większy niż budżet całej polskiej nauki" - powiedział PAP dr Jacek Szczytko z Wydziału Fizyki Uniwersytetu Warszawskiego.

Z tego powodu - jak powiedział - Polska szkoła półprzewodników raczej nie zajmowała się krzemem, mimo że cały

Zobacz podobne

Nobel z chemii za mikroskopię w skali nano

Nobel 2014 z chemii z opracowanie mikrosk fluorescencyjnego

Laureaci Nobla w dziedzinie chemii w ostatnich 10 latach

Laureaci Nobla w dziedzinie chemii w latach 1901-2013

Isamu Akasaki – na

Trochę historii

★ 1970 - J. Pankove (RCA labs) odkrył, że GaN może eimitować niebieskie światło.

★ 1989 - I. Akasaki & H. Amano (Matsushita, Nagoya University)
- domieszkowanie na typ p GaN (z Mg),
- nieskotemperaturowa warstwa buforowa

★ 1992-1996 - S. Nakamura (Nichia) LEDs oraz LD z MOVPE
- „two-flow MOVPE process" do wzrostu warstw GaN
- wygrzewanie termiczne GaN:Mg

Trochę historii

SCIENCEWATCH®

Why did you decide to use gallium nitride?

Nakamura: At that time, in 1989, there were two materials for making blue LEDs: zinc selenide (ZnSe) and gallium nitride (GaN). These had the right band gap energy for blue lasers. But everybody was working on zinc selenide because that was supposed to be much better. I thought about my past experience: **if there's a lot of competition, I cannot win.** Only a small number of people at a few universities were working with gallium nitride so I figured I'd better work with that. **Even if I succeeded in a making a blue LED using zinc selenide, I would lose out to the competition when it came to selling it.**

Trochę historii

SCIENCEWATCH®

You still weren't doing laser research?

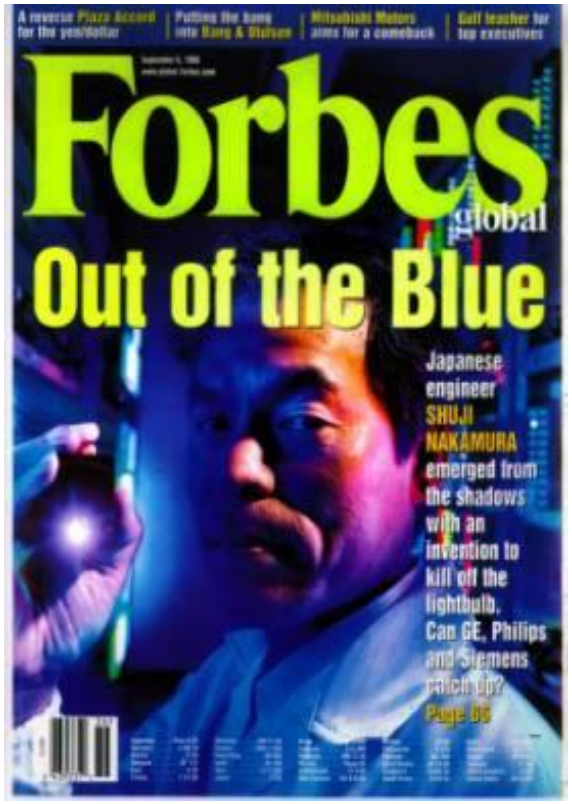
Nakamura. Not yet. In 1985, I went to work on a gallium aluminum arsenide epitaxial wafer. This is also used for LEDs. It's called an epitaxial wafer because you use very thin layers to make the LEDs. So I spent the next three years on that and came out with these gallium aluminum wafers for red and infrared LEDs, but the same thing happened: Our sales were not good because the bigger companies were already selling the same product by the time I was. The quality of our LEDs and epitaxial wafers was just as good and the prices were the same, but our company was small and local and couldn't compete. So once again my company was not happy.

By this time the R&D department was down to just me-the other two people left because the results were so terrrible. I kept at it, but I was dispirited. For ten years I had worked very hard to make these products. I worked twelve hours a day, seven days a week, except holidays. I had a very, very small budget and had to make everything I needed myself. I even made my own reactors- the furnaces needed to do the crystal work. The commercial reactors were too expensive. I made three products all by myself, and still my salary and position were not good at the company. My bosses always complained that my results were terrible, because I spent a lot of money, as far as they were concerned, and nothing sold. But for ten years I had been working to make these LED materials and I knew at the time there were no high-brightness blue LEDs. For LED researchers, this was a dream. But my bosses said it would be impossible to create a blue LED at Nichia, because many big companies and many research teams in big universities were trying to do it and were failing. So I went to went to my company's chairman, Nobuo Ogawa, who was my professor's friend, and the president Eji Ogawa, who was his son-in-law. **I asked them if they would let me do research on blue LEDs and they said "Sure. No problem. Go ahead."** I was very surprised. I asked them to give me a large budget so I could do it. **"Please give me three million U.S. dollars," and they said "Sure. No problem."** They had faith in me because, despite the dismal sales, I had developed three new products for this company and I was the only one at Nichia who had succeeded in making new products.

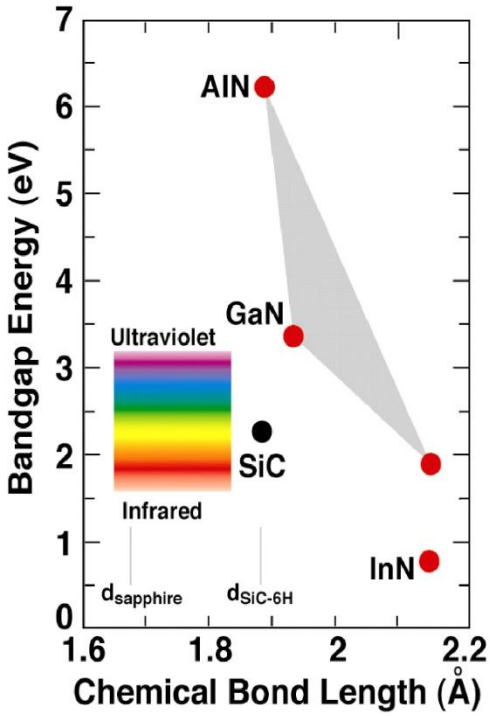
GaP, GaAs

http://www.sciencewatch.com/jan-feb2000/

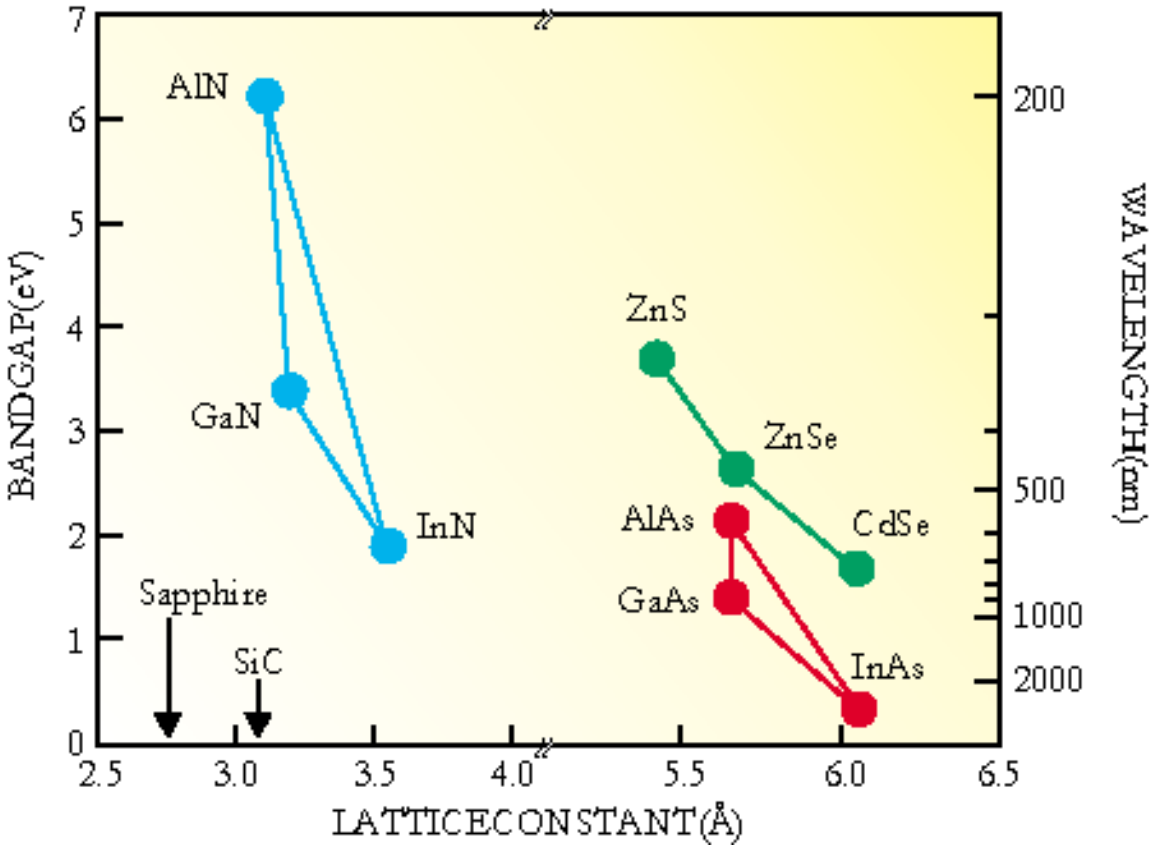
Trochę historii



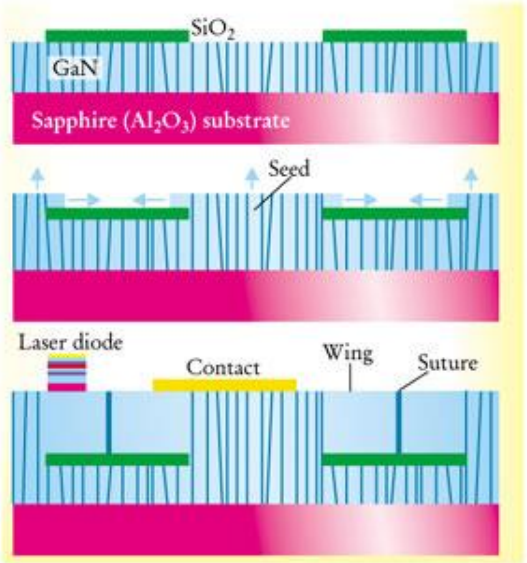
1992-1996

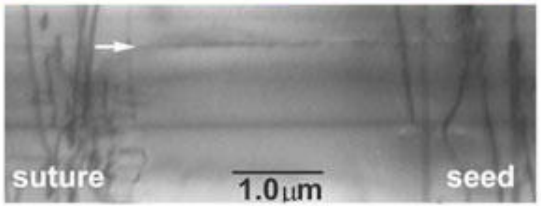


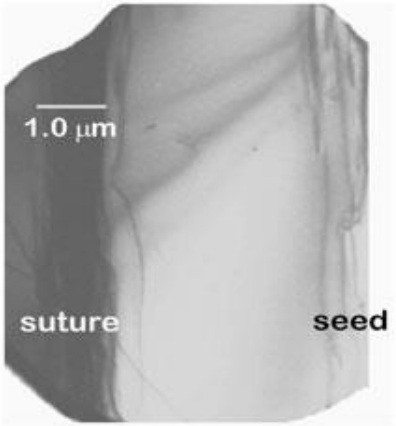
Jak zbudowany jest laser?



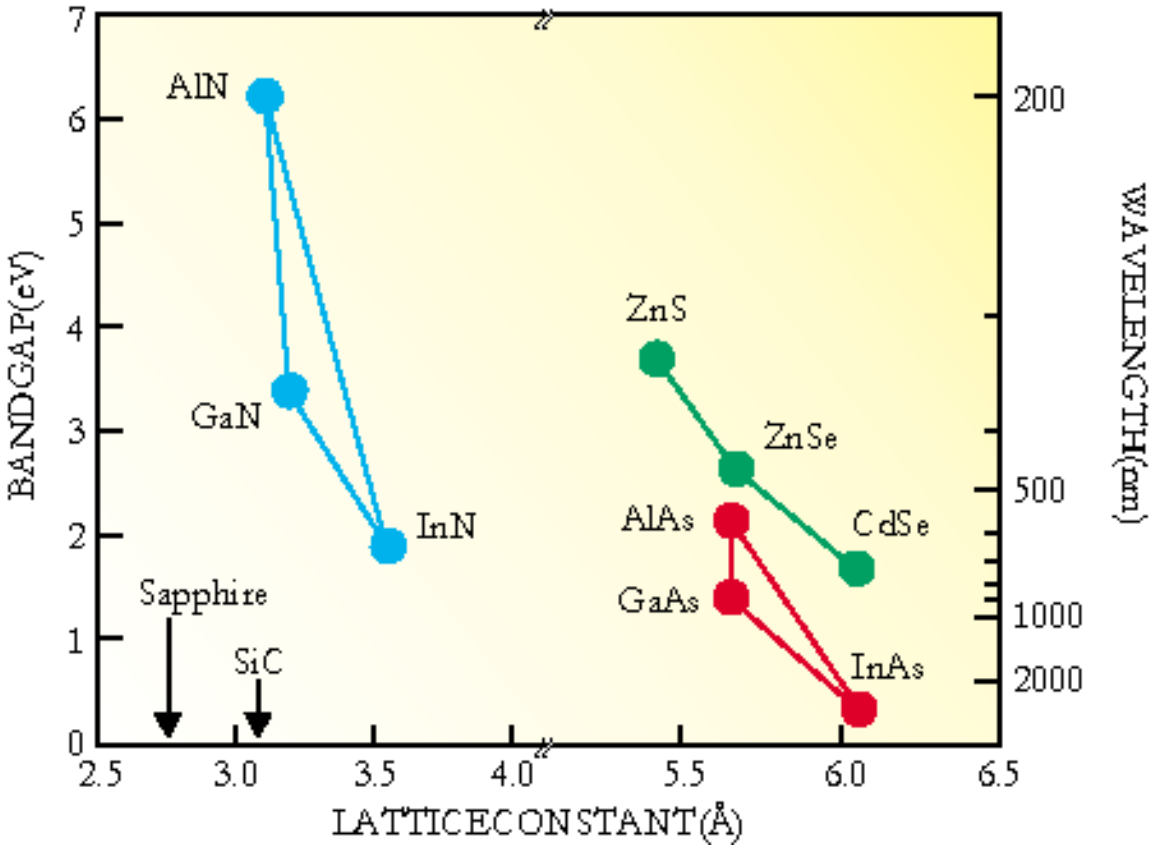
Jak zbudowany jest laser?



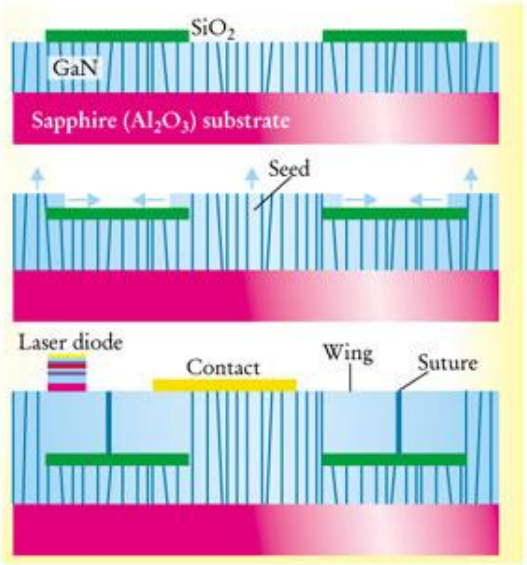


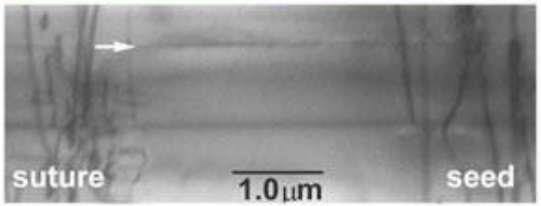


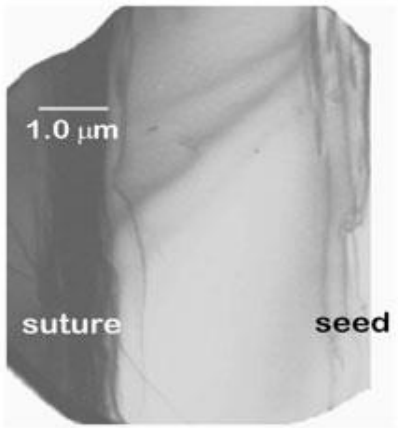
Lateral epitaxial overgrowth (LEO)
ELO

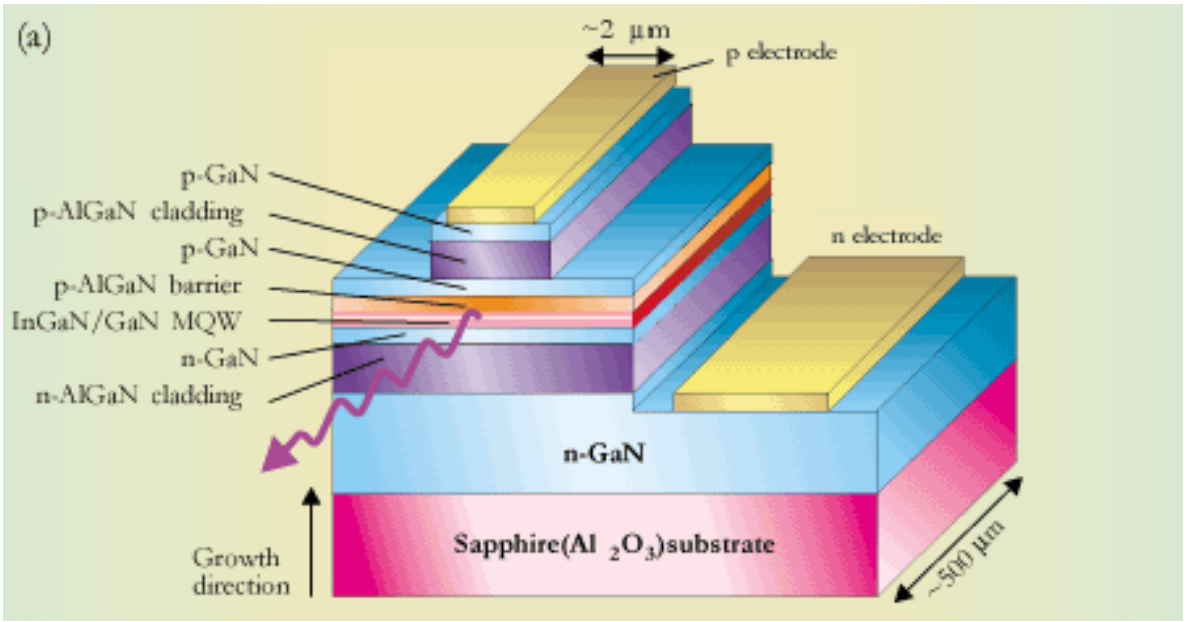


Jak zbudowany jest laser?

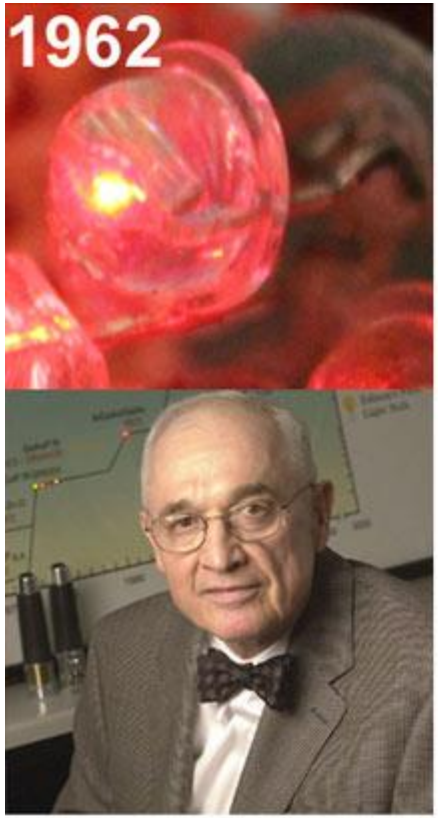






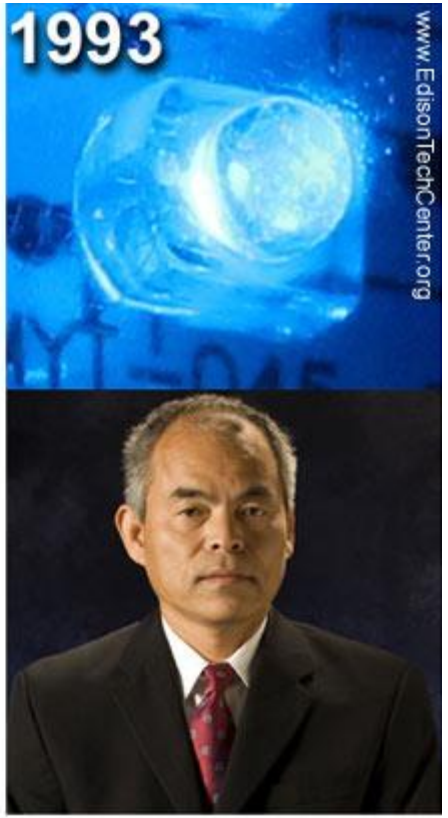


Trzy kolory



Nick Holonyak
Syracuse, NY

George Craford
St. Louis, MI



Shuji Nakamura
Tokushima, Japan

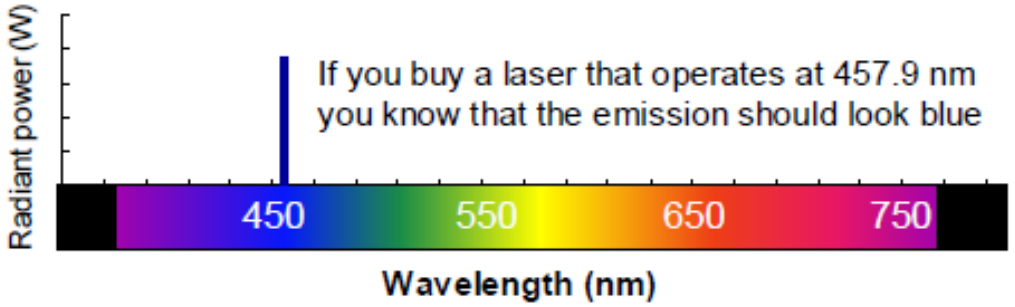
http://www.edisontechcenter.org/LED.html

Trzy kolory

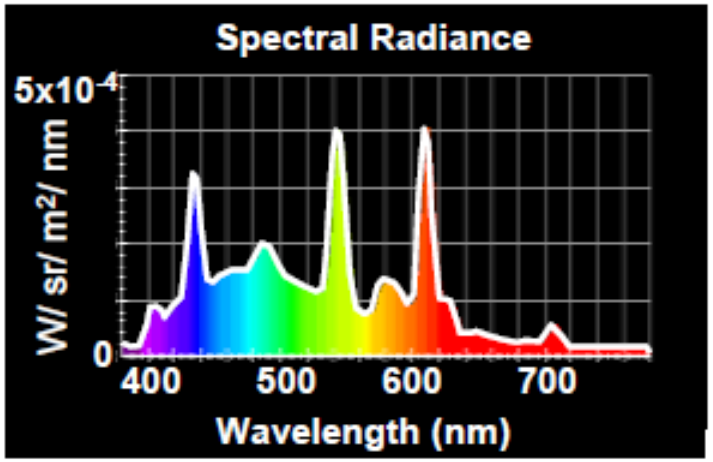
http://www.edisontechcenter.org/LED.html

Trzy kolory

Monochromatic / spectral colours have a single wavelength:

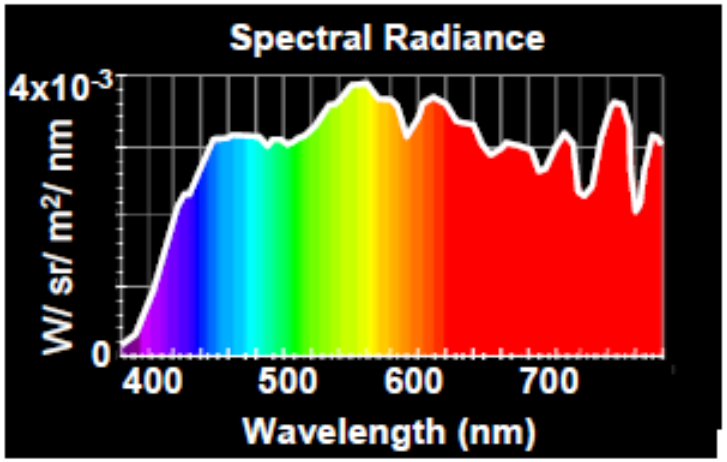


Colour of non-monochromatic light is more difficult to quantify:



Light spectrum of D65 fluorescent lamp

≡

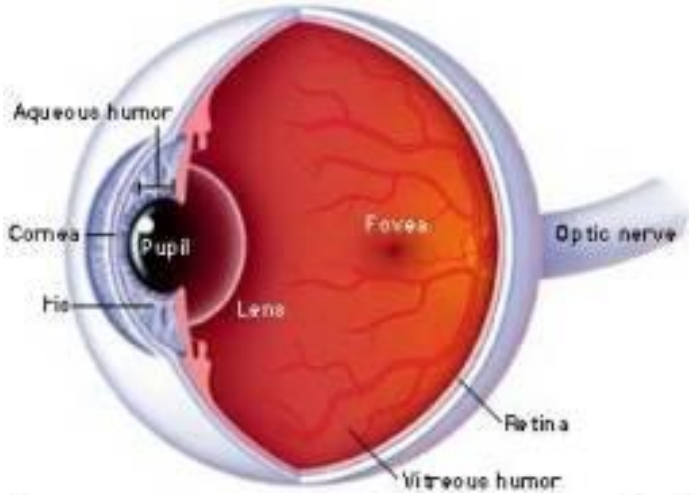


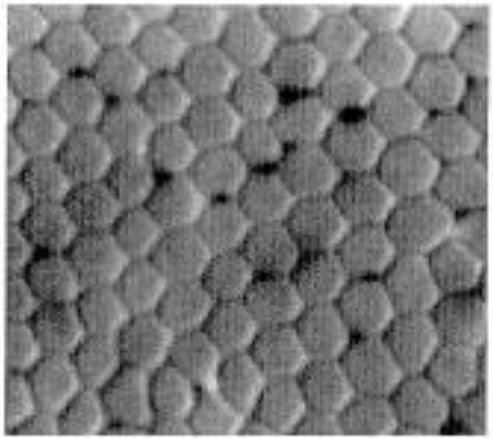
Light spectrum of late afternoon daylight

Taka sama biel!

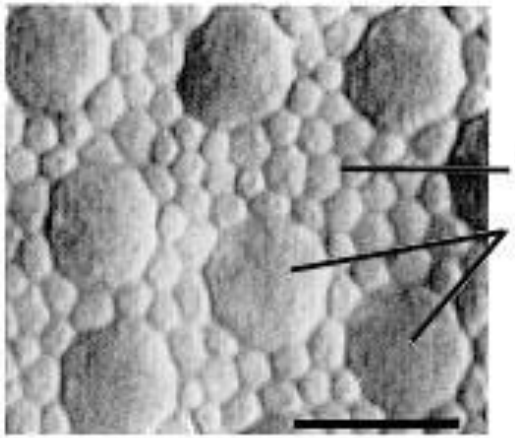
Prof. Thomas Anthopoulos

Trzy kolory

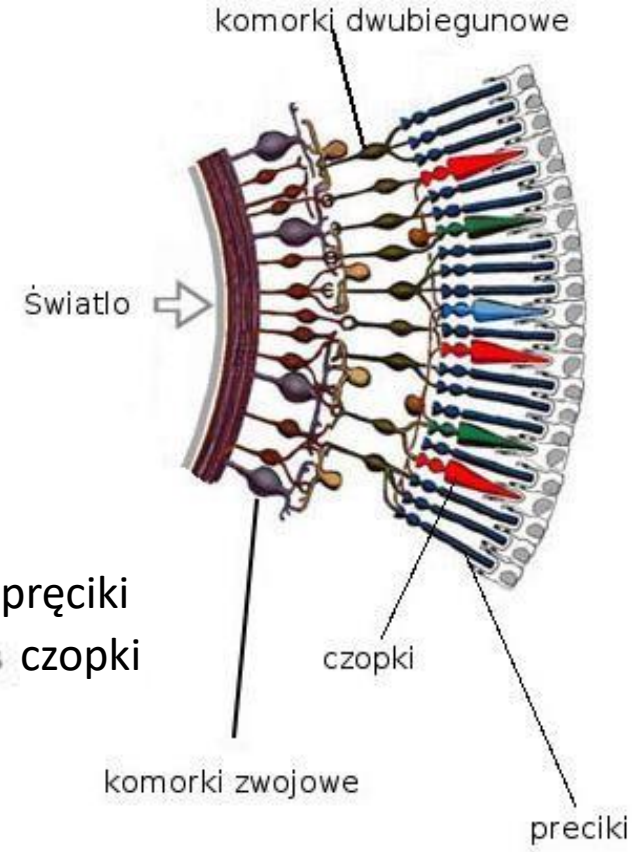




fovea



periphery



http://195.117.188.199/rozdzial_1_12.htm

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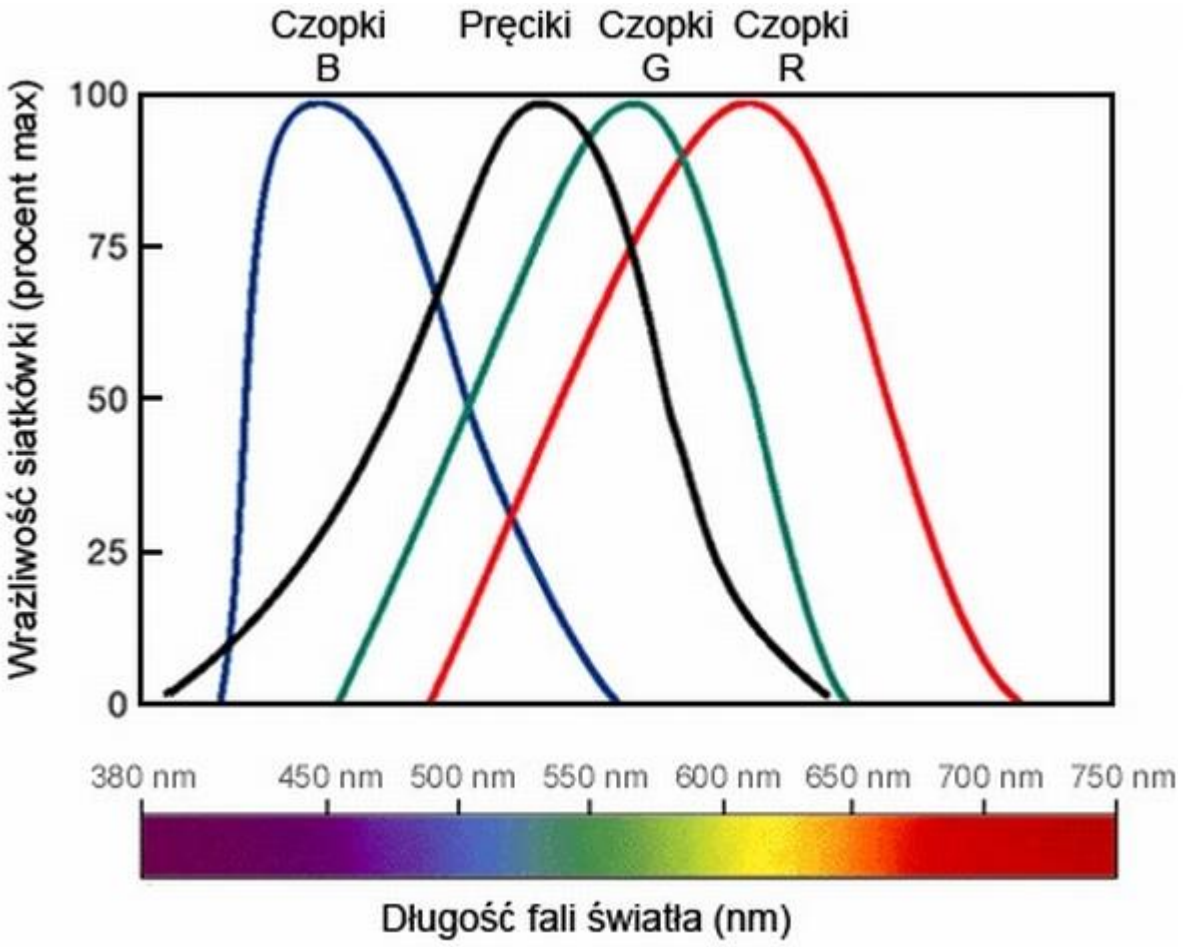
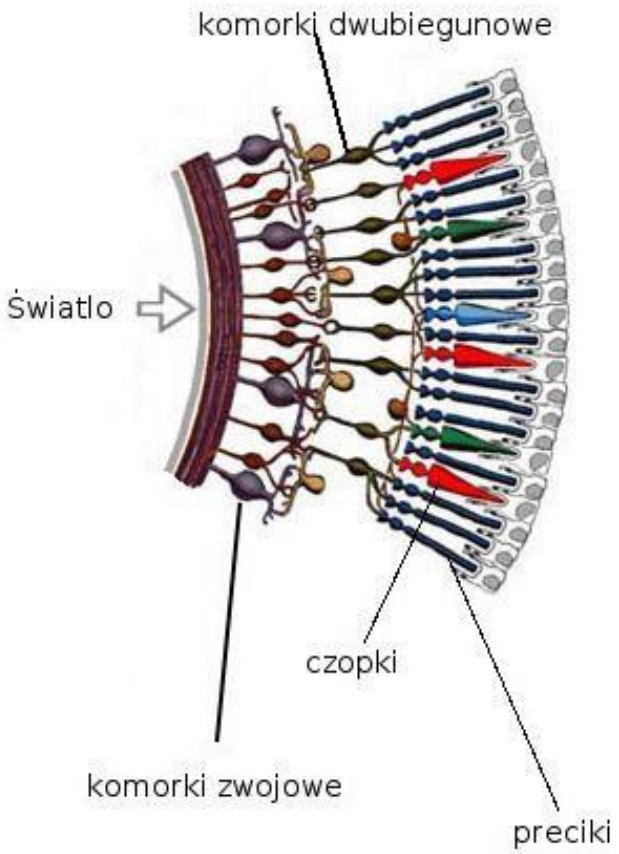
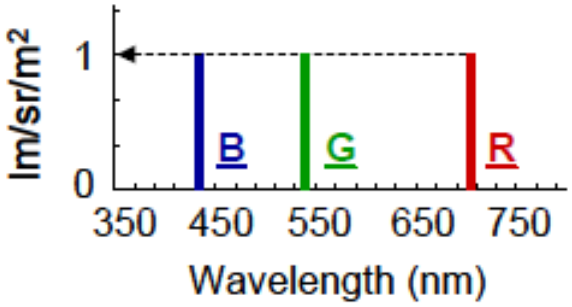

Czopki B
Pręciki
Czopki G
Czopki R
Wrażliwość siatkówki (procent max)
100
75
50
25
0
380 nm
450 nm
500 nm
550 nm
600 nm
650 nm
700 nm
750 nm
Długość fali światła (nm)

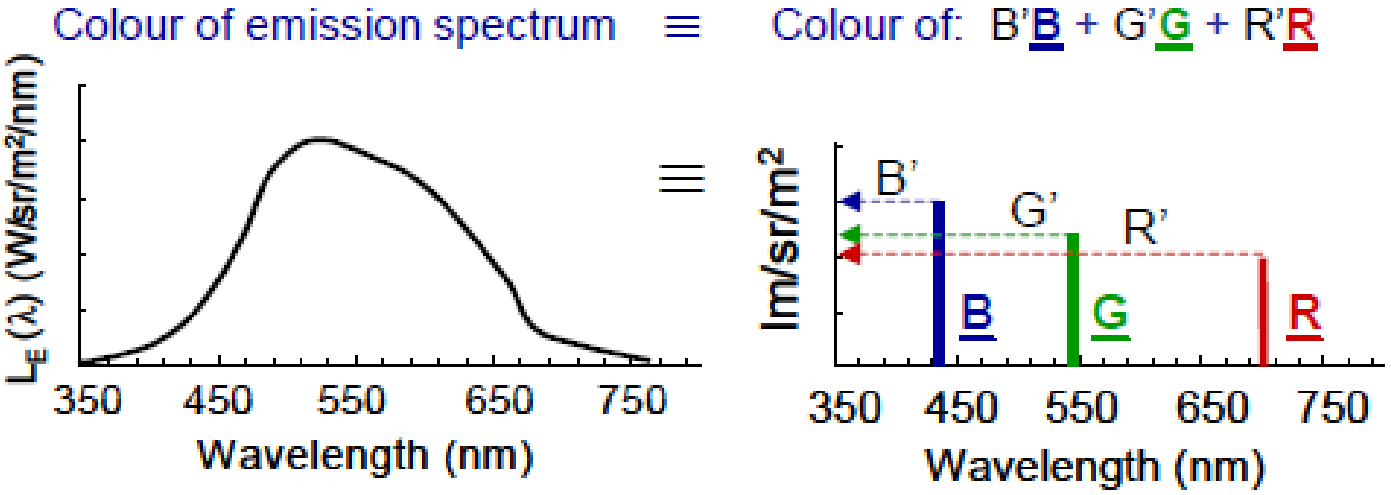

komorki dwubiegunowe
Światlo
czopki
komorki zwojowe
preciki

Trzy kolory

- Early experiments used **B** (435.8 nm), **G** (546.1 nm) and **R** (700 nm) as "unit amounts" of blue, green and red primary colours in luminance (lm/sr/m²)

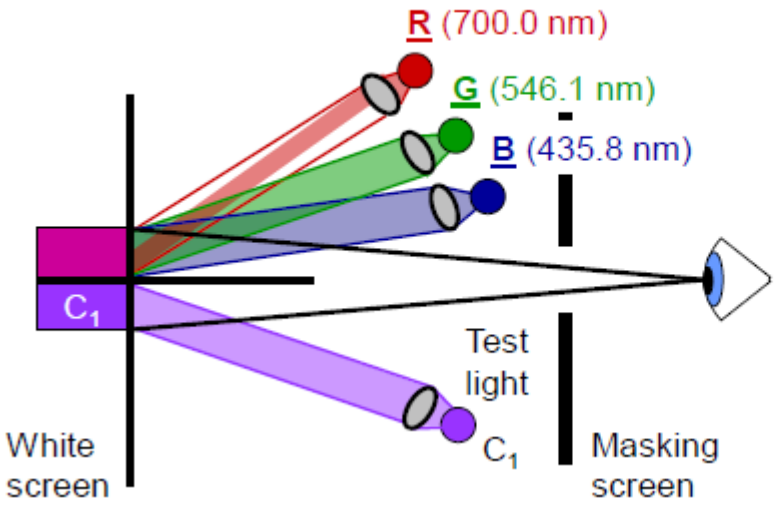


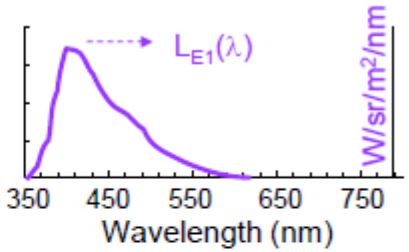
- Note that **B**, **G** and **R** are of different size in radiometric power units (W/sr/m²) because the sensitivity of the eye will be different for different colours

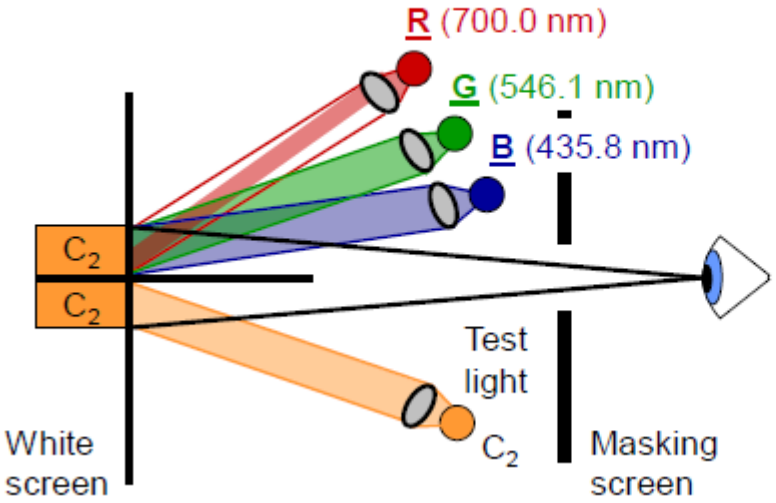


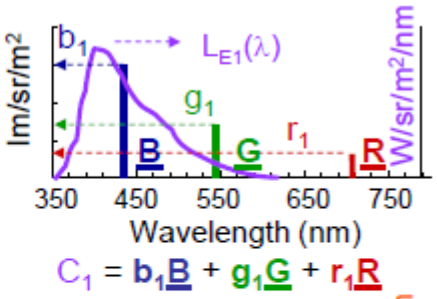
Prof. Thomas Anthopoulos

Trzy kolory

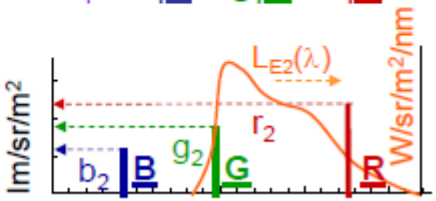








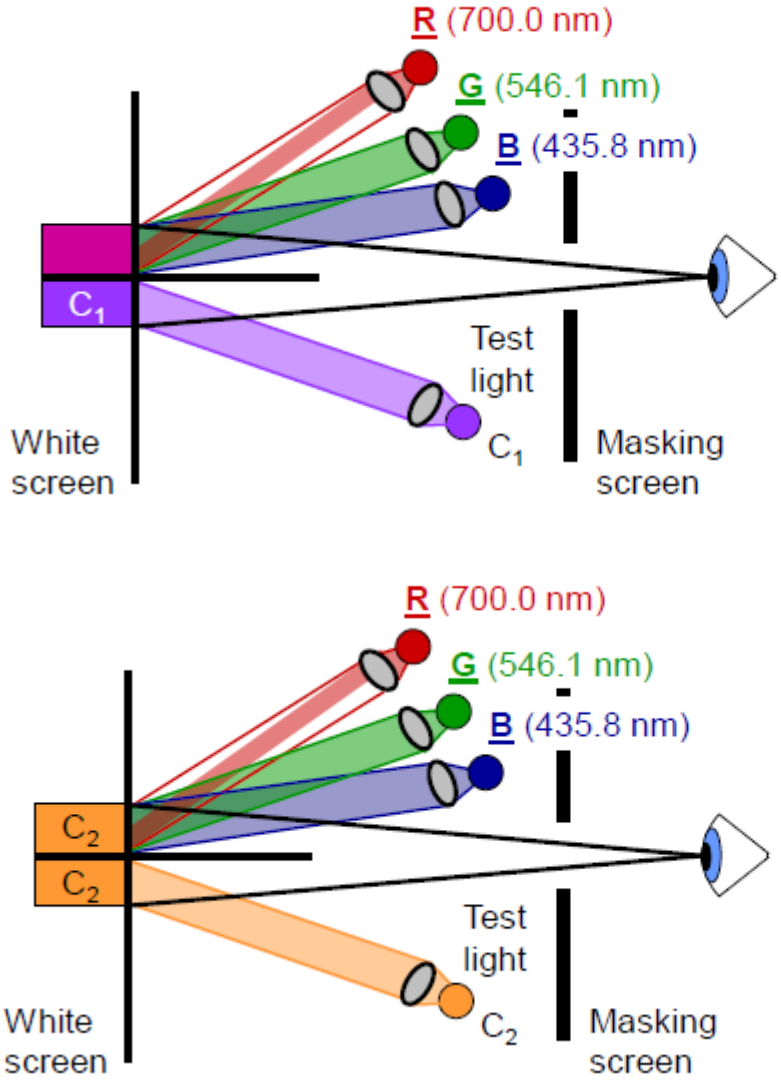
$C_1 = b_1\underline{B} + g_1\underline{G} + r_1\underline{R}$

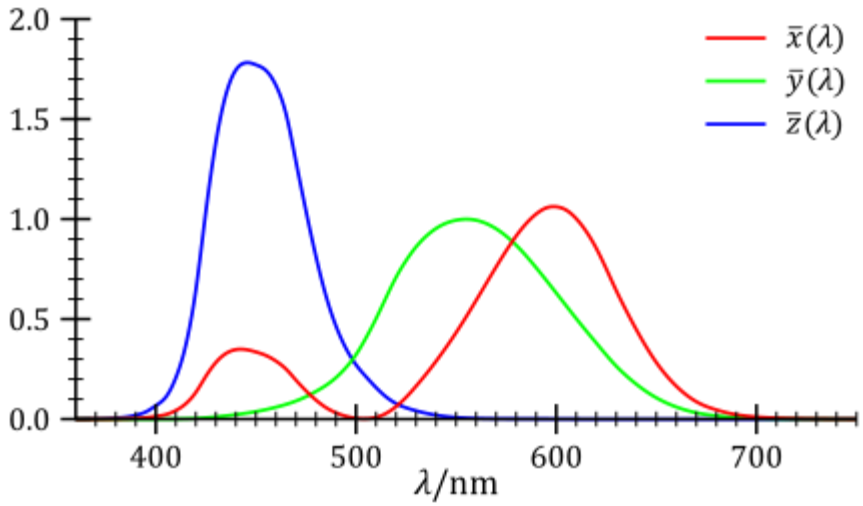


$C_2 = b_2\underline{B} + g_2\underline{G} + r_2\underline{R}$

Prof. Thomas Anthopoulos

Trzy kolory

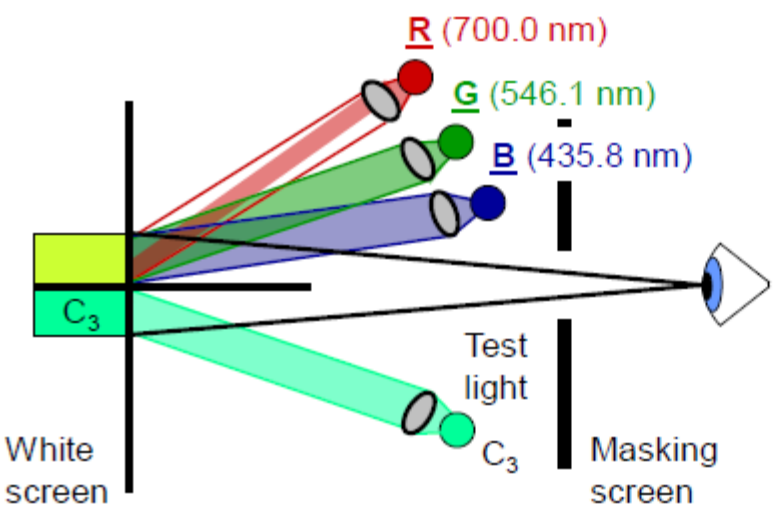


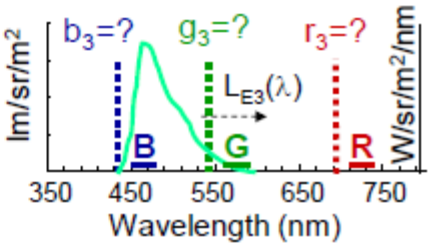


Trójchromatyczne składowe widmowe

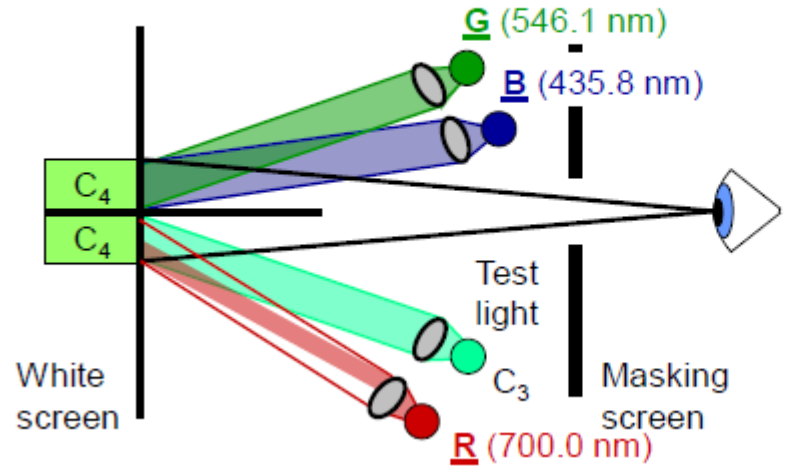
Wiki

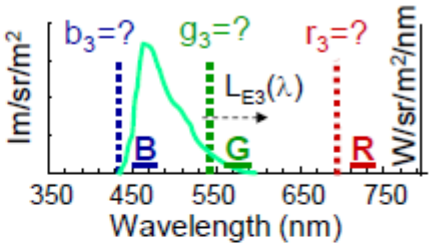
Trzy kolory





C_3 = ?B + ?G + ?R



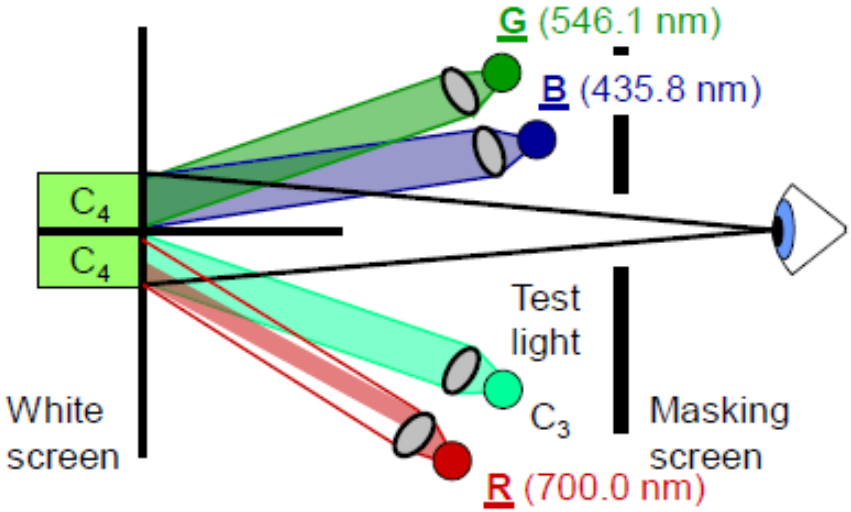


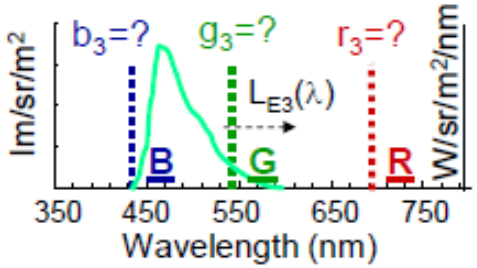
C_3 = ?B + ?G + ?R

Niektórych kolorów NIE DA się otrzymać!

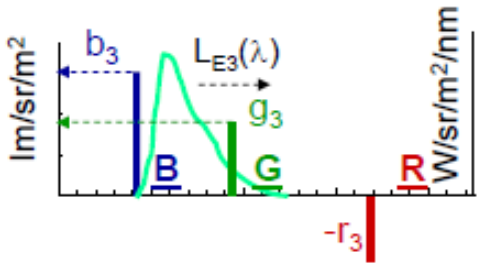
Prof. Thomas Anthopoulos

Trzy kolory





$C_3 = ?\underline{B} + ?\underline{G} + ?\underline{R}$



$C_4 = (C_3 + r_3\underline{R}) = b_3\underline{B} + g_3\underline{G}$

$C_3 = b_3\underline{B} + g_3\underline{G} - r_3\underline{R}$

Niektórych kolorów NIE DA się otrzymać!

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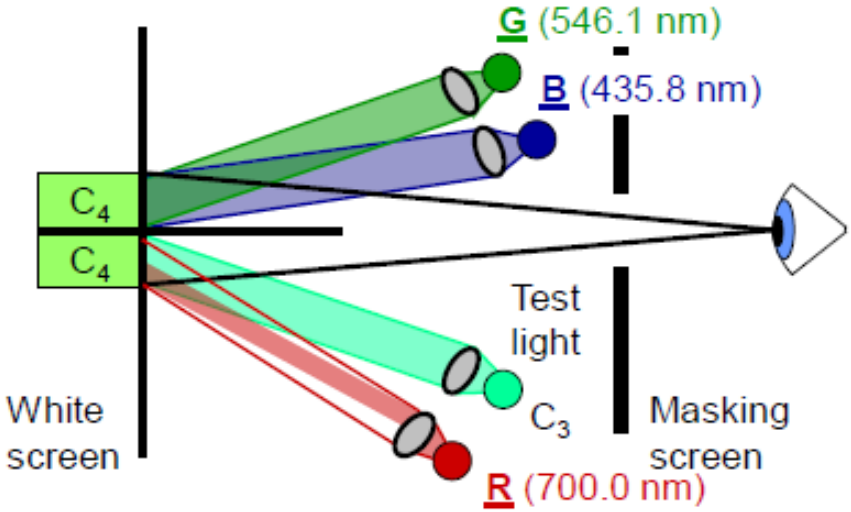
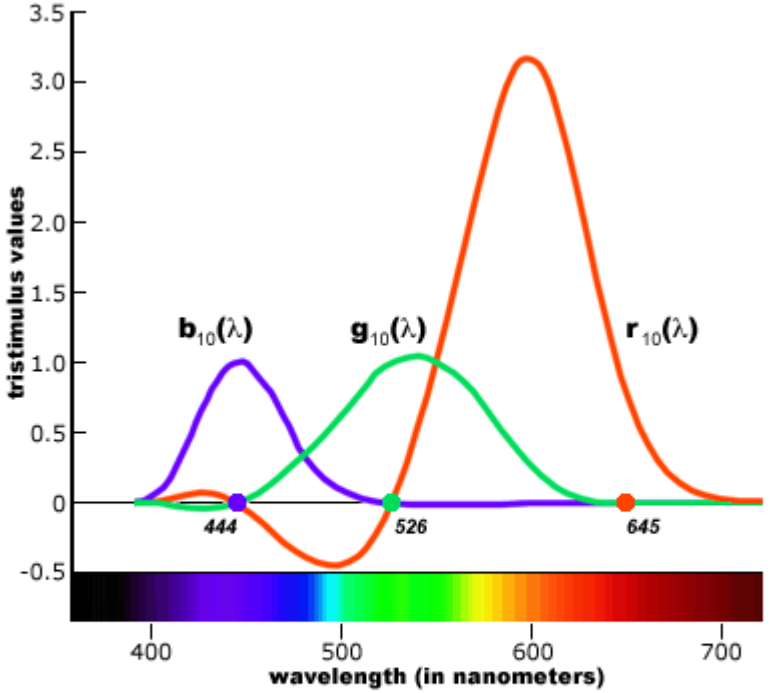
Trzy kolory



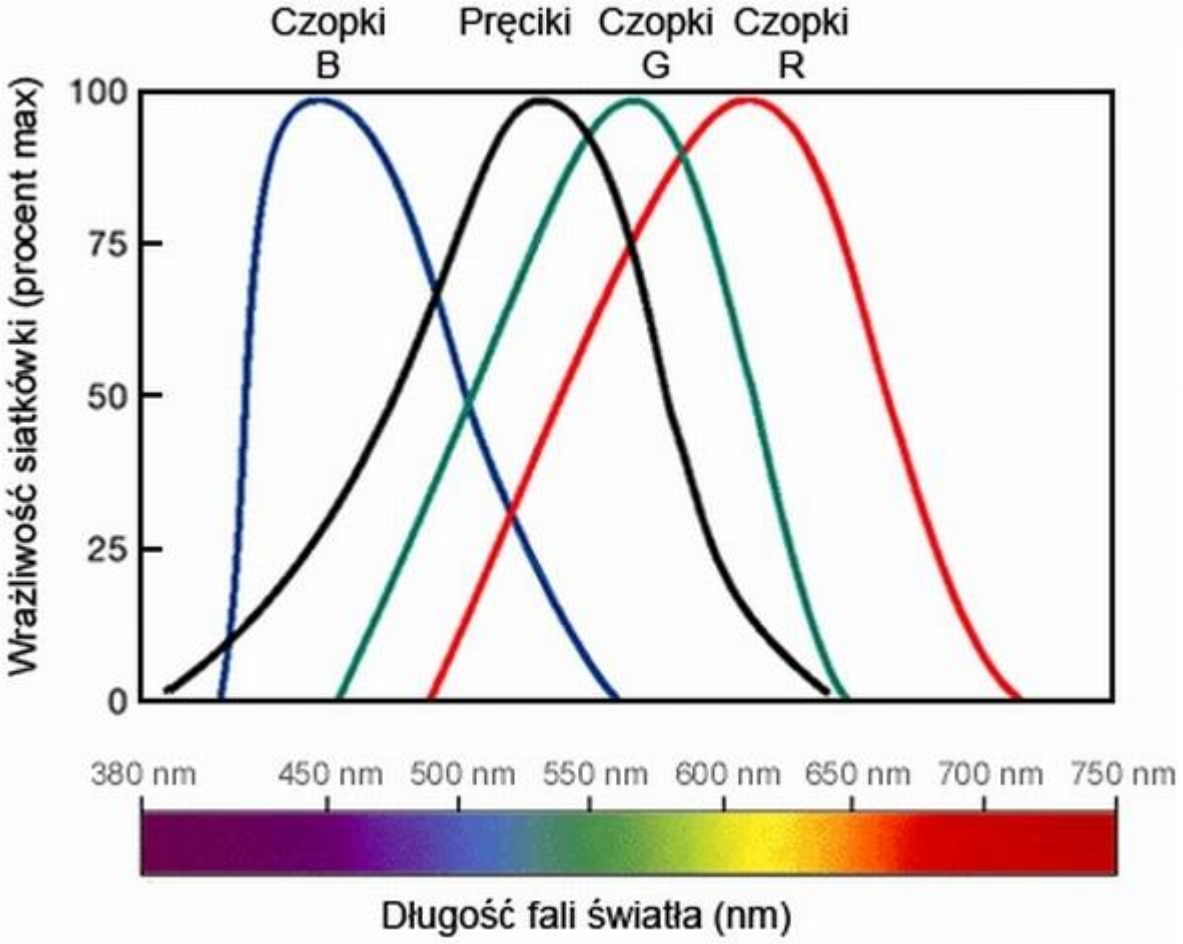


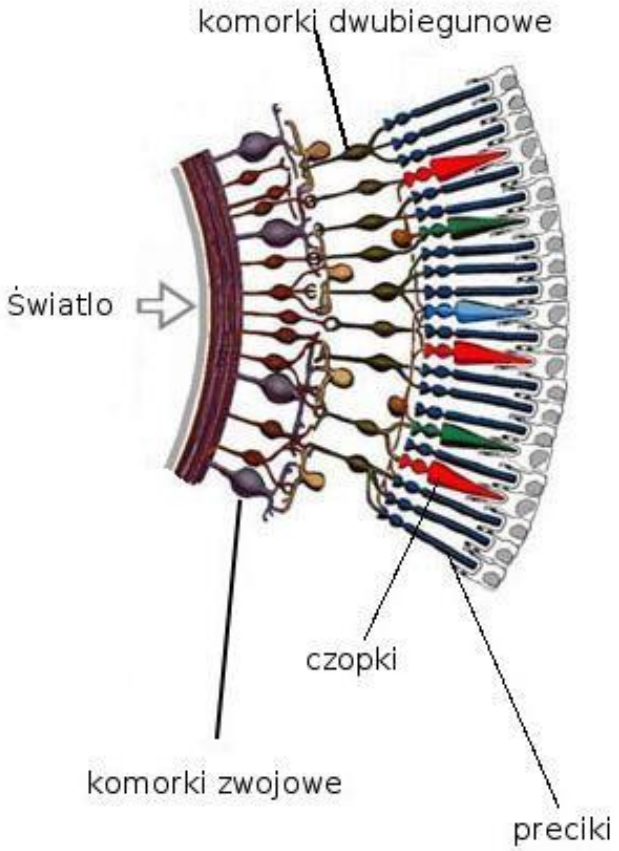
RGB color matching functions

Stiles-Burch 10° color matching functions averaged across 37 observers
(adapted from Wyszecki & Stiles, 1982)

http://www.handprint.com/HP/WCL/color6.html

Trzy kolory


Czopki B
Pręciki
Czopki G
Czopki R
Wrażliwość siatkówki (procent max)
100
75
50
25
0
380 nm
450 nm
500 nm
550 nm
600 nm
650 nm
700 nm
750 nm
Długość fali światła (nm)


komorki dwubiegunowe
Światlo
czopki
komorki zwojowe
preciki

Enchroma glasss

TRY NOT TO CRY CHALLENGE #2, EnChroma glasses
Vrrr Tube • 1,2 mln wyświetleń • 1 rok temu
Watch these amazing videos of colorblind people seeing more of the spectrum of color for the very first time.

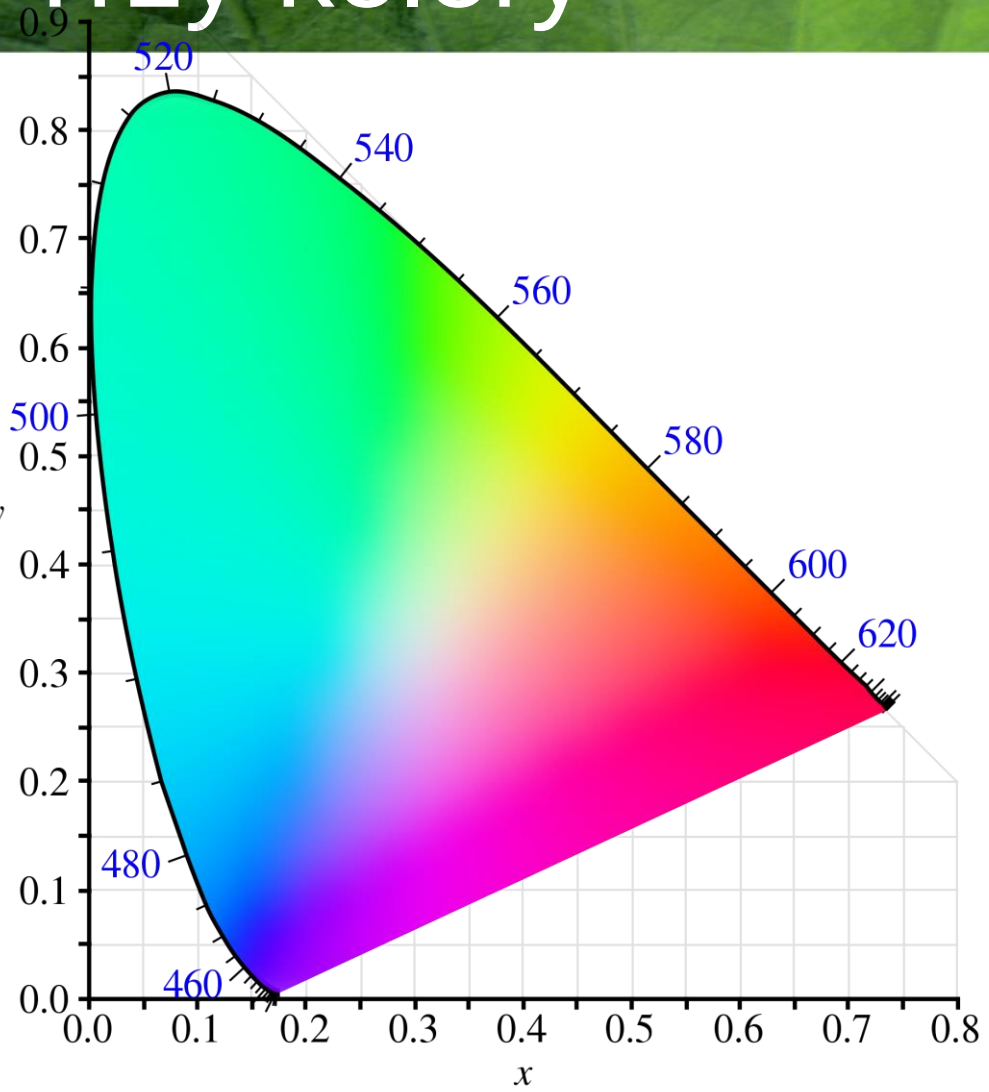
Max sees color! Enchroma 12/23/17
Kandra Jones • 140 tys. wyświetleń • 10 miesięcy temu
The best gift I received this Christmas was JOY! A joy I have never before experienced. A joy so wide and deep that my heart felt ...

COLORBLIND WOMEN see color for the first time! (Enchroma Glasses Compilation)
Pepper • 491 tys. wyświetleń • 1 rok temu
Colorblindness is rarer in women - about 1 in 200 has it. But colorblind women should see themselves represented too! Watch as ...

Our Favorite Reactions of 2015
EnChroma, Inc. • 971 tys. wyświetleń • 2 lata temu
Take the Color Blindness Test: http://enchroma.com/test/instructions/ Shop Color Blindness Glasses: http://enchroma.com/shop/ ...
napisy

This Is What Color Blind People See With These Viral Glasses
Tech Insider 489 tys. wyświetleń • 8 miesięcy temu
These glasses bring more color to the color blind by helping them see more hues and differentiate colors. You have seen the viral ...

Trzy kolory



Kolory CIE (1931) – przestrzeń barw

$$L(\lambda) = Z'\boldsymbol{Z} + Y'\boldsymbol{Y} + X'\boldsymbol{X}$$

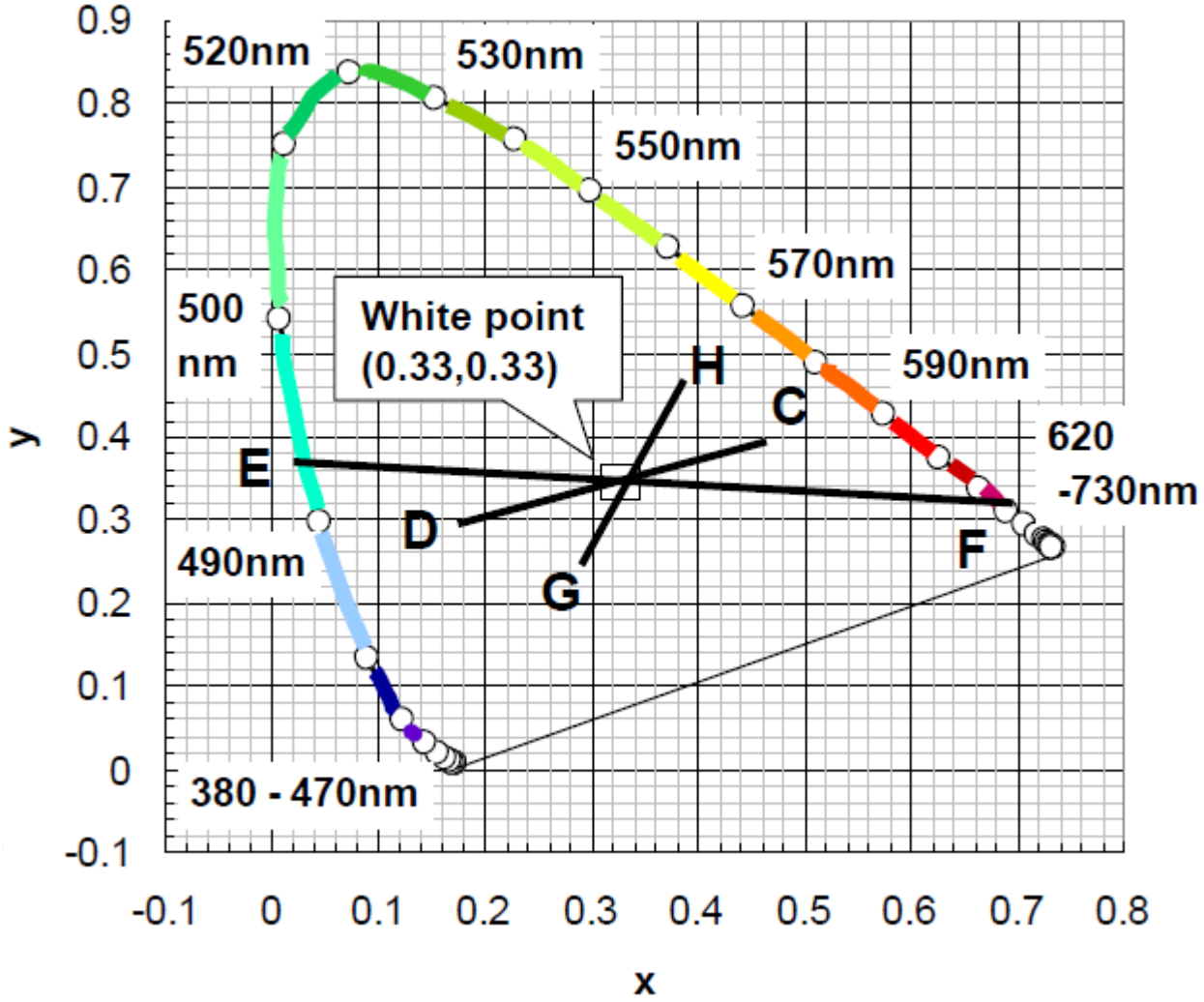
$$x = \frac{X'}{X' + Y' + Z'}$$

$$y = \frac{Y'}{X' + Y' + Z'}$$

$$z = \frac{Z'}{X' + Y' + Z'} = 1 - x - y$$

Tylko dwie zmienne (x i y) są niezależne, więc wykres 2D wystarcza do reprezentowania wszystkich barw w tzw. Współrzędnych trójchromatycznych

Trzy kolory



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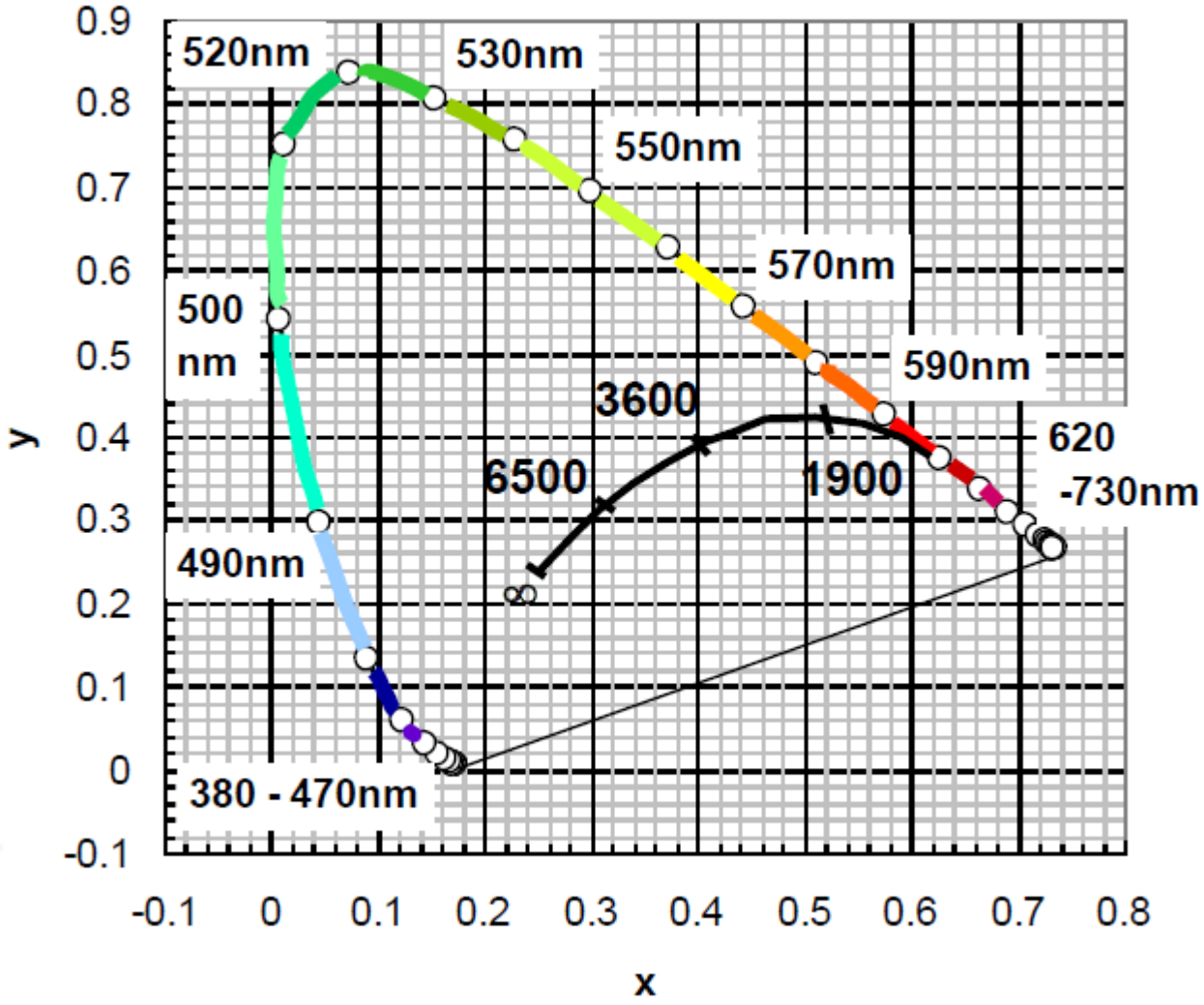
Trzy kolory



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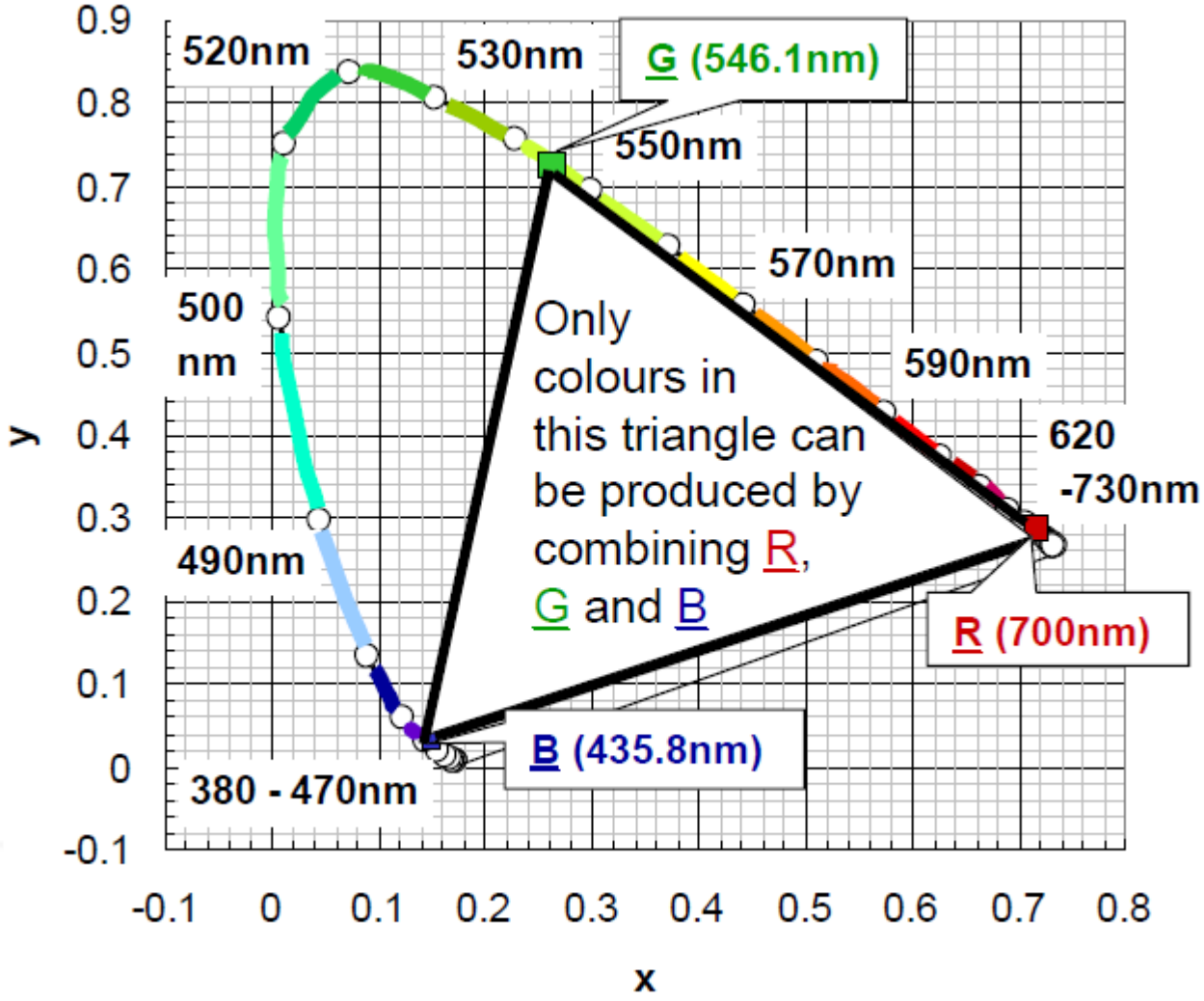
Trzy kolory



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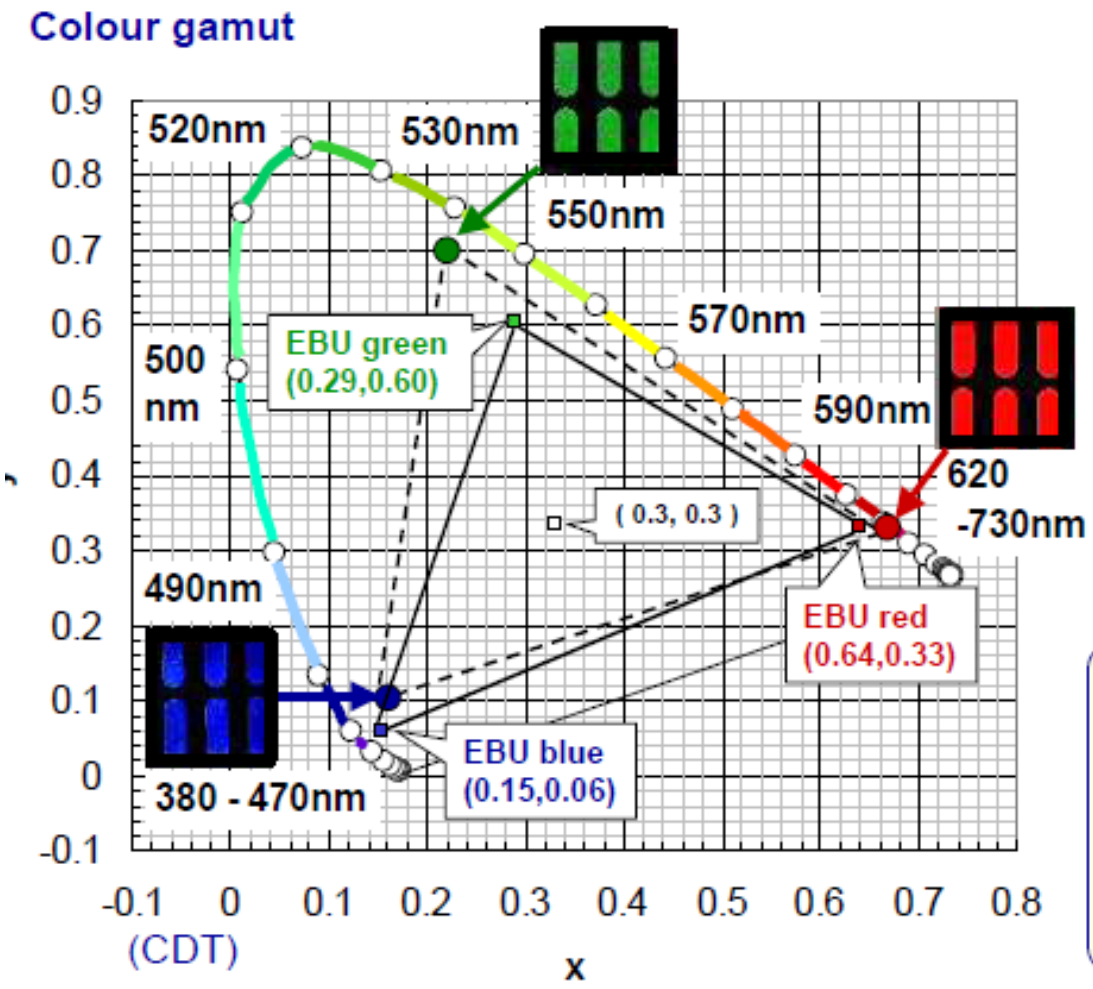
Trzy kolory

Why use organic LEDs for displays?



- Coordinates shown are for solution deposition, but powders give similar coordinates, apart from green which is slightly better for the solutions

- Range of emission colours obtained by using organic semiconductors with different chemical structures
- Good colour gamut

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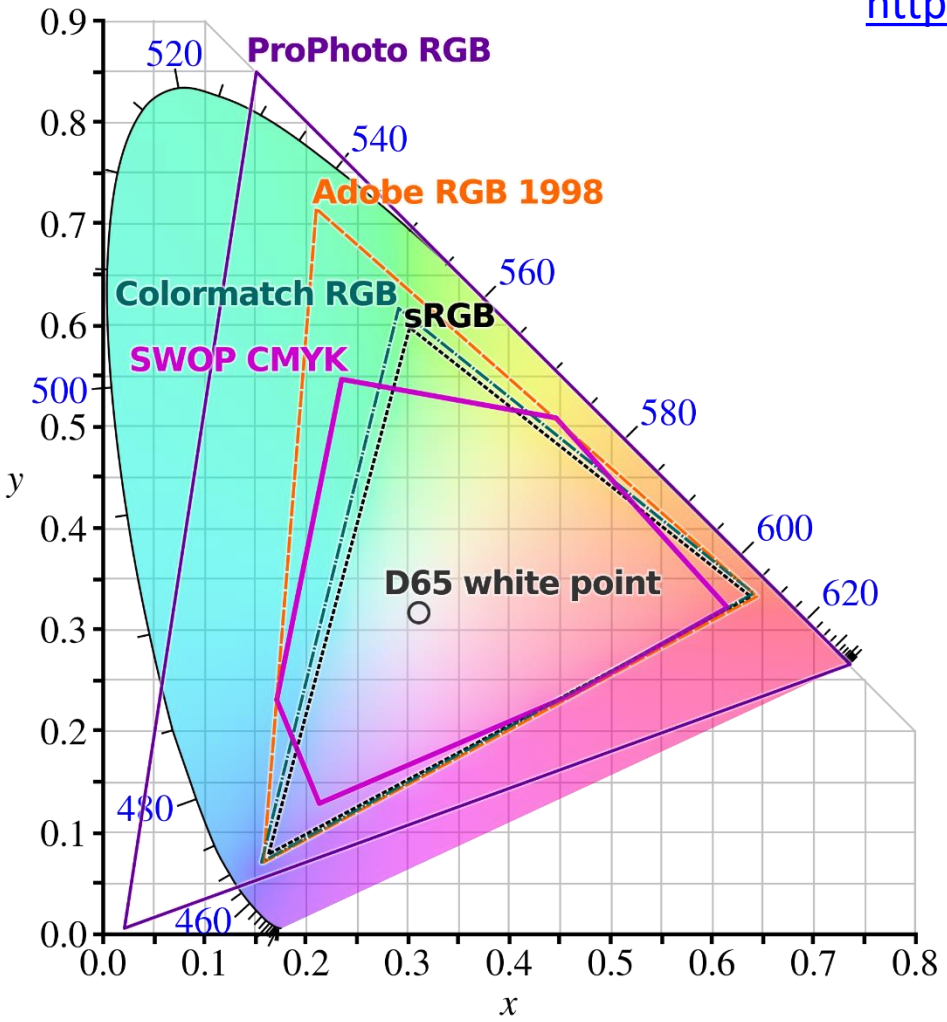
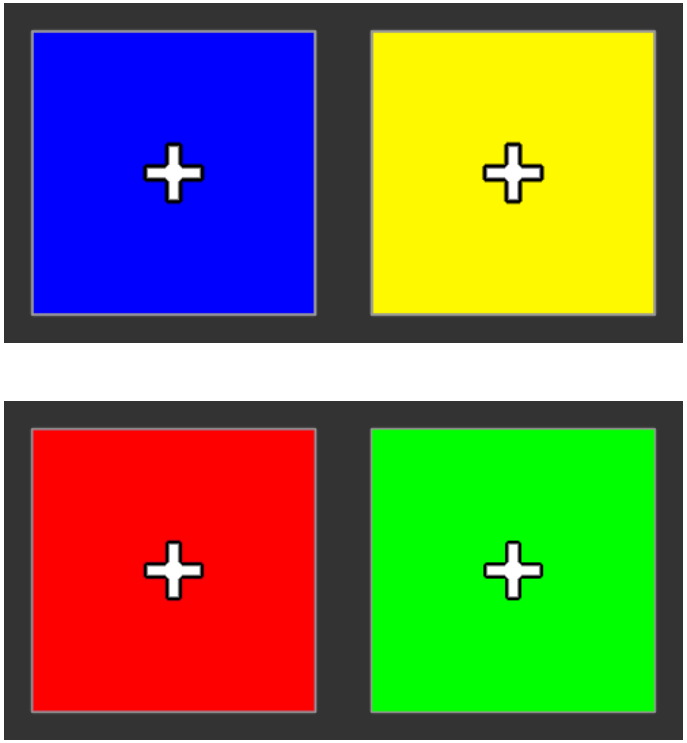
Trzy kolory

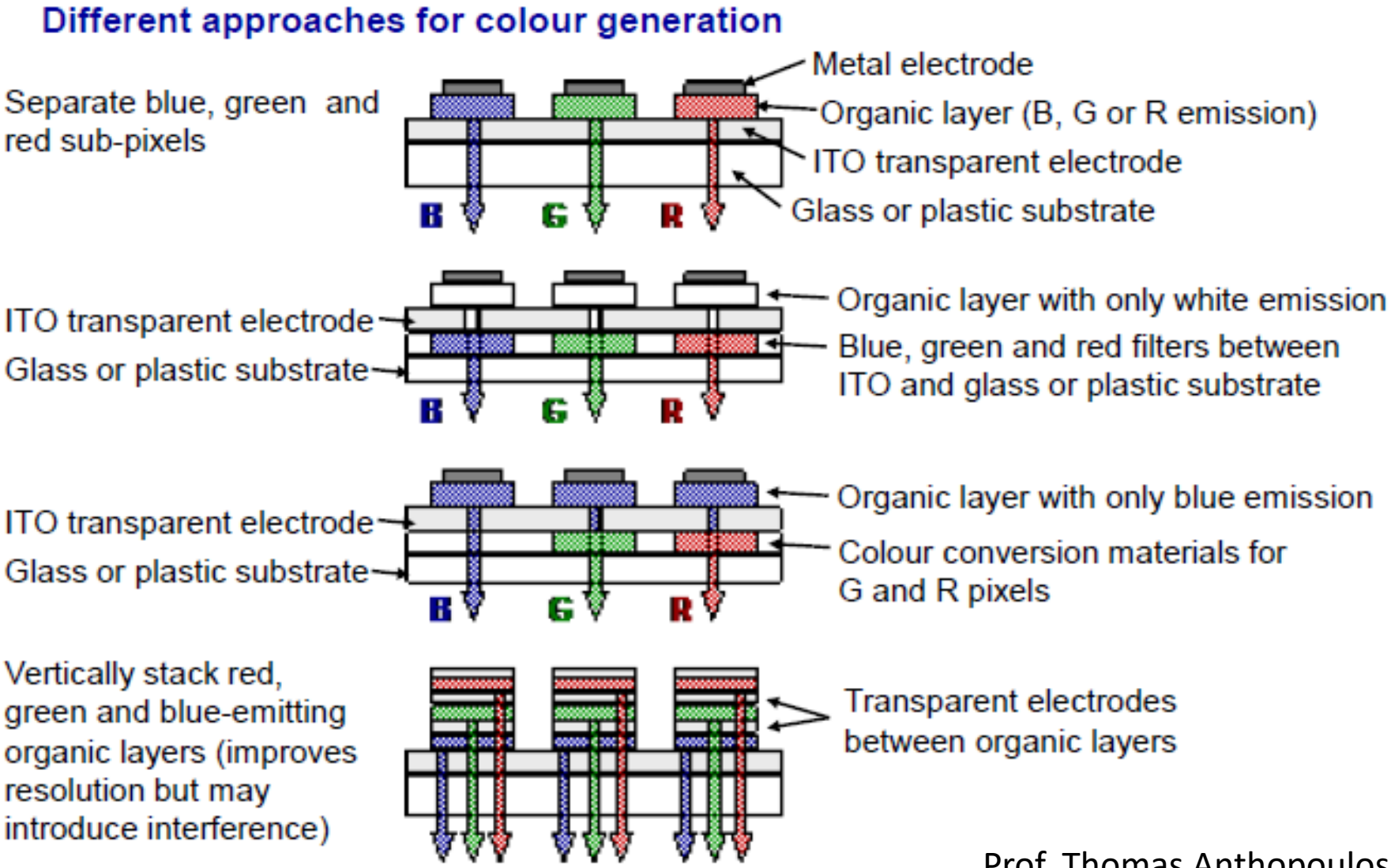


https://en.wikipedia.org/wiki/Impossible_color



https://en.wikipedia.org/wiki/SRGB#/media/File:CIE1931xy_gamut_comparison.svg

Trzy kolory



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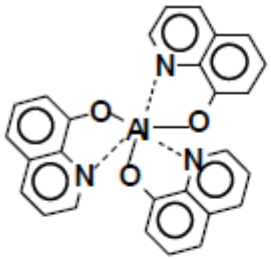
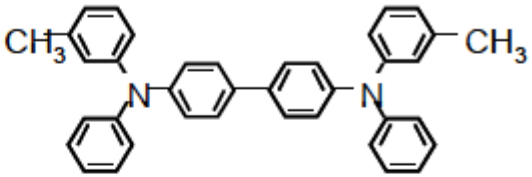
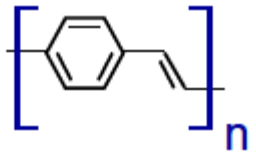
Trzy kolory



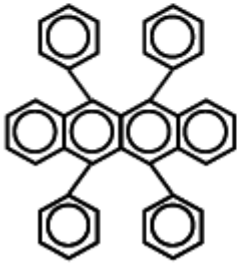
Alq_3



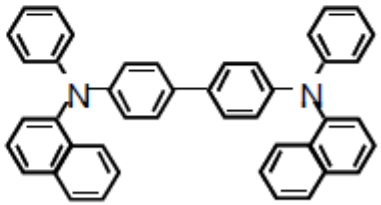
TPD



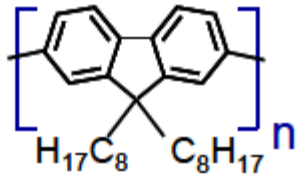
Poly(p-phenylenevinylene)
(PPV)



Rubrene



α–NPD



Poly(9,9-dioctylfluorene)
(PFO)

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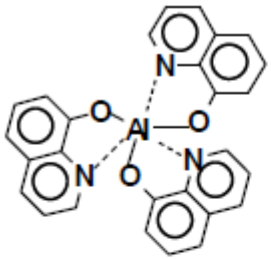
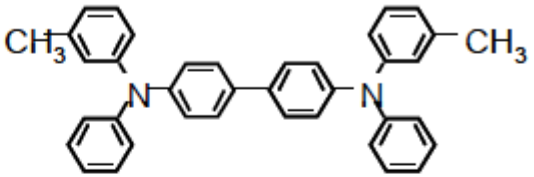
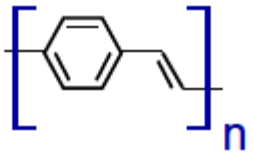
Trzy kolory



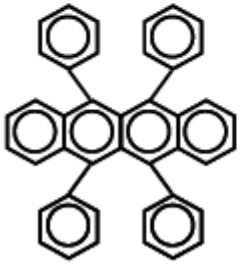
Alq_3



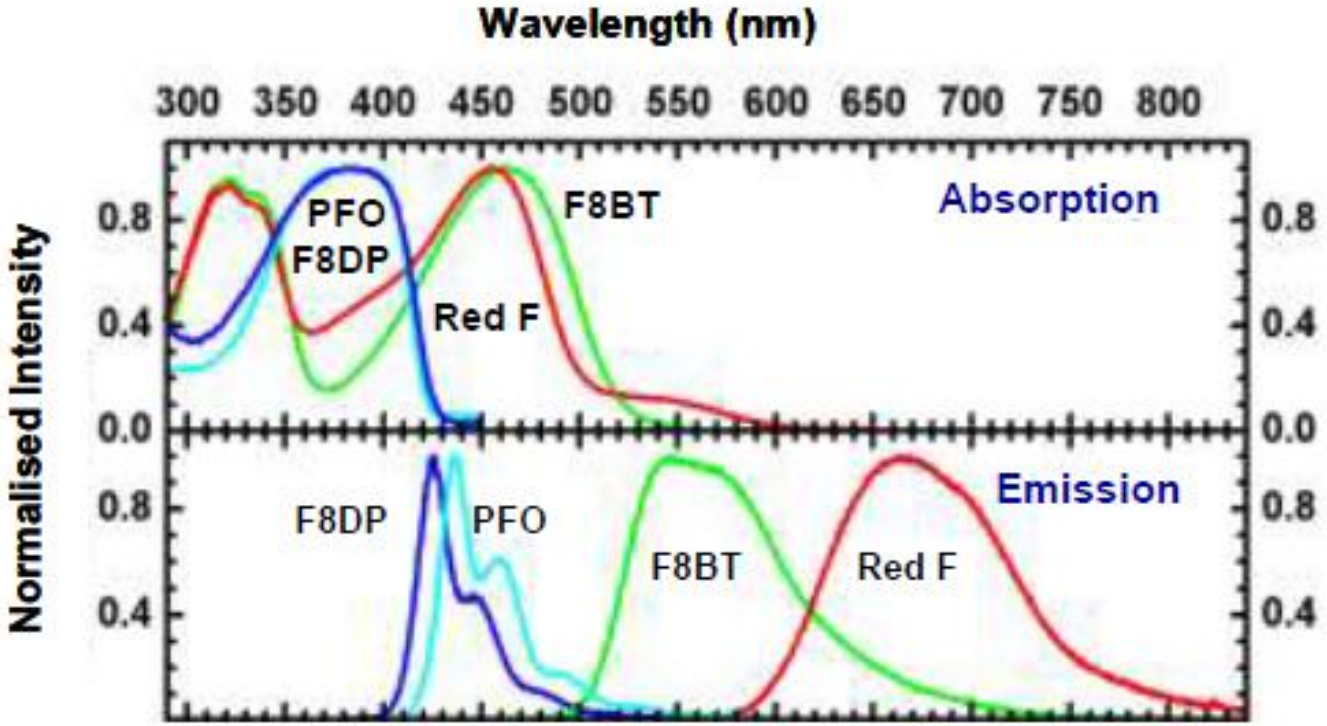
TPD



Poly(p-phenylenevinylene)



Rubrene



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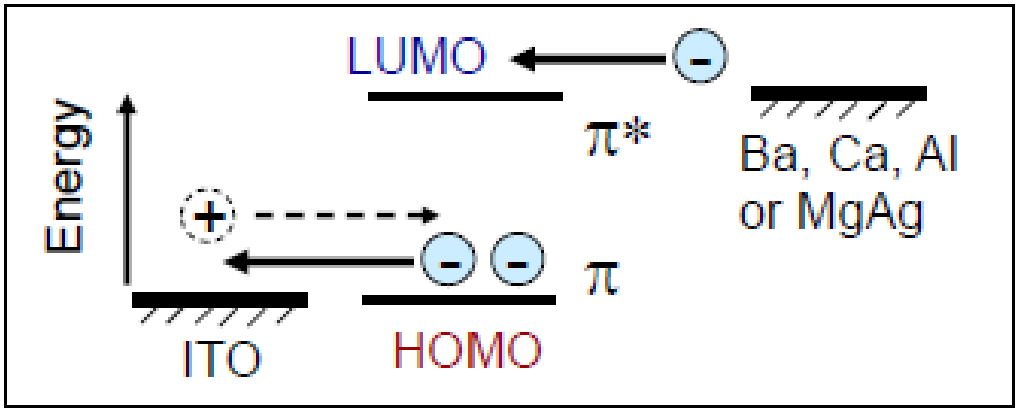
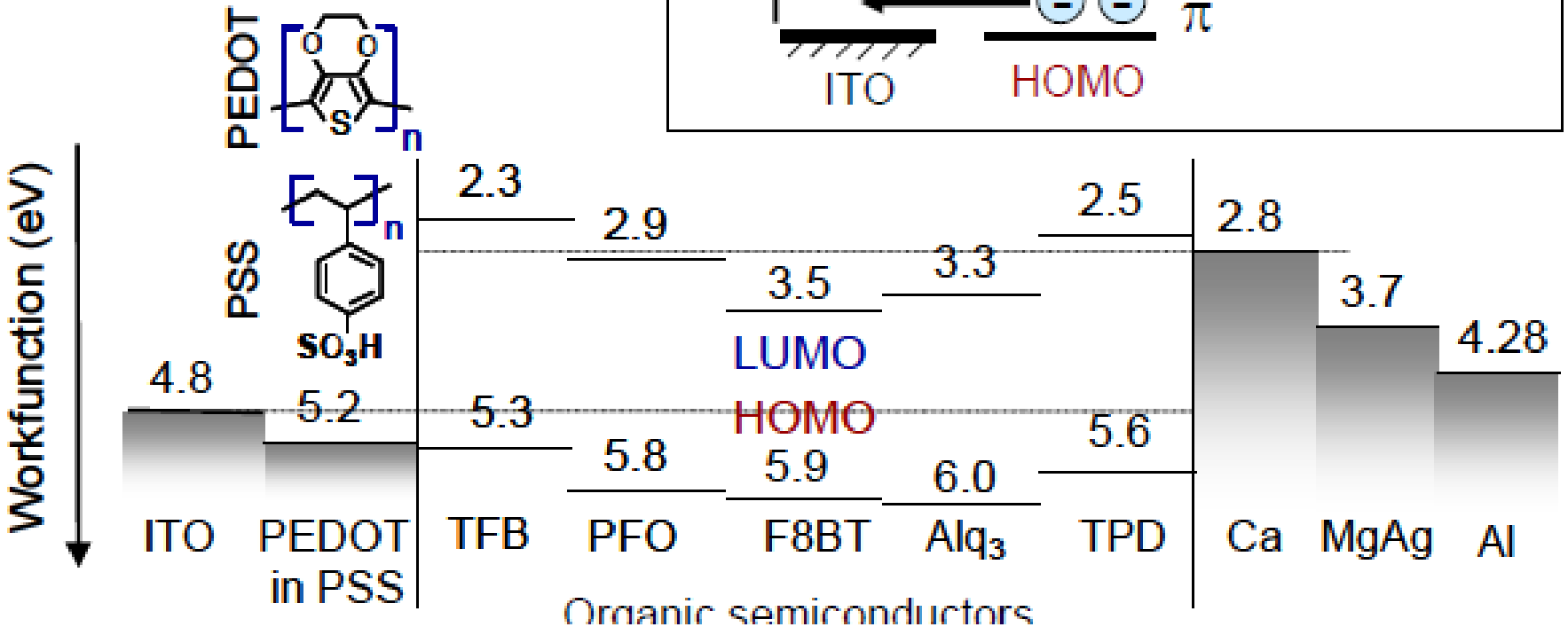
Trzy kolory

- Need to match workfunctions of electrodes to HOMO and LUMO energies of organic semiconductor





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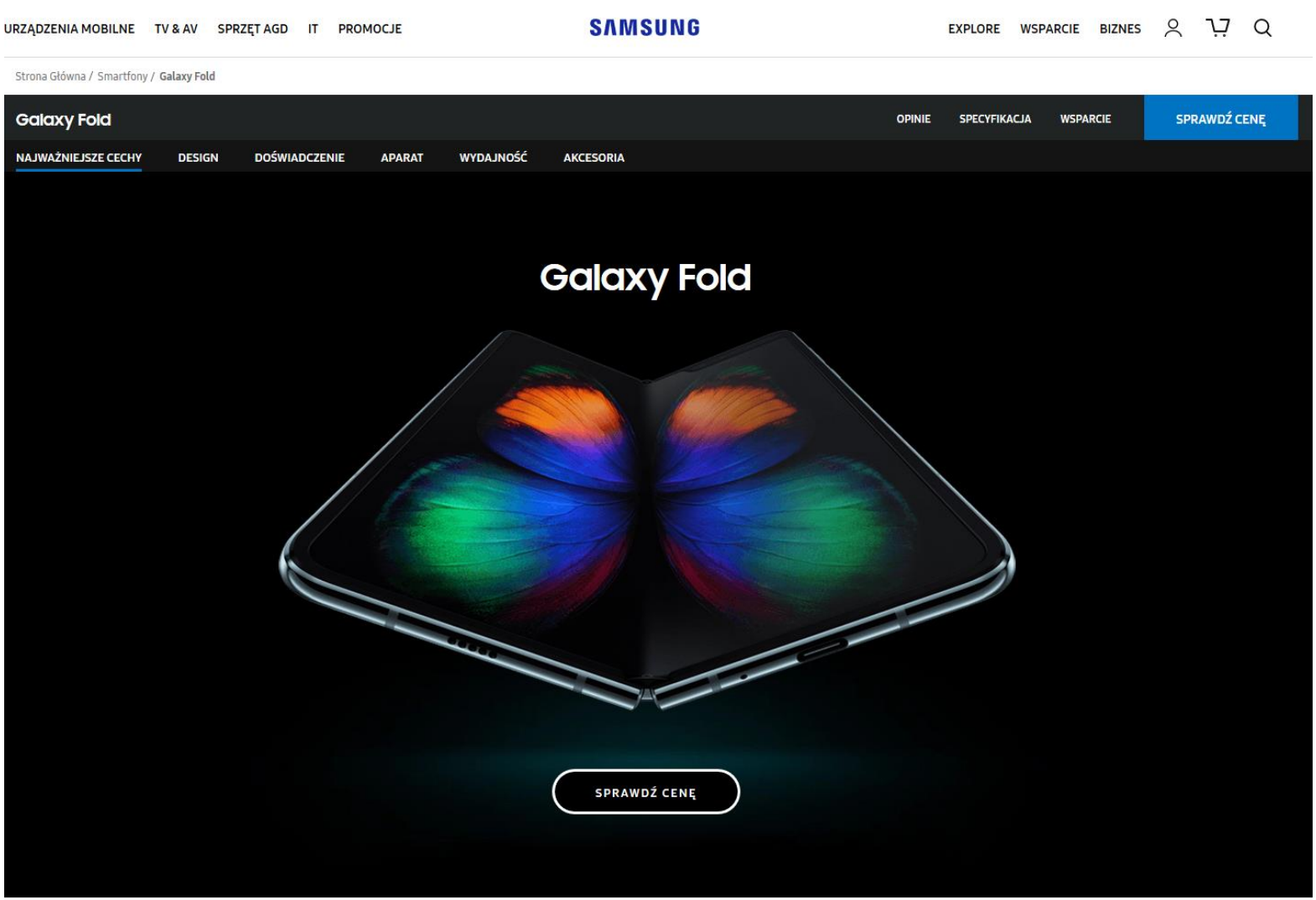
Trzy kolory

Trzy kolory

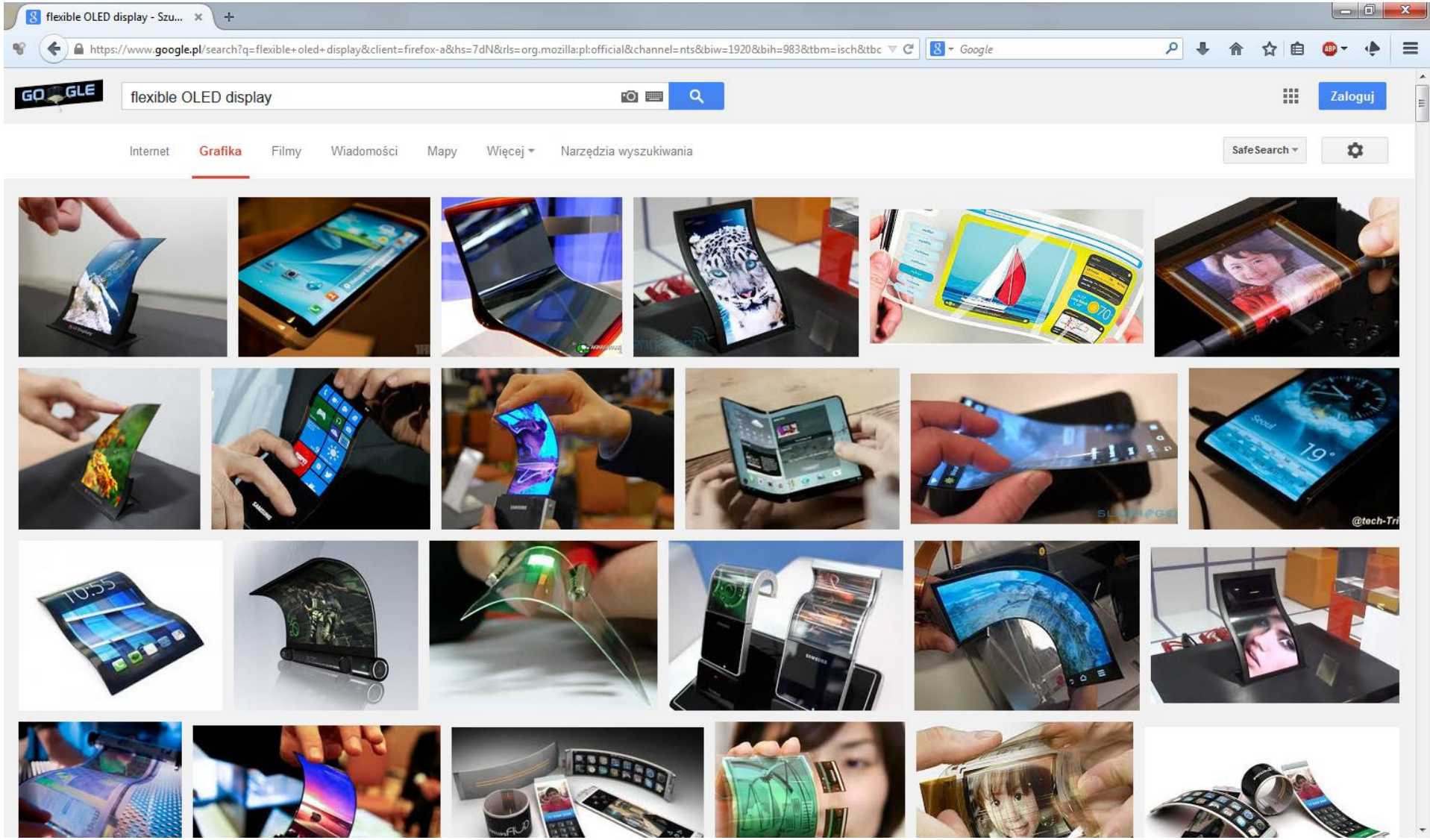
CES 2013

Trzy kolory



2019

Trzy kolory


flexible OLED display - Szu...
https://www.google.pl/search?q=flexible+oled+display&client=firefox-a&hs=7dN&rls=org.mozilla:pl:official&channel=nts&biw=1920&bih=983&tbm=isch&tbc
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Grafika
Filmy
Wiadomości
Mapy
Więcej
Narzędzia wyszukiwania
SafeSearch

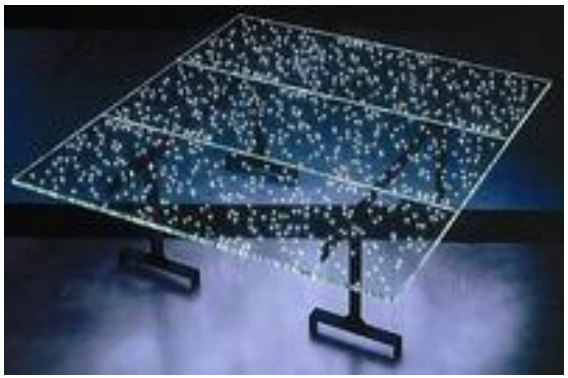
S va

Biel, Biel i jeszcze raz biel!

Żarówka 15-20 lumenów/watt (standardowa 100W – 17 lumenów/watt)
Halogen 20 lumenów/watt
Świetlówka 60-110 lumenów/watt
Świetlówki kompaktowe 45-60 lumenów/watt

Biała dioda: typowo 20-50 lumenów/watt, rekord z 2005r. 130 lumenów/watt!

http://www.otherpower.com/otherpower_lighting.html
http://www.theinquirer.net/?article=27731



Trochę historii

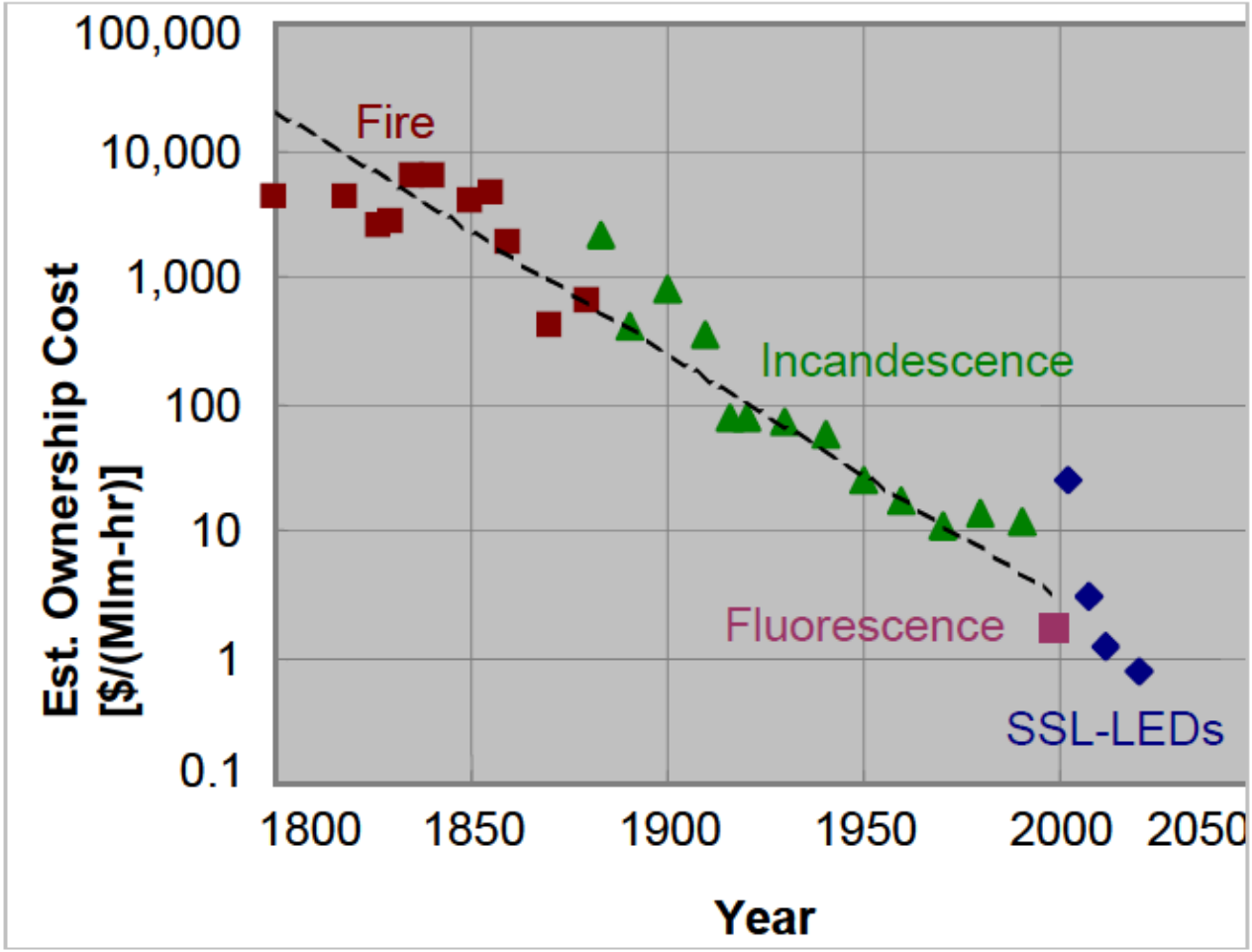
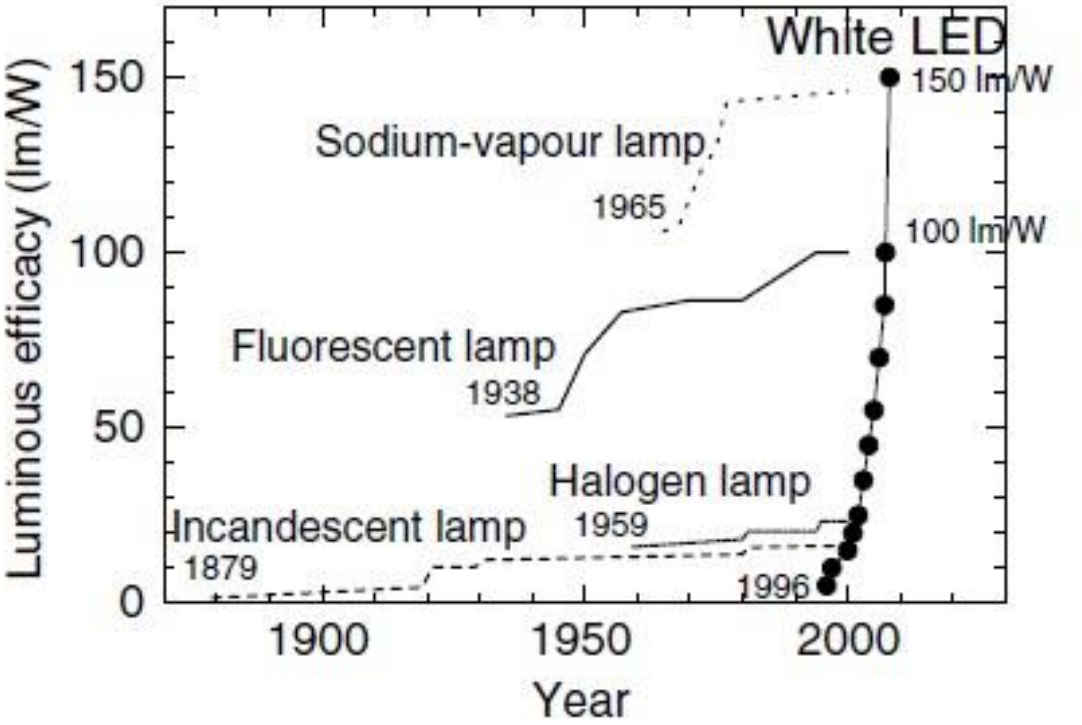


Figure 6. Estimated ownership costs of light, in 1992 dollars. Data for Fire and Incandescence for operating cost are from the work of W. Nordhaus,[15] to which estimates of capital cost have been added. Data for Fluorescence are from our estimates. Data for SSL-LEDs are the targets of this Roadmap.

http://lighting.sandia.gov/lightingdocs/OIDA_SSL_Roadmap_Tutorial.pdf

Trochę historii

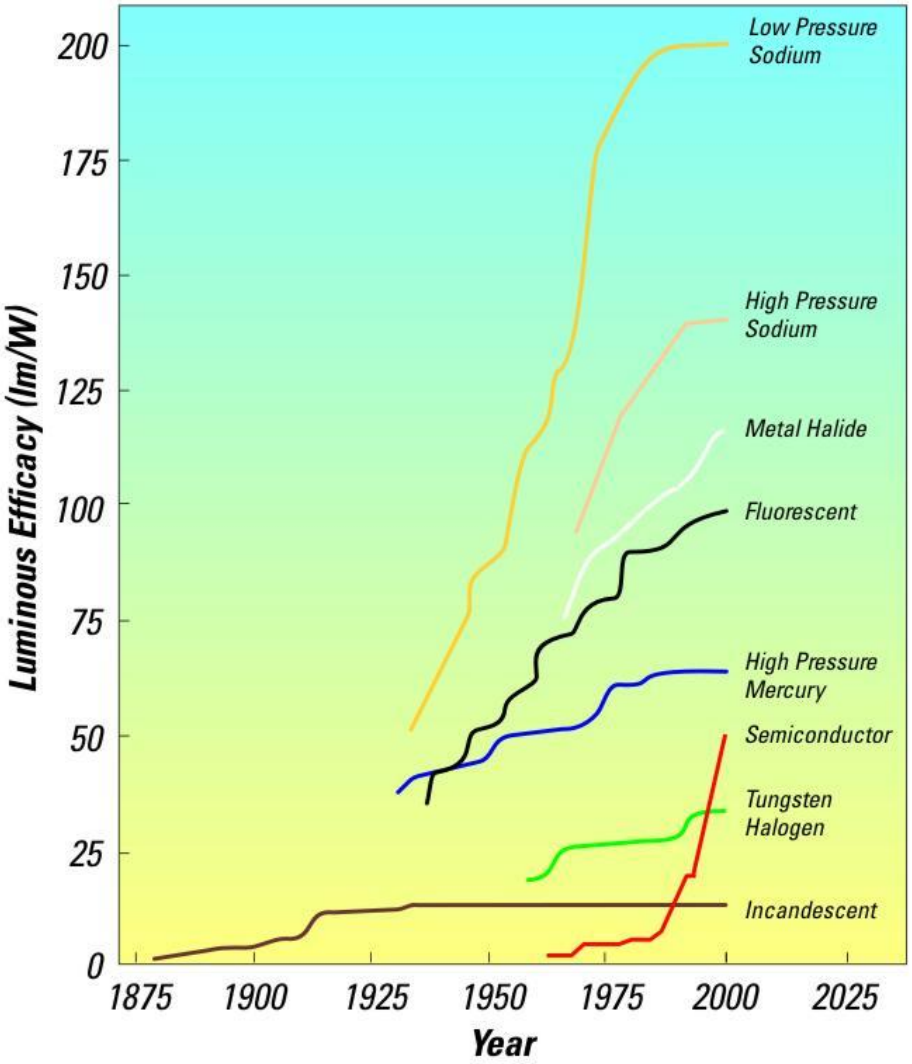


The history of luminous efficacy in different types of lighting shows the rapid improvements in white LEDs. The years in which the white light sources were developed are also shown. Credit: Yukio Narukawa, et al.

Read more at: http://phys.org/news202453100.html#jCp

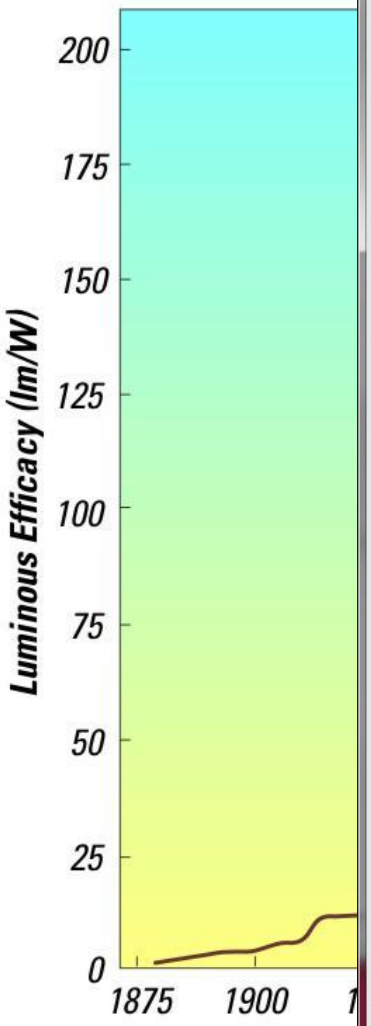
http://phys.org/news202453100.html

Trochę historii



http://phys.org/news202453100.html

Trochę h



Firefox

Cree shatters LED theoretical maximum ...

reefbuilders.com/2011/05/09/led-theoretical-maximum-efficiency-200-lumens/

Google

Cree shatters LED theoretical maximum efficiency of 200 lumens per watt in the lab

By Jake Adams on May 09, 2011

Today Cree announced that they have trounced previous luminous efficiency records of Light Emitting Diodes with 231 lumens per watt being produced by a single-die component. The record-setting efficient LED has a color temperature of 4500K, the results were produced at room temperature and the LED was running at 350mA, or about one watt. Back in the day (only a few years in LED time) it was believed that 200 lumens per watt might be the

reefbuilders.com/2013/10/29/keeping-butterflyfish-reefs-avoid/

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Comical crustaceans for your coral cushions – the

„Biała dioda”

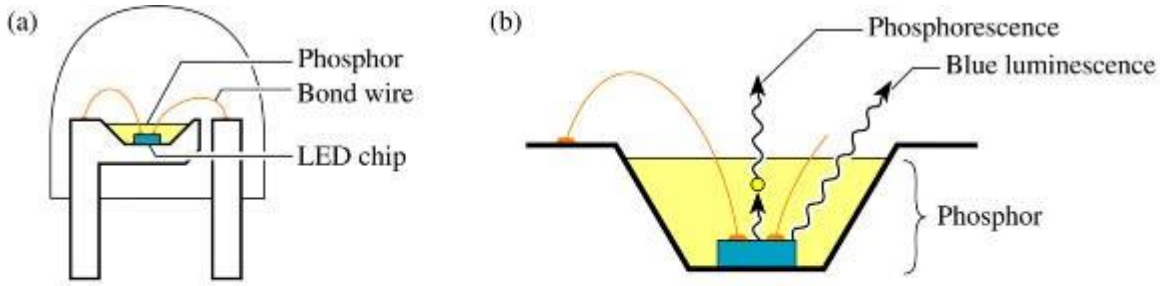
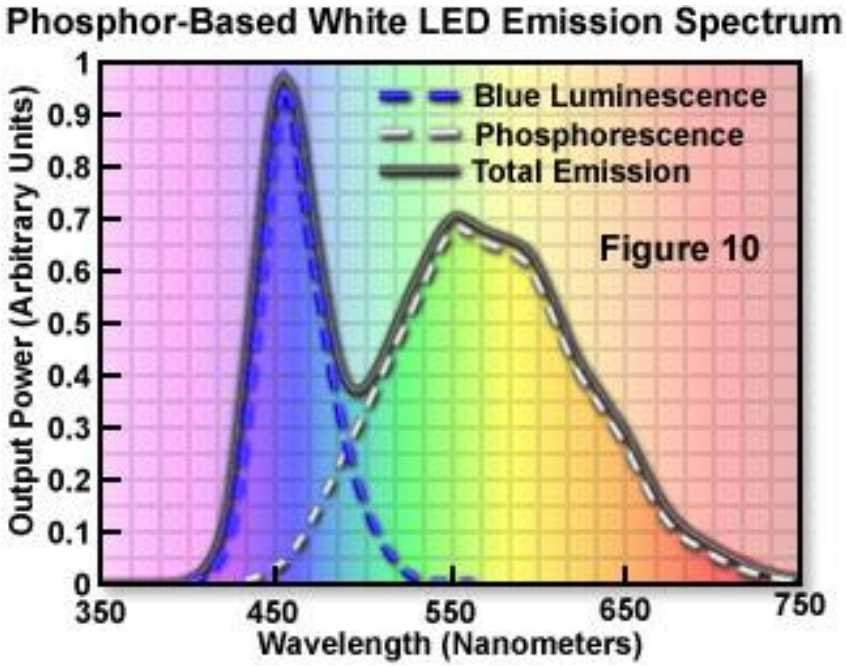


Fig. 11.5. (a) Structure of white LED consisting of a GaInN blue LED chip and a phosphor-containing epoxy encapsulating the semiconductor die. (b) Wavelength-converting phosphorescence and blue luminescence (after Nakamura and Fasol, 1997).



http://www.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap11/F11-04-R.jpg

Photon Recycling

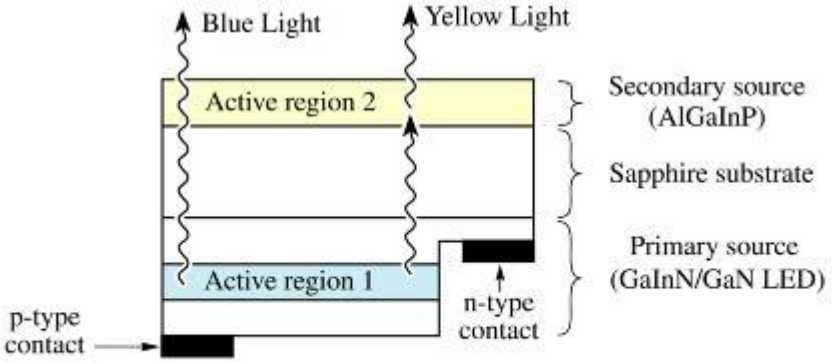


Fig. 11.8. Schematic structure of a photon-recycling semiconductor LED with one current-injected active region (Active region 1) and one optically excited active region (Active region 2) (after Guo *et al.*, 1999).

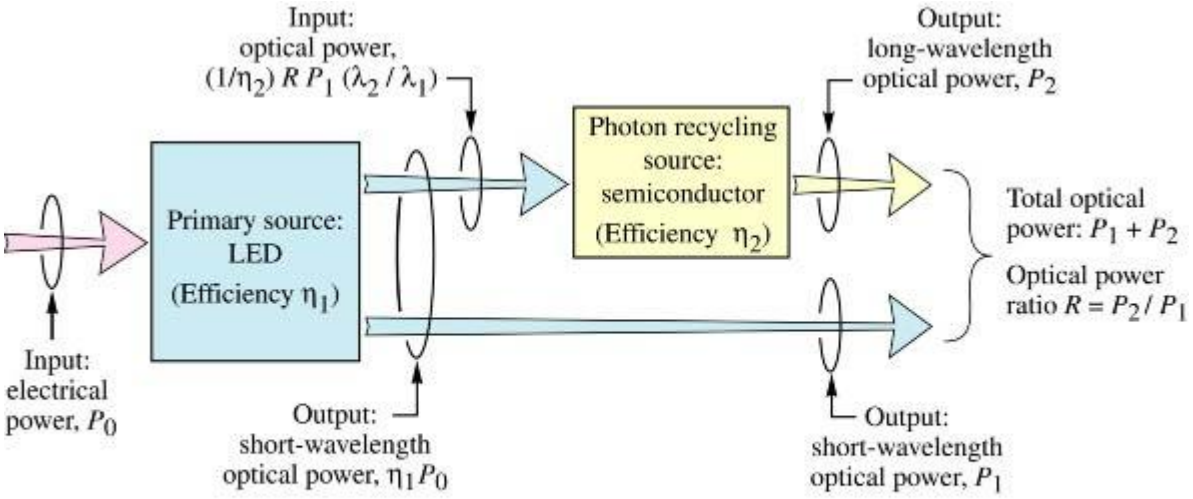


Fig. 11.9. Photon-recycling semiconductor LED power budget with electrical input power P_0 and optical output power P_1 and P_2.

http://www.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/chap11/F11-04-R.jpg

Trzy kolory

http://www.edisontechcenter.org/LED.html

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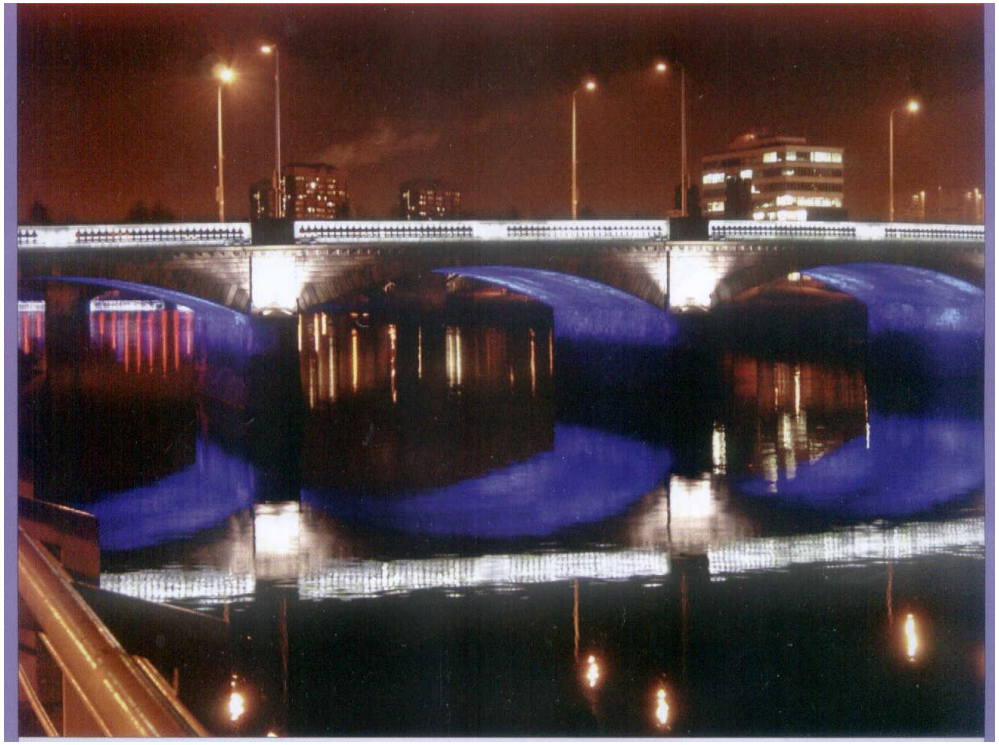
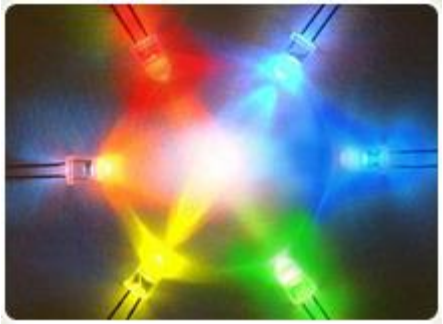


http://www.treehugger.com/files/lighting/

Biel, Biel i jeszcze raz biel!










http://www.treehugger.com/files/lighting/

Biel, Biel i jeszcze raz biel!

Forever Flashlights.

http://www.treehugger.com/files/lighting/

S va

Studnia kwantowa

http://www.lc-led.com/

http://www.albeotech.com/

http://www.albeotech.com/

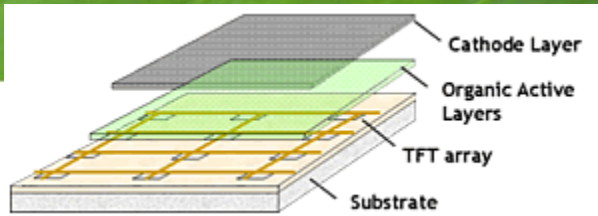
http://www.hollysolar.com/

http://www.whiteled.net/

OLED

Art. Lebedev Studio

http://www.universaldisplay.com/foled.htm

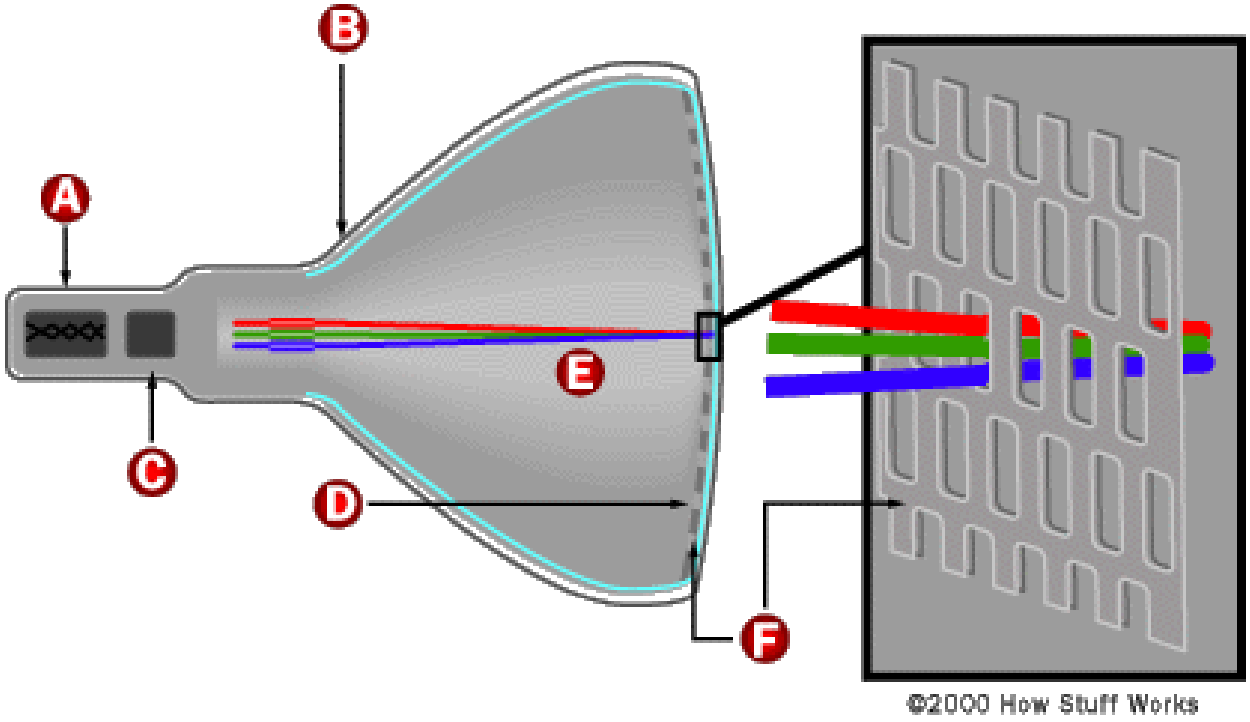


Courtesy of Sony Corporation.

Courtesy of Samsung SDI.

http://www.universaldisplay.com/active.htm

Projektory

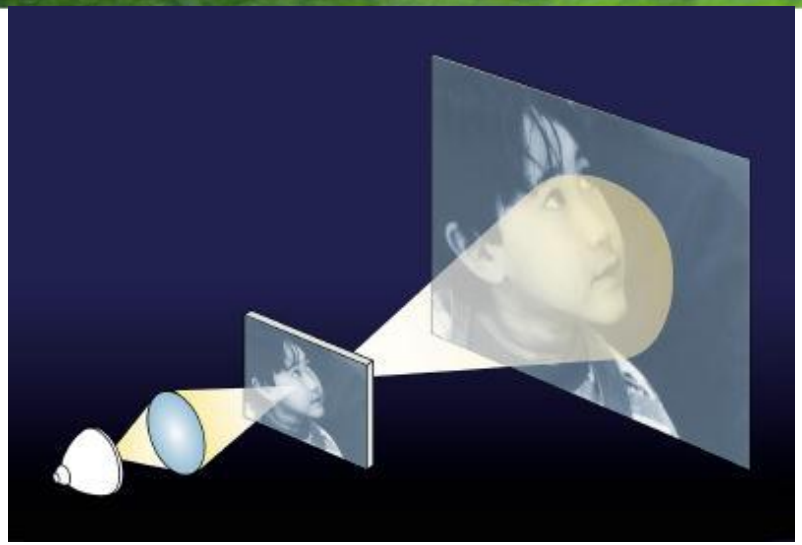


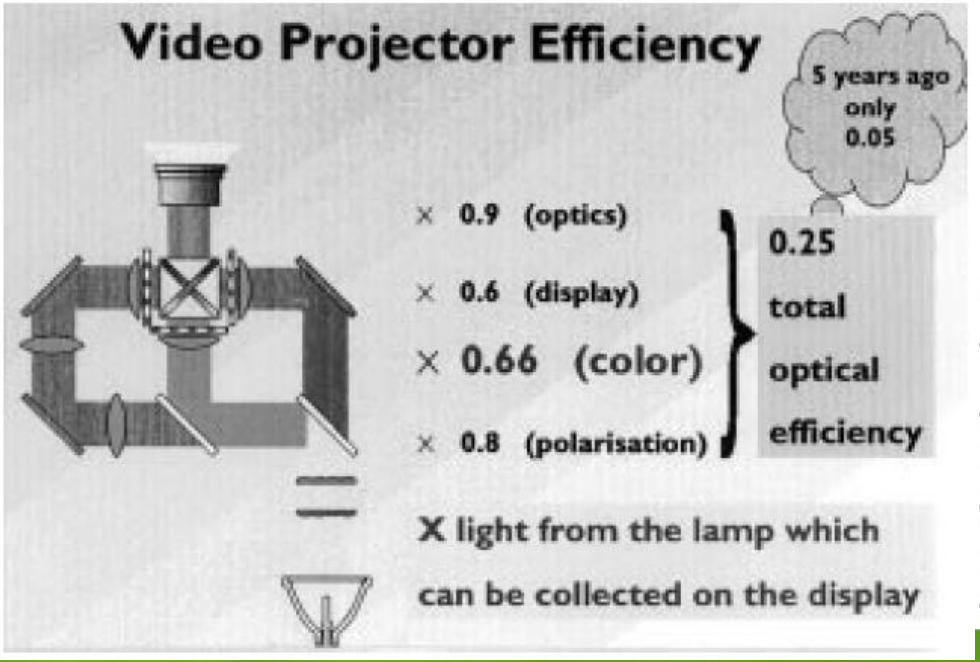
A Cathode
B Conductive coating
C Anode
D Phosphor-coated screen
E Electron beams
F Shadow mask

http://electronics.howstuffworks.com/projection-tv1.htm

Projektory

- LCD





CHARLES W. MCLAUGHLIN

http://electronics.howstuffworks.com/projection-tv1.htm

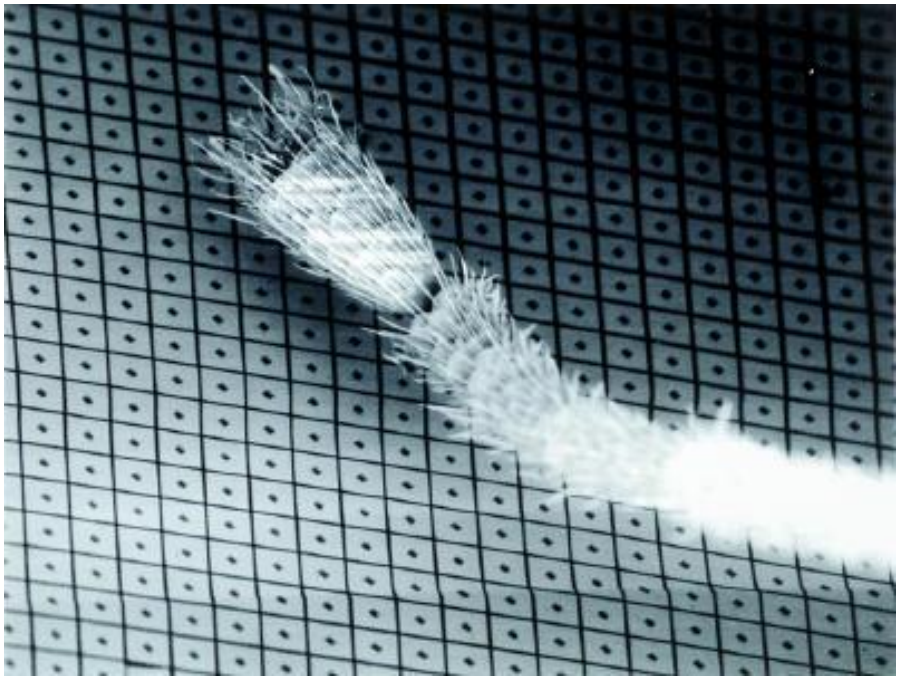
Projektory

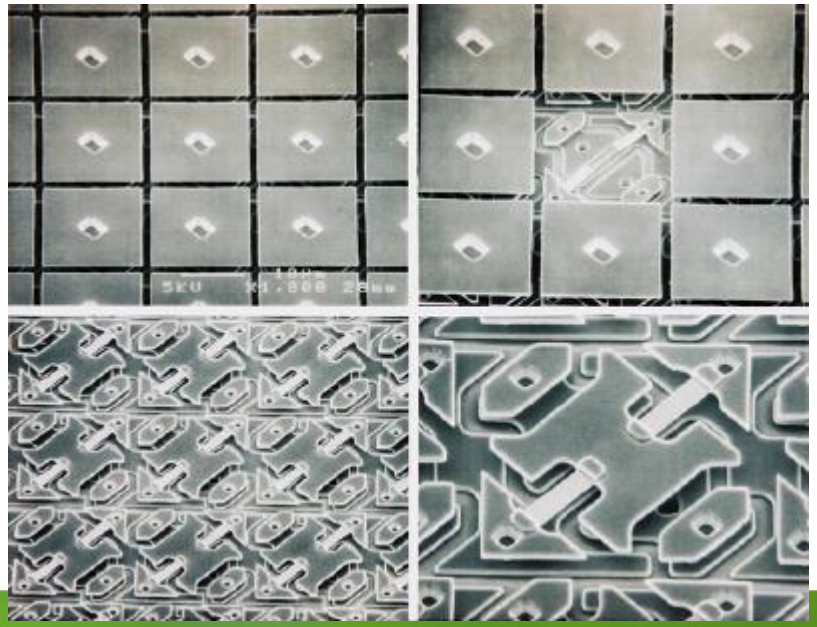
- LCD
- Liquid Crystal on Silicon

http://electronics.howstuffworks.com/projection-tv1.htm

Projektory

- LCD
- Liquid Crystal on Silicon
- Microelectromechanical Systems (MEMS)
    - Digital Micromirror Devices (DMD) = Digital Light Processing (DLP), (1000:1, BENQ 10000:1)

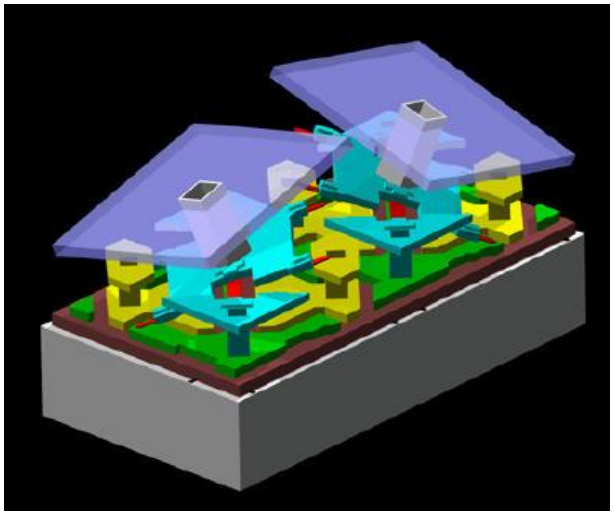


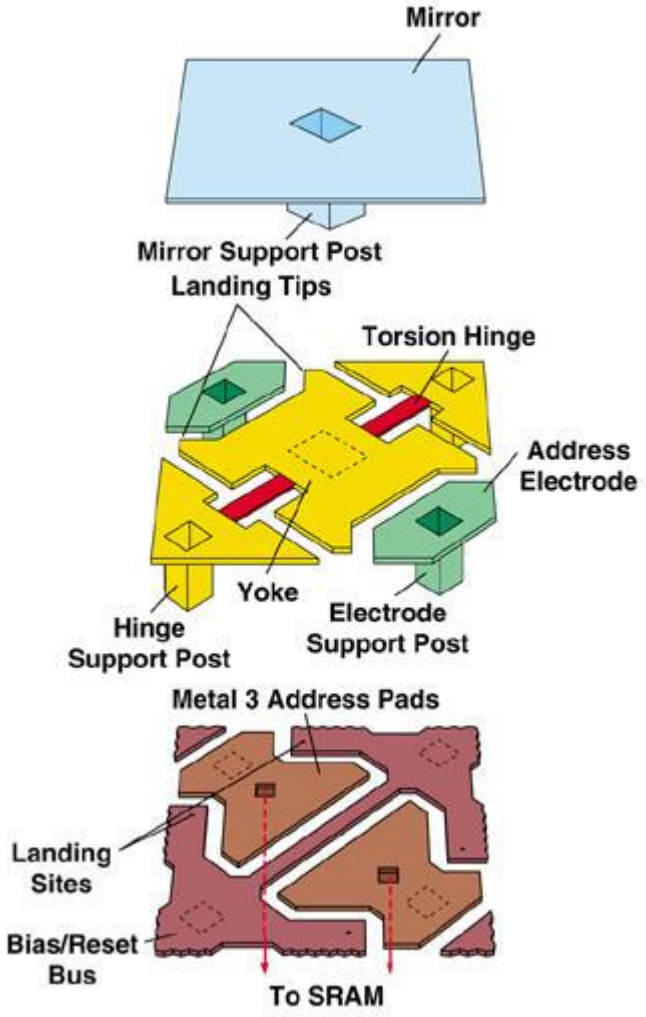


http://electronics.howstuffworks.com/projection-tv1.htm

Projektory

- LCD
- Liquid Crystal on Silicon
- Microelectromechanical Systems (MEMS)
    - Digital Micromirror Devices (DMD) = Digital Light Processing (DLP), (1000:1, BENQ 10000:1)

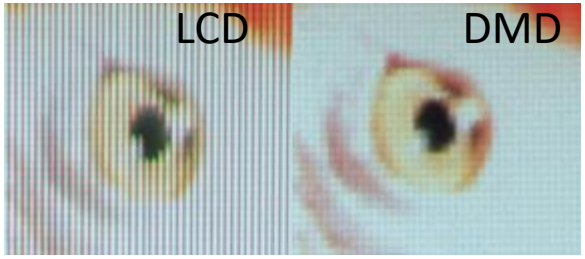


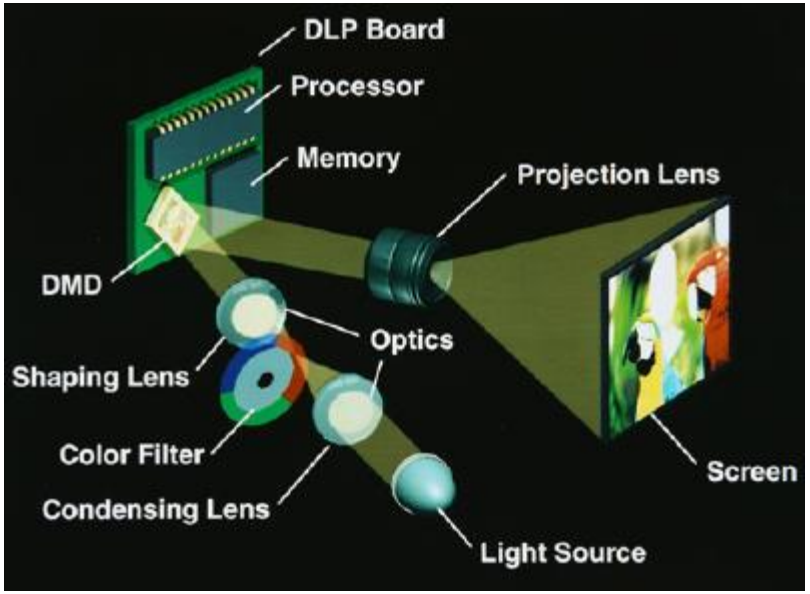


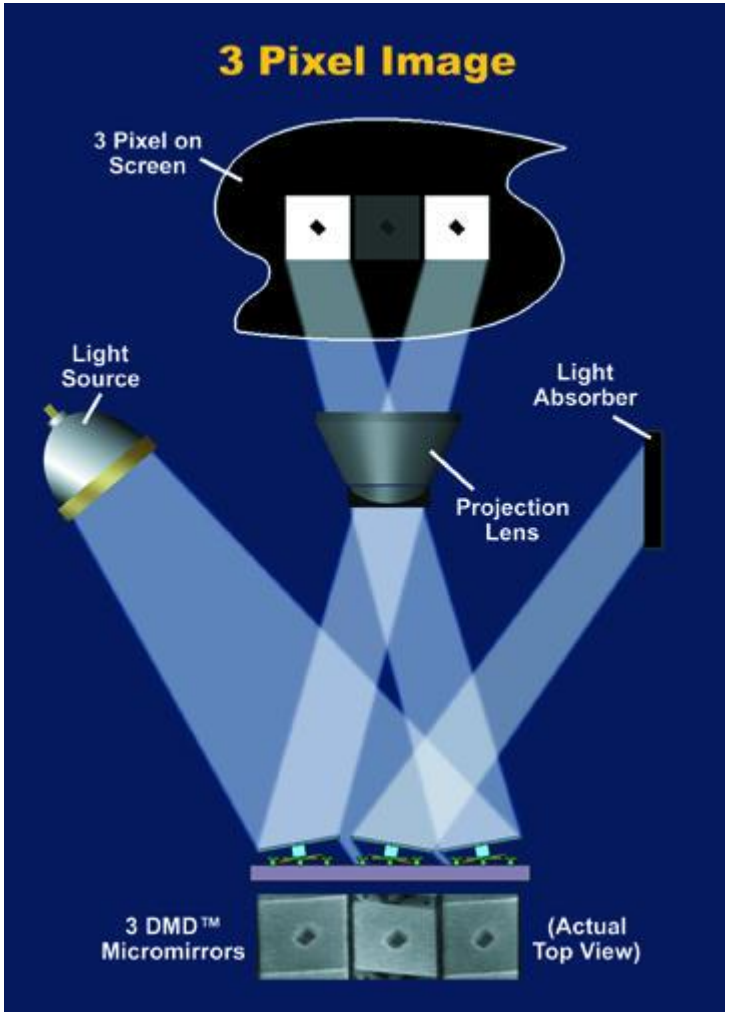
http://electronics.howstuffworks.com/projection-tv1.htm

Projektory

- LCD
- Liquid Crystal on Silicon
- Microelectromechanical Systems (MEMS)
  - Digital Micromirror Devices (DMD) = Digital L Processing (DLP), (1000:1, BENQ 10000:1)







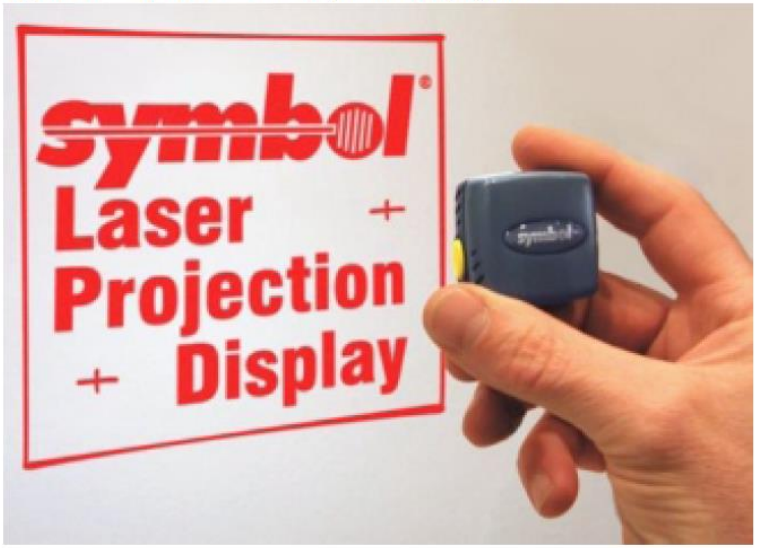
http://electronics.howstuffworks.com/projection-tv1.htm

Lasery

http://www.laseronics.com/

http://www.spacelaser.com/laser/

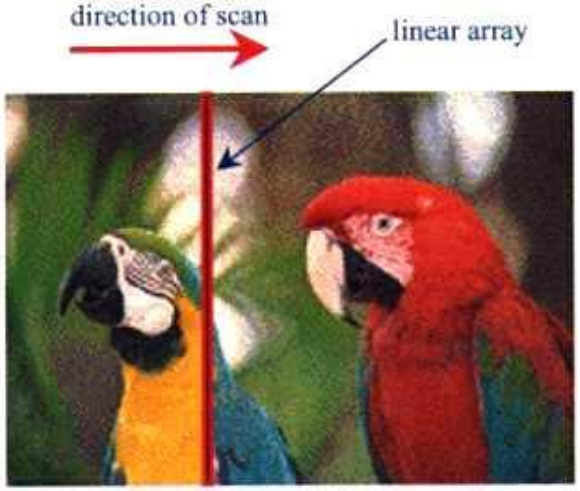
Figure 16: Symbol Laser Projection Display Demo

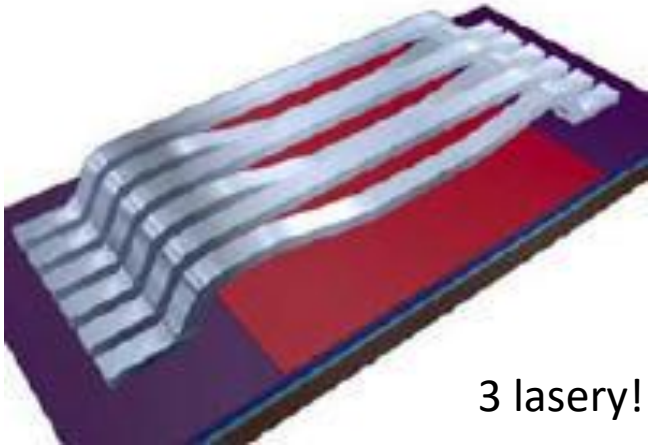


http://www.symbol.com/

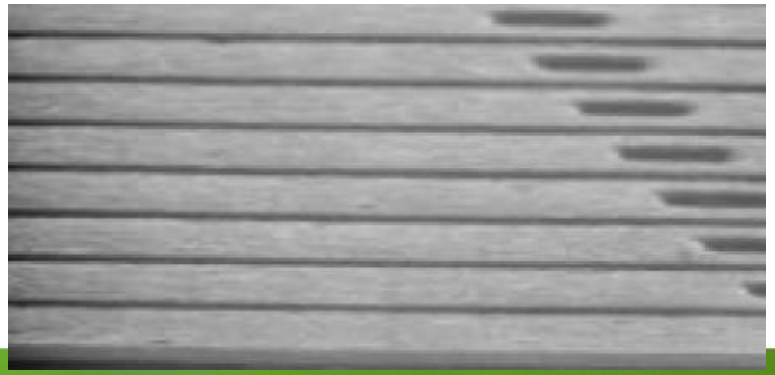
Projektory

- LCD (1000:1)
- Liquid Crystal on Silicon
- Microelectromechanical Systems (MEMS)
    - Digital Micromirror Devices (DMD) = Digital Light Processing (DLP), (3000:1, BenQ 10000:1)
- Grating Light Valves (GLV) (Sony 4000:1)





3 lasery!



http://electronics.howstuffworks.com/projection-tv1.htm

HDTV

HDTV - Mozilla Firefox

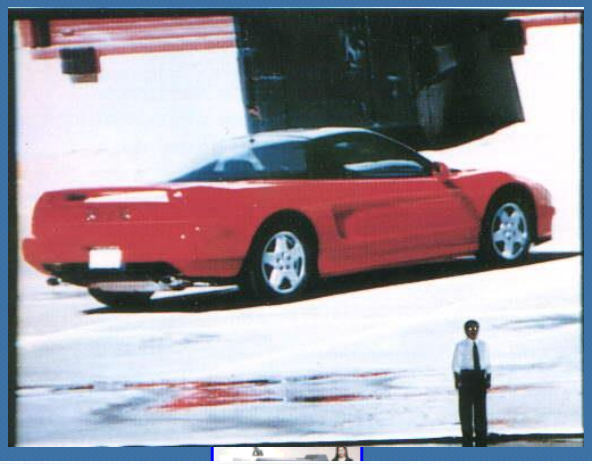
Plik Edycja Widok Przejdź Zakładki Narzędzia Pomoc

http://www.mitsi.com/Projects/alp.htm

Getting Started | Latest Headlines | Gazeta.pl | INTERIA.PL - Fakty | Tabela NBP | Slownik Ang. | Slownik Fra. | Google Desktop | Strona główna serwis... | Union Investment TFI... | Notowania i wykresy/...

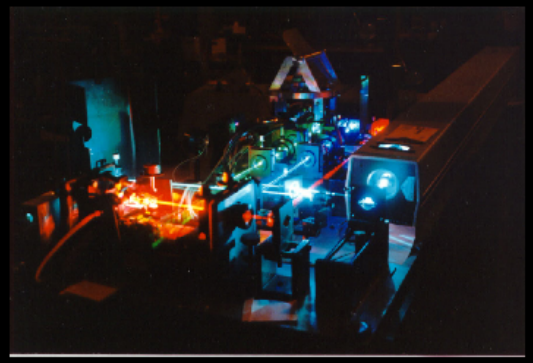
laser projection TV - Google Search | eBay: JHE RG-3 LASER SYSTEM (3-color) C... | HDTV | IEEE2002.pdf (Obiekt application/pdf)

The ProFX Laser Projection System



It's not 26 inches, it's a 26 foot diagonal TV.

Laser Projection System



A 6' tall person standing in front of a 30' wide by 40' tall screen shows the capabilities of the new projection system. Yoshi is about 5'5" so you can get some idea of the scale.

Linden Laser Systems now shows and supports the ProFX giant screen color projection television system. Intended for trade shows and rock concerts, the system has attracted a great deal of attention from major entertainment companies.

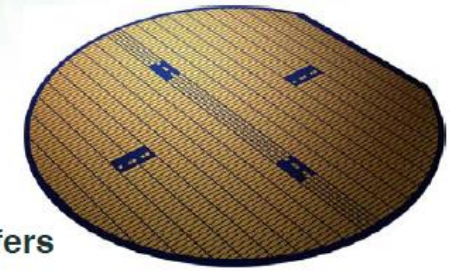
Red/Green/Blue laser beams are steered by the motor which spins at over 80,000 RPM! Paul Linden, President started this project with the vision of the best and brightest projection TV system with the capability of growth to High-Definition TV. One year after Paul and Stan asked Mitsi to develop this

Zakończono

Laser TV

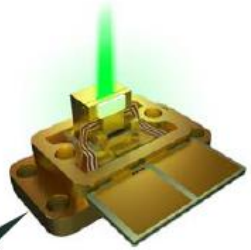
NOVALUX

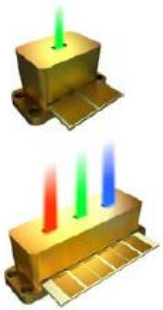
What is a Novalux Necsel™ Laser?

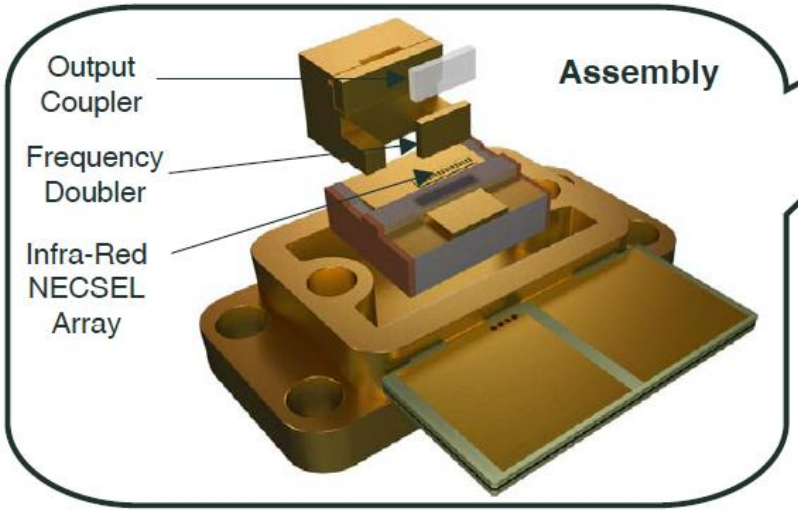


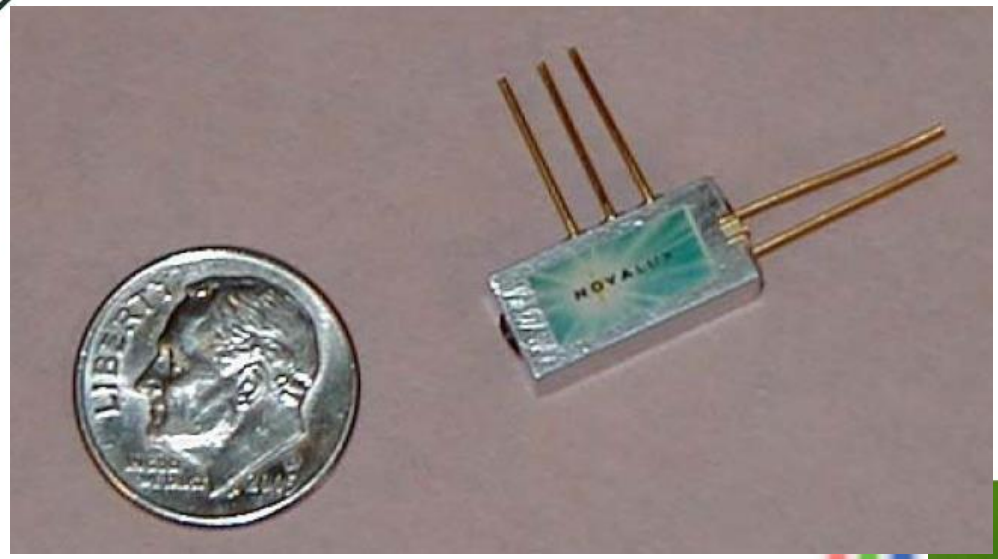
4" Wafers

>1000 Arrays/Wafer

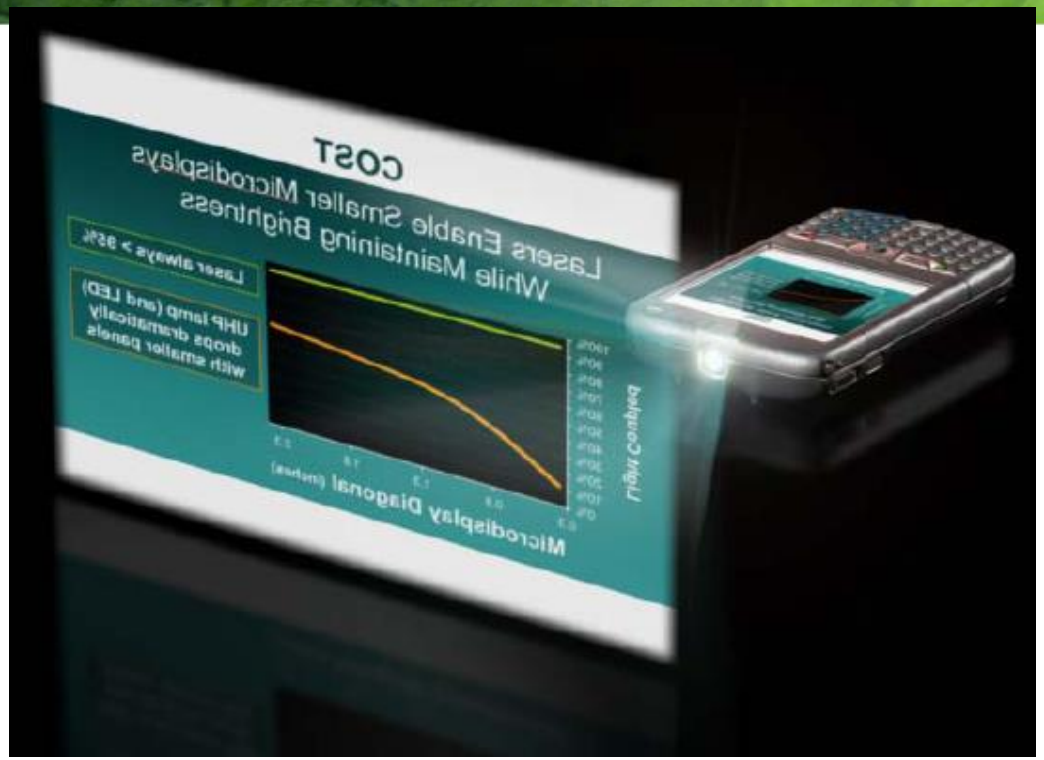








Laser TV


COST
Lasers Enable Smaller Microdisplays
While Maintaining Brightness
Laser always > 85%
UHP lamp (and LED)
drops dramatically
with smaller panels
Microdisplay Diagonal (inches)
Projected Watts

Laser TV

Hands-on with Texas Instruments' cellphone projector

Posted Sep 20th 2007 12:15PM by Evan Blass

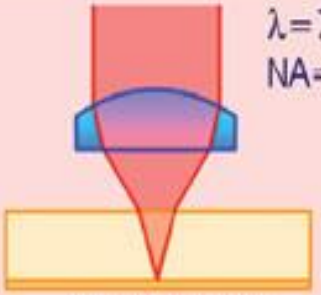
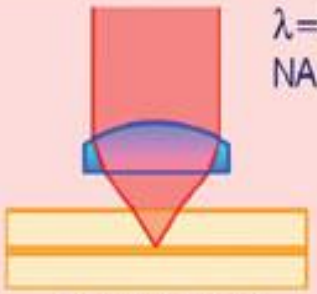
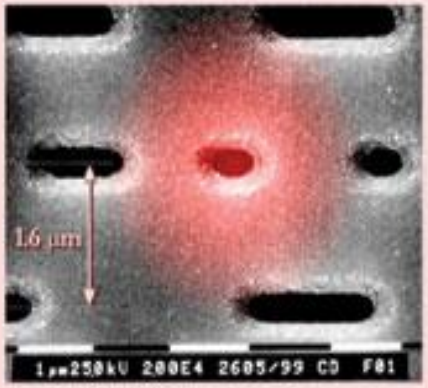
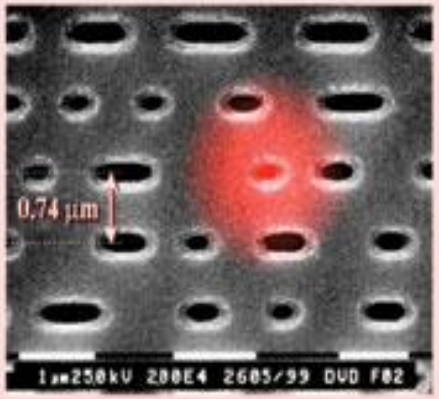
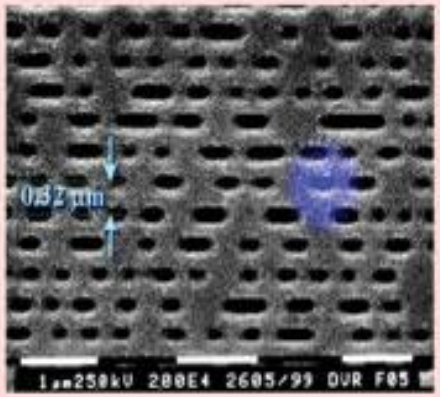
Filed under: Cellphones, Displays, Features

Now that we have email, internet, TV, GPS, cameras, and satellite radio on our cellphones, our next wish is for bigger, higher resolution screens -- which seems paradoxical, because larger displays almost always mean bulkier devices. Well Texas Instruments thinks it'll soon be able to nullify this trade-off with an in-handset projector that we've heard about several times before, but last night's Pepcom event in New York was the first time we've been able to peep the technology up close. Not that the TI reps made it easy to do so: the prototype unit was in a locked metal case underneath the table, and we had to swear up and down that we saw Walt Mossberg getting a demo before they'd cough it up. As you can see, the reason they want to keep this under wraps for the time being is that the quality and brightness are certainly not ready for prime time yet; while the unit we saw used lasers as the light source, we're told that an LED-based model still in the lab offers significant improvements. Keep reading for more shots of this rare prototype -- along with a video courtesy of Popular Science -- and give yourself a few moments to bask in the future before returning to the stark reality of your own phone and its dim little QQVGA action...

http://www.engadget.com/tag/TexasInstruments/

Lasery w akcji

Zapis o dużej gęstości: CD, DVD, Blu-ray

CD	DVD	Blu-ray Disc
 λ=780 nm NA=0.45 1.2 mm substrate	 λ=650 nm NA=0.6 0.6 mm substrate	 λ=400 nm NA=0.85 0.1 mm cover layer
		

0.8 GB **4.7 - 9 GB** **24 - 50 GB**

Niebieskość 405 nm

- **Drukowanie**: drukarka laserowa 600 dpi drukująca 60 stron na minute (60 ppm) korzysta obecnie z lasera 760 nm i systemu optycznego o aperturze 6mm by uzyskać 35 µm FWHM. Dla wydruku 1200 dpi (17 µm FWHM) czerwony laser potrzebuje droższego i większego systemu optycznego o aperturze 12 mm i głębi ostrości jedynie 0.5mm (z taką precyzją względem papieru laser musi być ogniskowany). Laser GaN 390 nm może dać wydruk 1200 dpi za pomocą systemu optyki 6mm i głębi ostrości 1mm.

- Do wydruku 60 ppm potrzeba laserów GaN 6 mW CW (większa moc umożliwia większe prędkości wydruku).

- Długosc fali powinna być >430 nm, żeby nie dopuścić do uszkodzenia (rozkładu) materiałów organicznych (plastików) używanych w budowe .

Fotowoltaika

Perowskity

Perowskity wkraczają na s...

tvn24bis.pl/z-kraju,74/perowskity-wkraczaja-na-salony-

TVN24 | TVN METEO | TVN WARSZAWA | FAKTY | TVN24 BIZNES I ŚWIAT | KONTAKT24 | TVN | ZALOGUJ SIĘ | ZAREJESTRUJ SIĘ

Oglądaj w TVN24 BiS
22:00 "24 Godziny"

Sprawdź, gdzie oglądać
TVN24 Biznes i Świat »

START | TERAZ | NAJNOWSZE | INFORMACJE | NOTOWANIA | KALENDARIUM | BLOGI | OPINIE I KOMENTARZE | WIDEO | MAGAZYNY

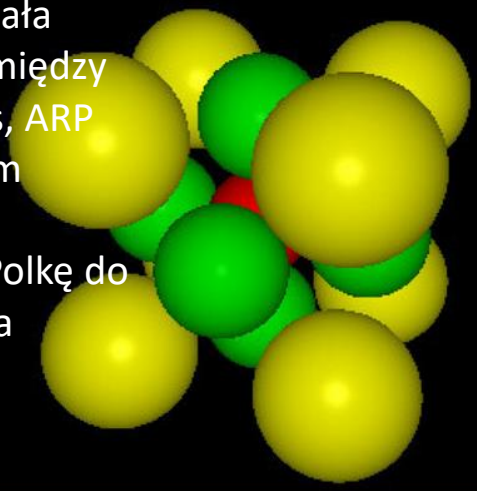
ROZWIŃ WIG20 2011.94 -0.49% WIG30 2237.47 -0.60% WIG 49397.33 -0.28%

10 WRZEŚNIA 2015, 17:33

Perowskity wkraczają na salony. Polka zrewolucjonizuje energetykę?

Dr Olga Malinkiewicz

Umowa, która została zawarta dzisiaj pomiędzy Saule Technologies, ARP Venture i japońskim inwestorem Hideo Sawadą przybliża Polkę do skomercjalizowania pomysłu.



Elektrownie słoneczne

Historyczny przełom. Elektrownie słoneczne tańsze już od wiatrowych. A prąd z węglowych droższy dwa razy

Marcin Kaczmarczyk
16.12.2016 17:18

Panele fotowoltaiczne w Rudzie Śląskiej (GRZEGORZ CELEJEWSKI)

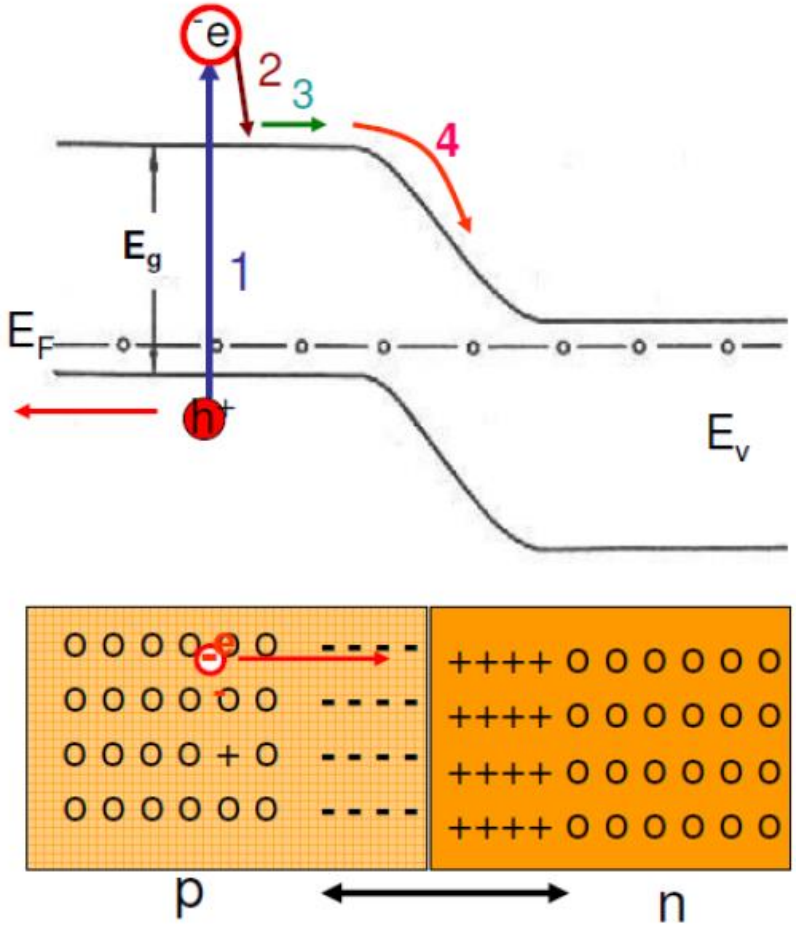
Z danych regularnie zbieranych przez agencję Bloomberg wynika, że 2016 rok przejdzie do historii w energetyce. Energia słoneczna stała się najtańszym źródłem prądu na świecie.

NAJCZĘŚCIEJ CZYTANE

1. Szukasz prezentu w dobrej cenie? Oto najlepsze okazje, jakie
2. Państwo zarabia krocie na akcyzie za alkohol i papierosy. Teraz
3. Rząd podarował góralom aquapark i hotele zbudowane dla
4. Instytucje finansowe znalazły nowe zastosowanie dla GPS.
5. Polak dostrzegł coś nietypowego na zdjęciach z Marsa. NASA

Fotowoltaika

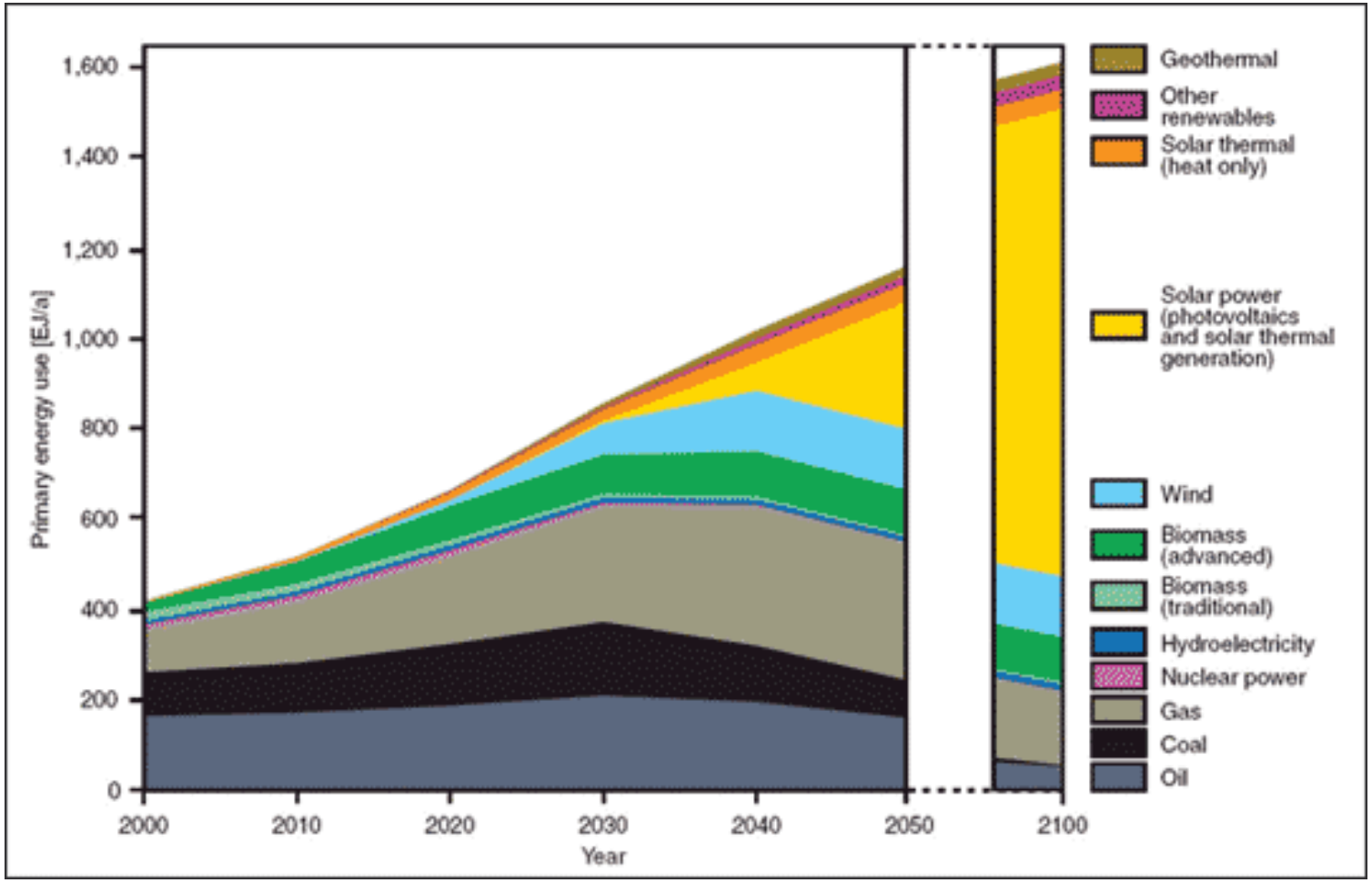
Photovoltaic effect in pn junction



1. absorption
2. **thermalisation**
3. **diffusion**
4. drift

important parameters:
- o band gap E_g
- o doping level
- o absorption coefficient α
- o lifetime of carriers τ
- o diffusion length L_d
- o mobility μ

Źródła energii



German Advisory Council on Global Change

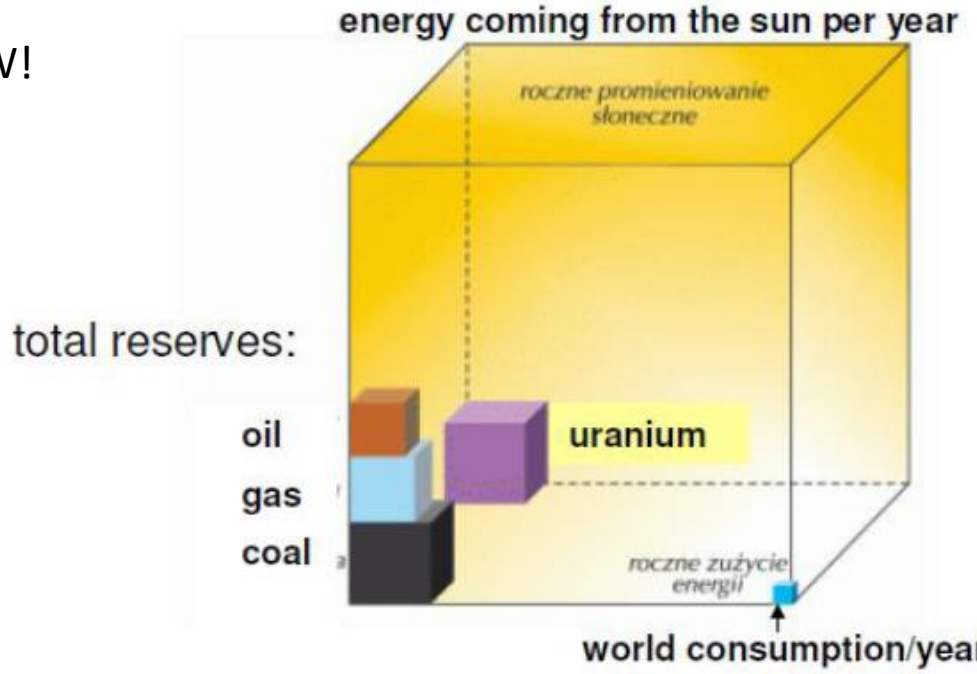
Źródła energii

Ziemskie źródła ropy naftowej są szacowne na 3 tryliony baryłek i zawierają 1.7×10^{22} J energii, którą Słońce dostarcza do Ziemi w 1,5 dnia.

Ilość energii, którą ludzkość zużywa rocznie wynosi około 4.6×10^{20} J, Słońce dostarcza ją w ciągu godziny.

Moc, która Słońce dostarcza ciągle do Ziemi, 1.2×10^{5} TW, jest znacznie większa od wszystkich innych form energii.

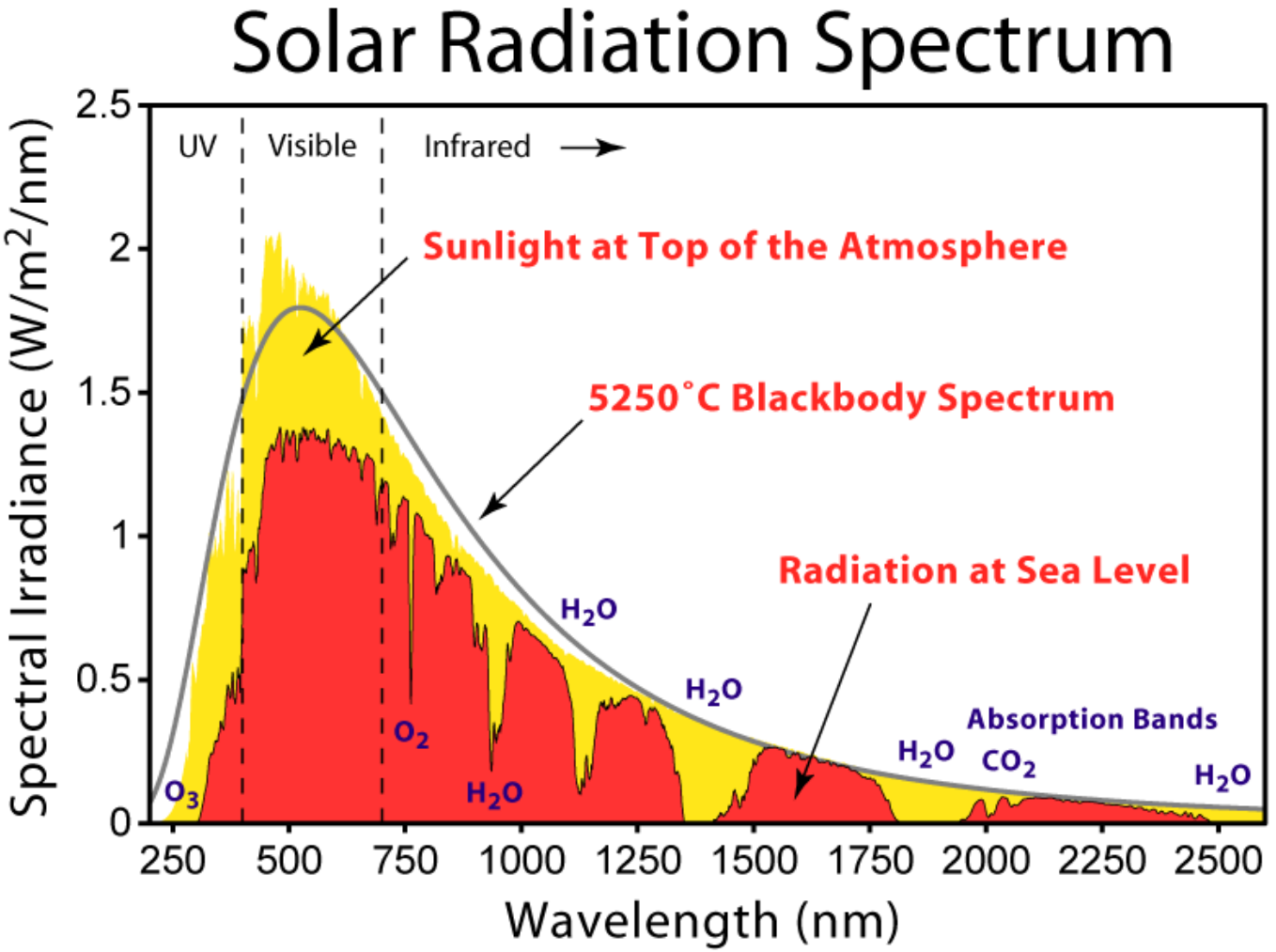
2020: Szacowane potrzeby ludzkości to 20 TW!



Prof. M. Kamińska

Źródła energii

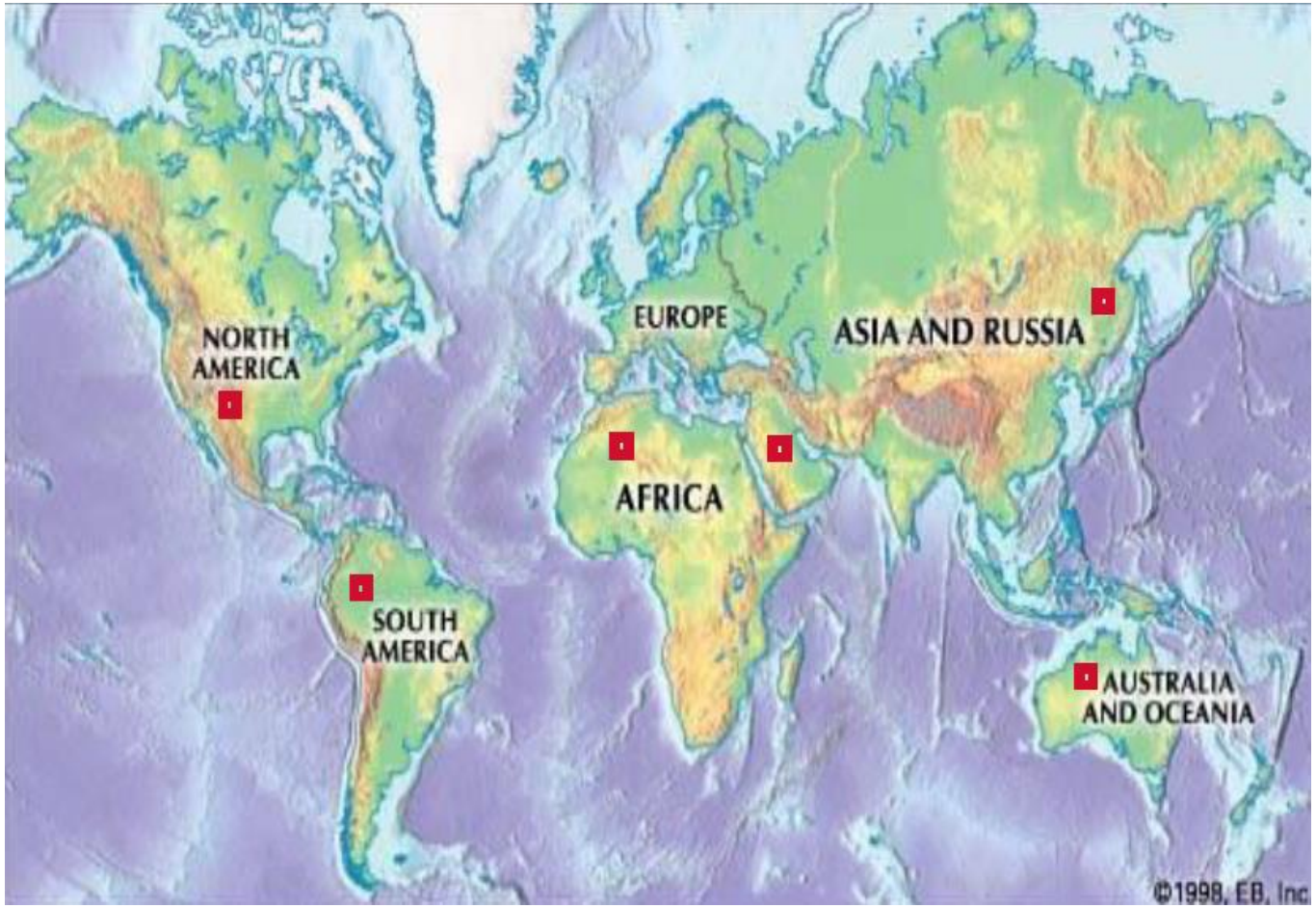
Słońce:



http://commons.wikimedia.org/wiki/File:Solar_Spectrum.png

Źródła energii

Obszar potrzebny do produkcji 20 TW w samej PV: 6 miejsc, każde 250 x 250 km^2 produkujące 3.3 TW



Prof. M. Kamińska

Źródła energii

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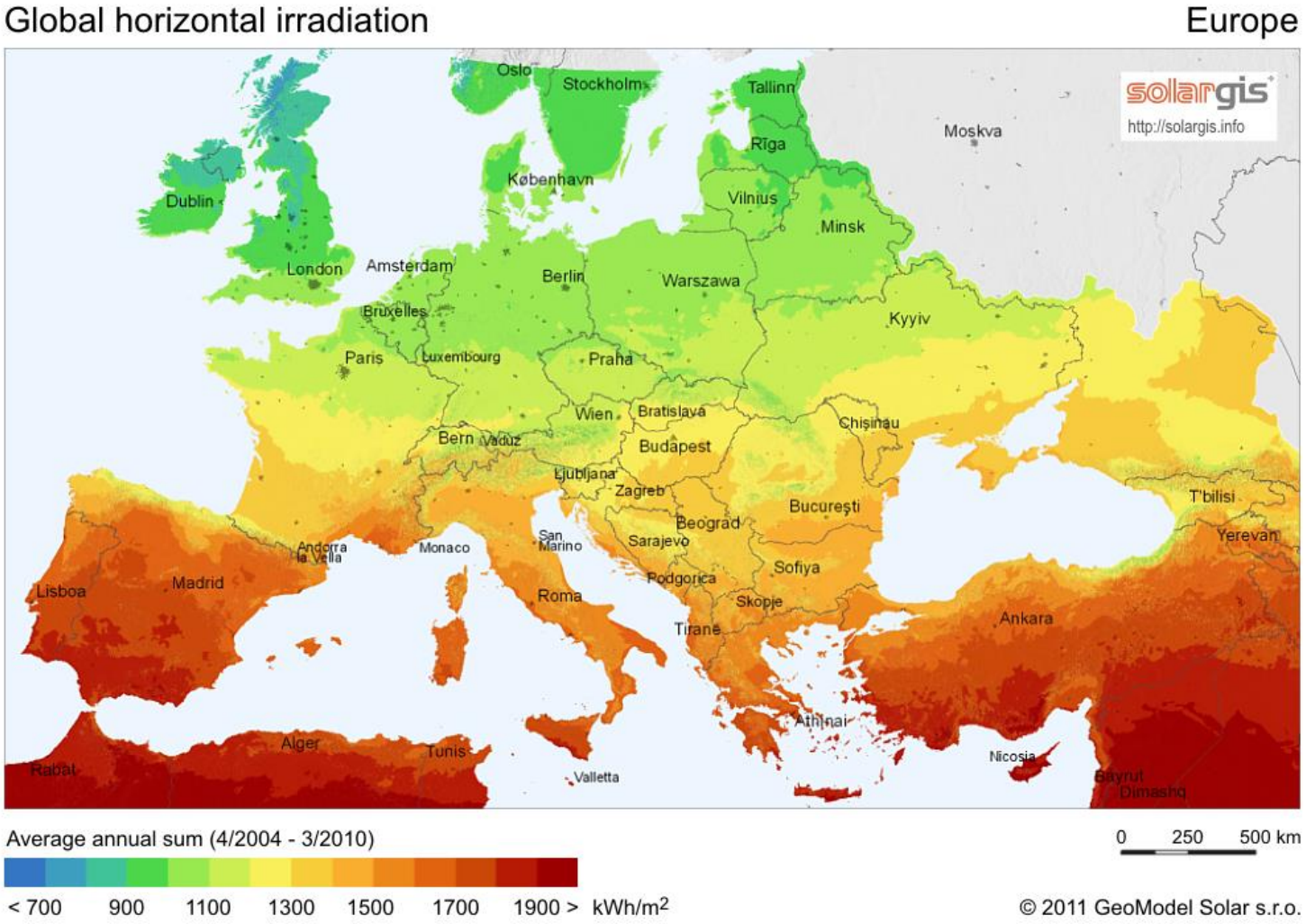
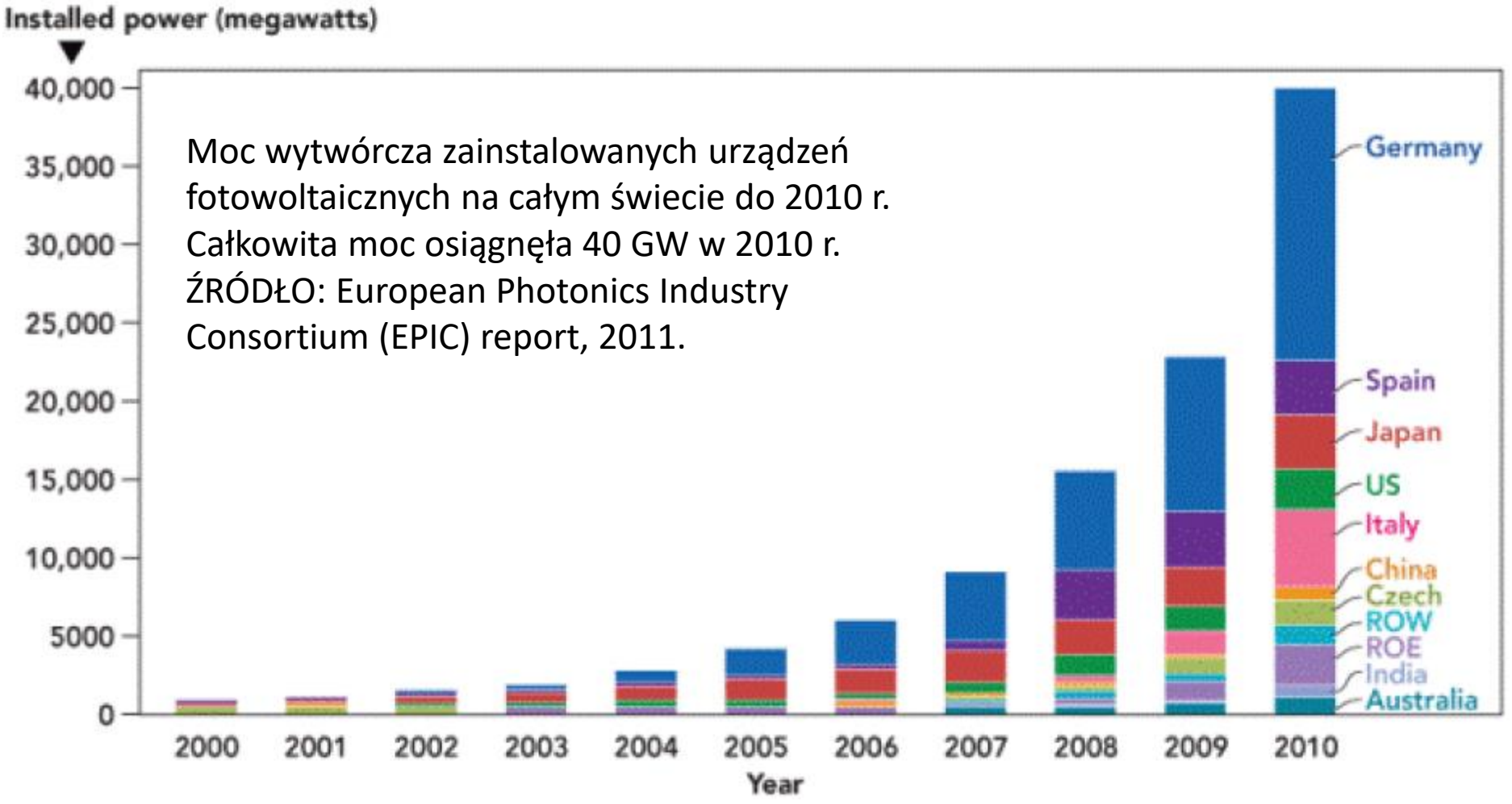


Prof. M. Kamińska

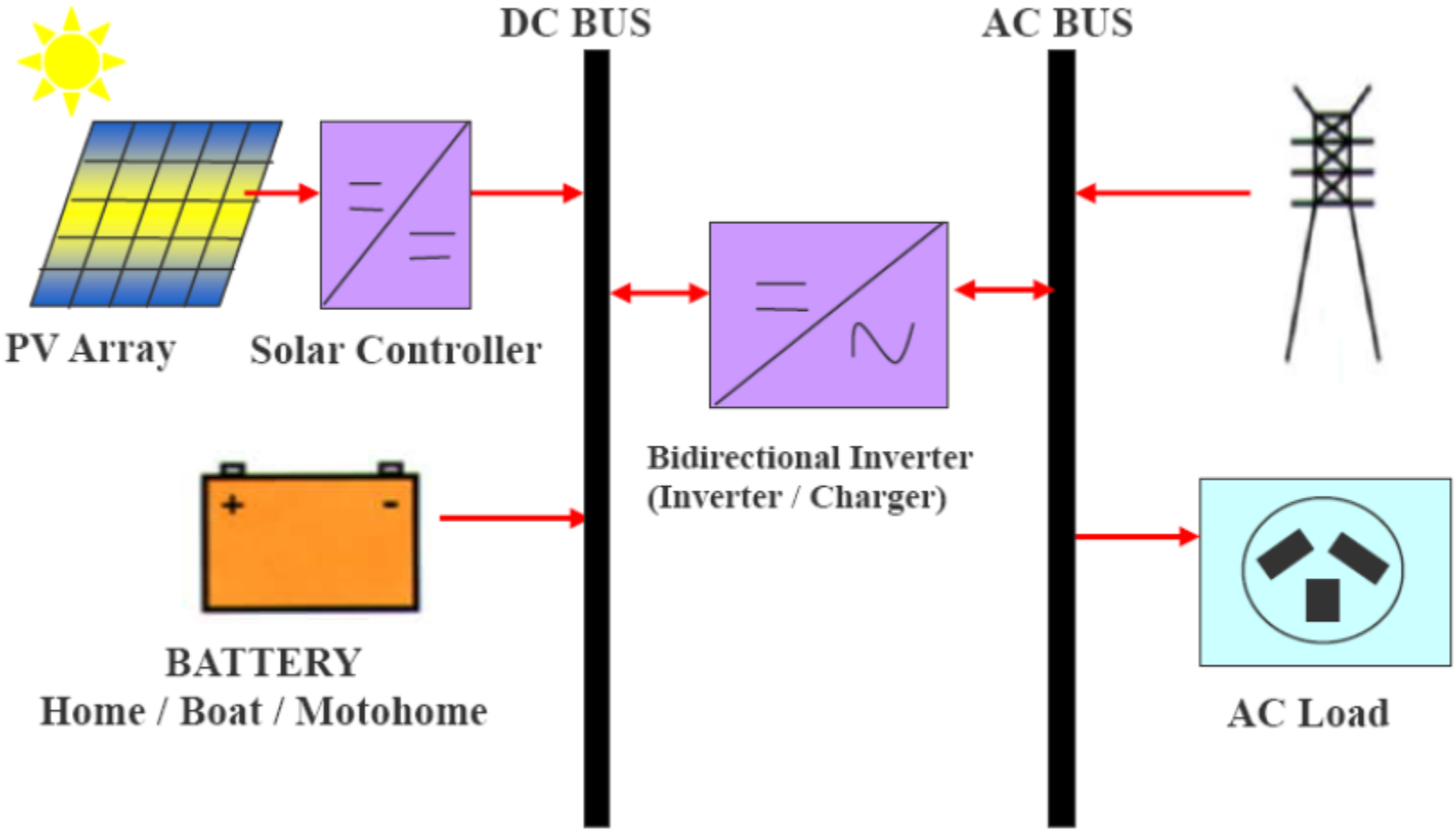
Źródła energii



Moc wytwórcza zainstalowanych urządzeń fotowoltaicznych na całym świecie do 2010 r. Całkowita moc osiągnęła 40 GW w 2010 r.
ŹRÓDŁO: European Photonics Industry Consortium (EPIC) report, 2011.

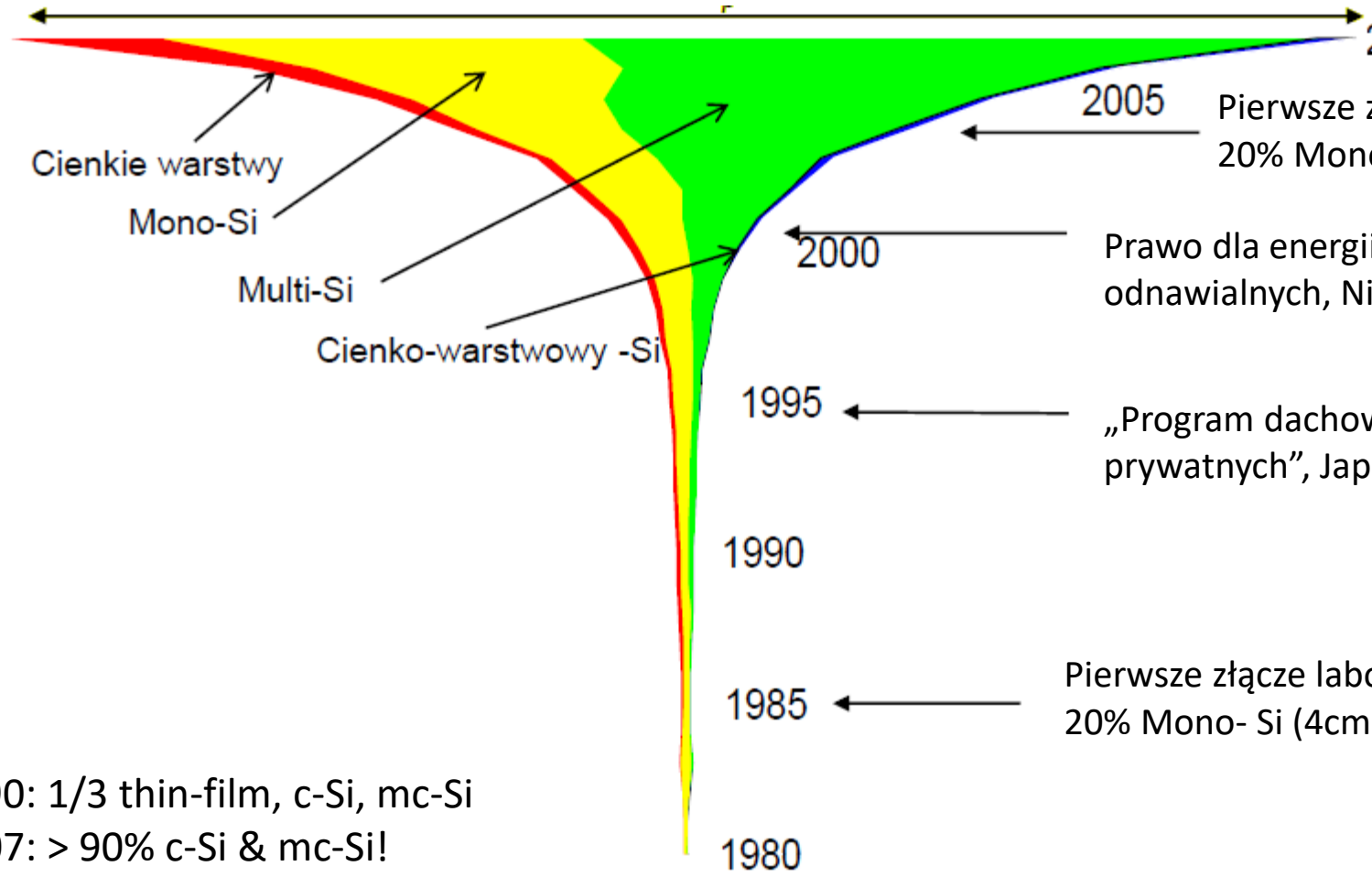
Prof. M. Kamińska

Fotowoltaika



Prof. M. Kamińska

Fotowoltaika

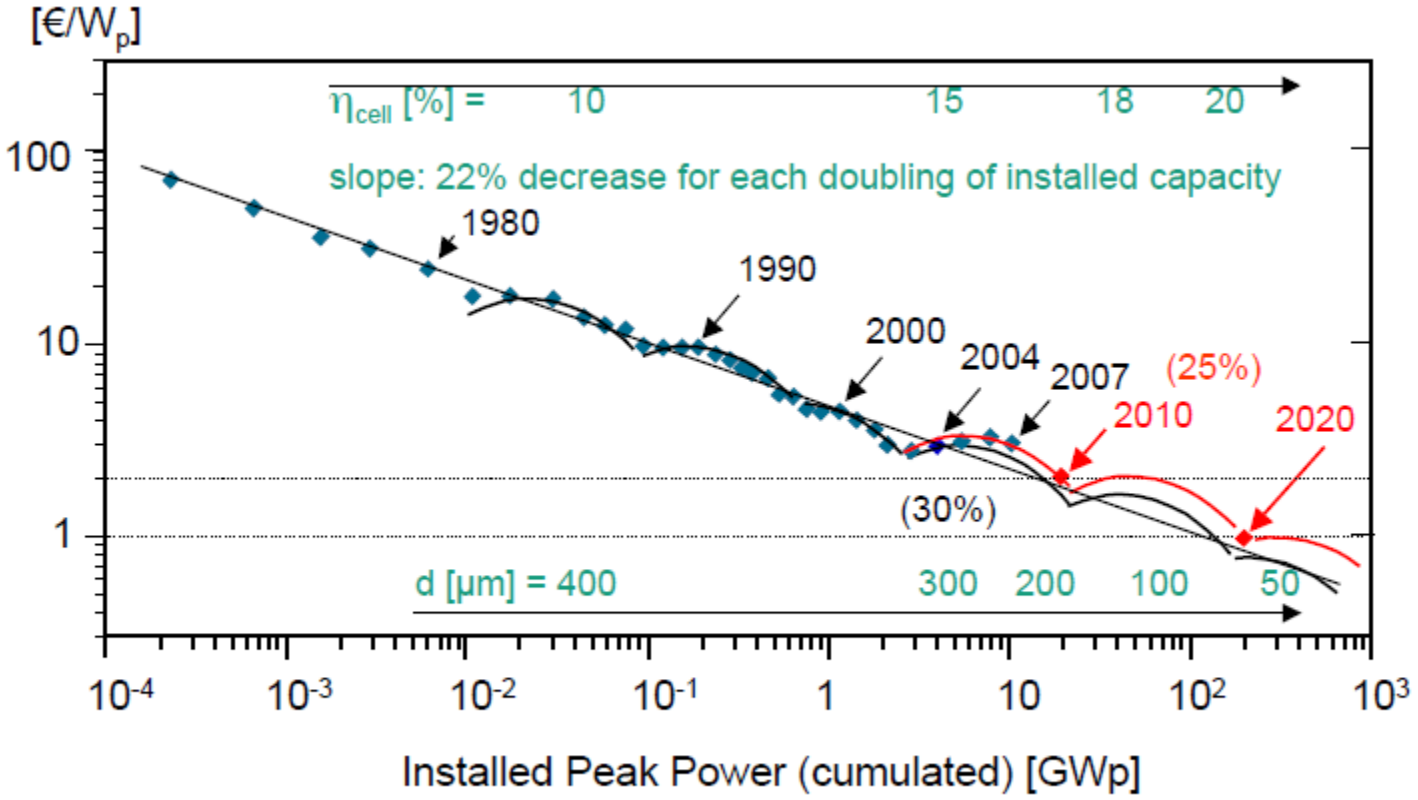


1990: 1/3 thin-film, c-Si, mc-Si
2007: > 90% c-Si & mc-Si!

Prof. M. Kamińska

Fotowoltaika

Krzywa cen modułów PV z krystalicznego krzemu

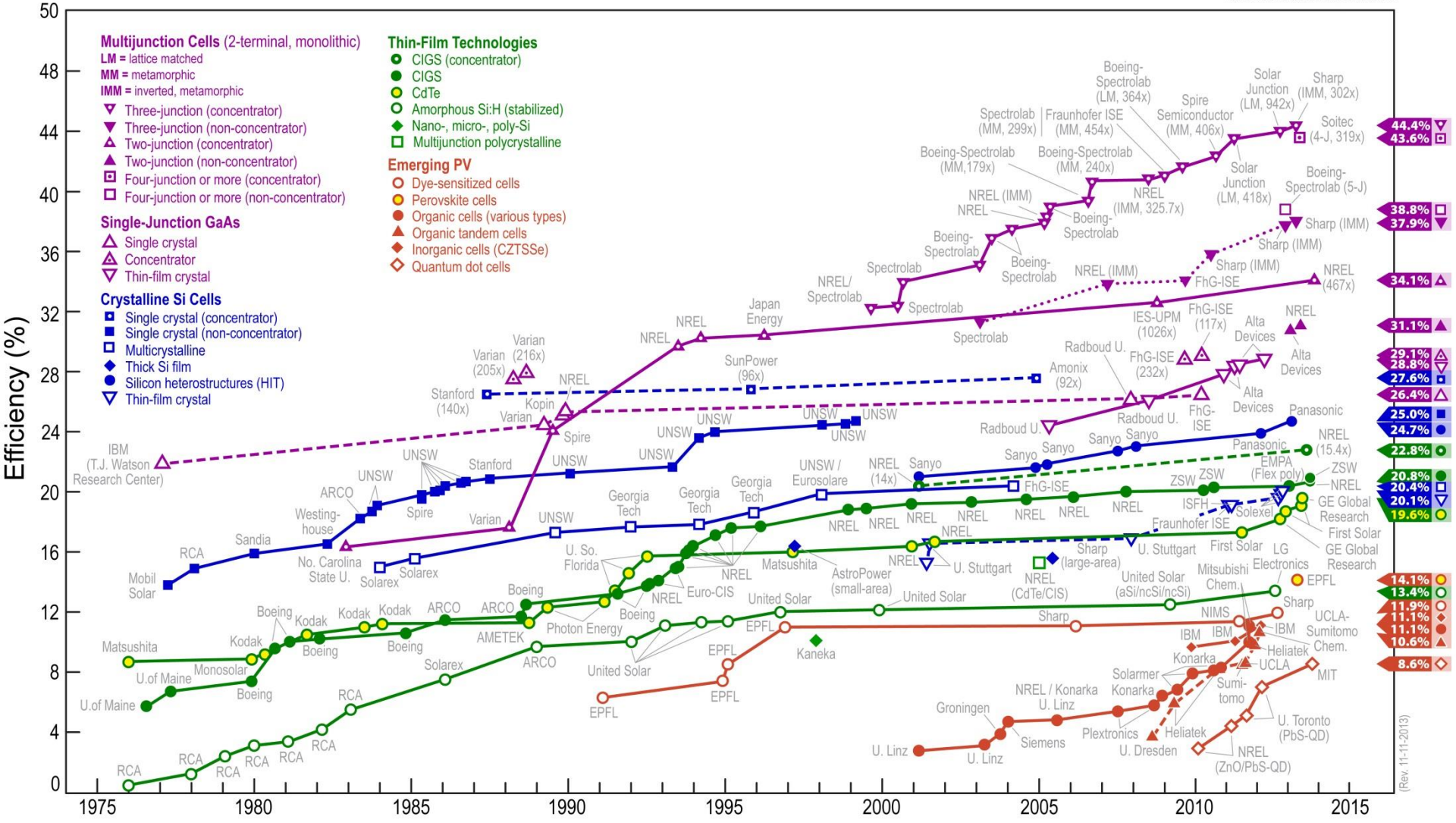


5Slide courtesy of G. Willeke

100% RE for SKA et al., Berlin, April 7, 2011

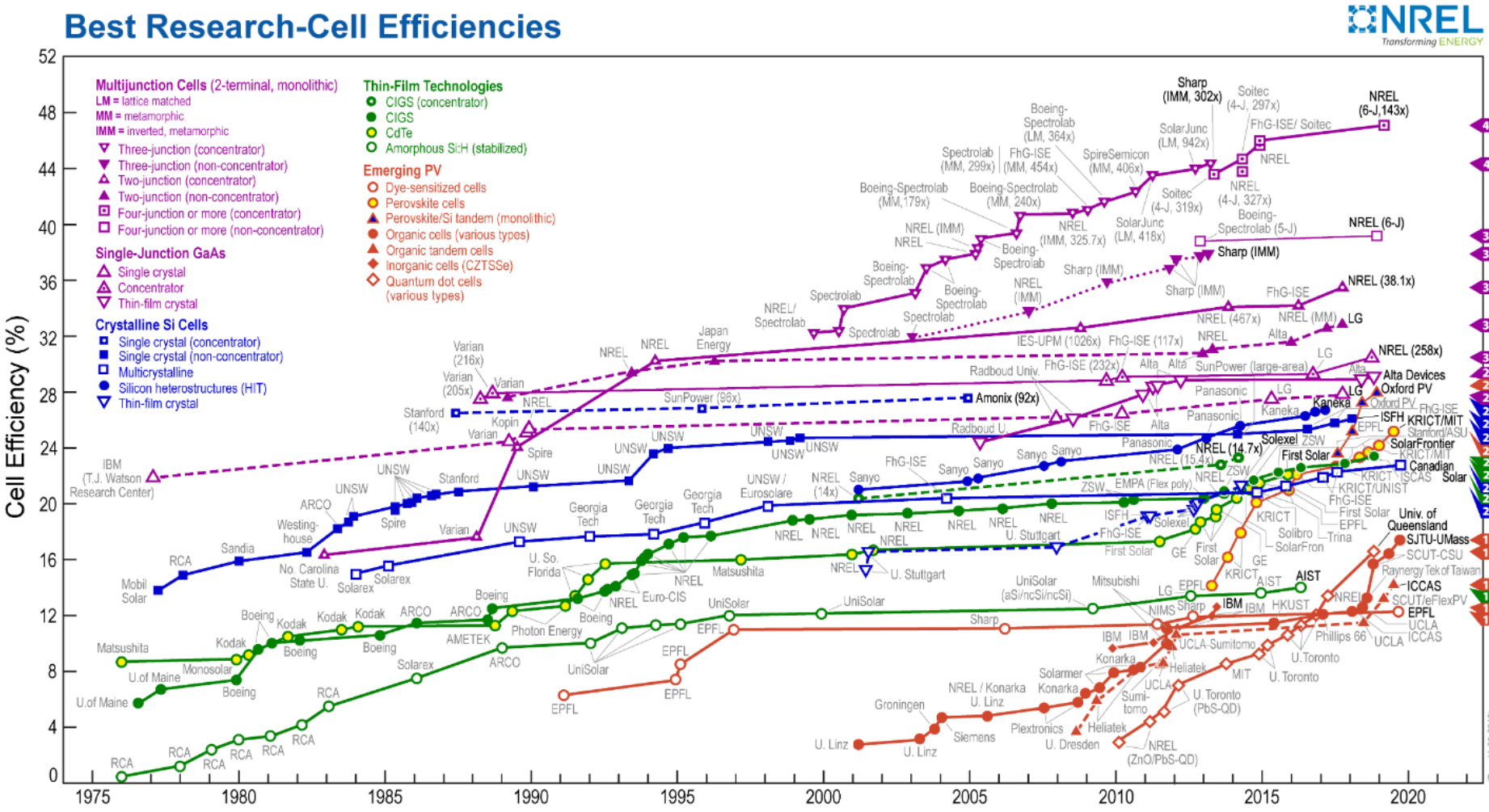
Prof. M. Kamińska

Best Research-Cell Efficiencies



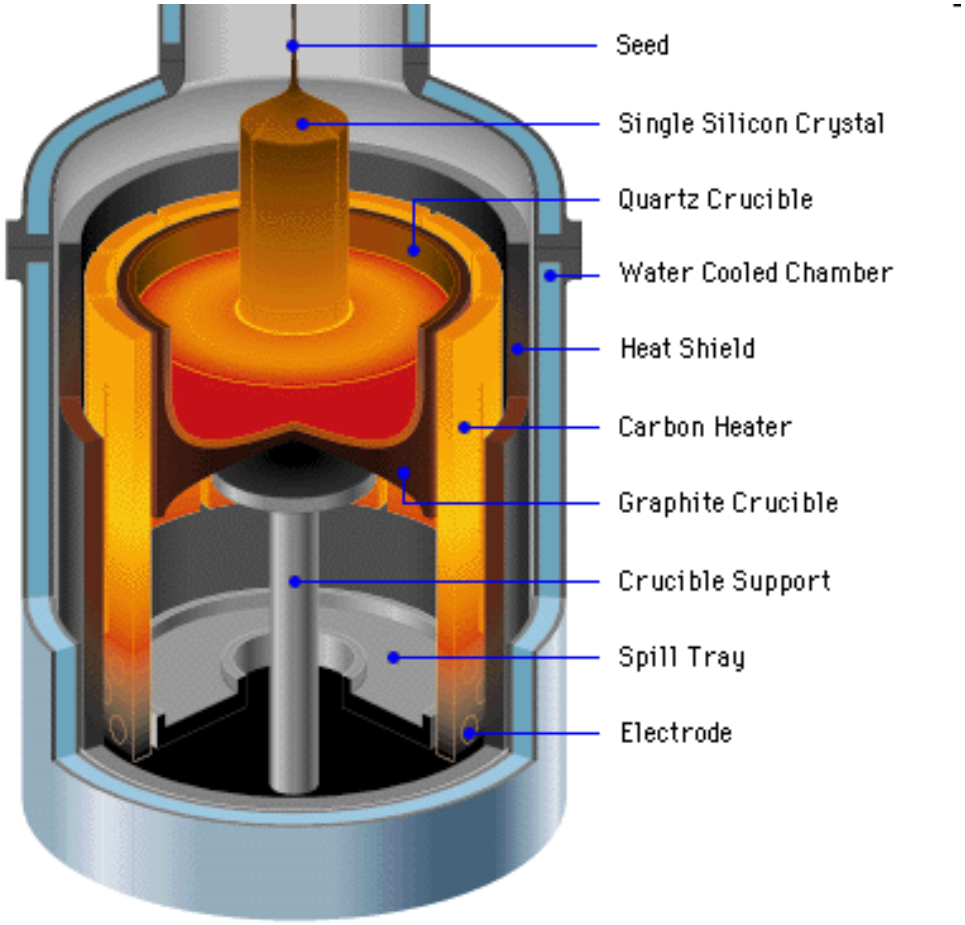
http://www.nrel.gov/ncpv/images/efficiency_chart.jpg

Best Research-Cell Efficiencies

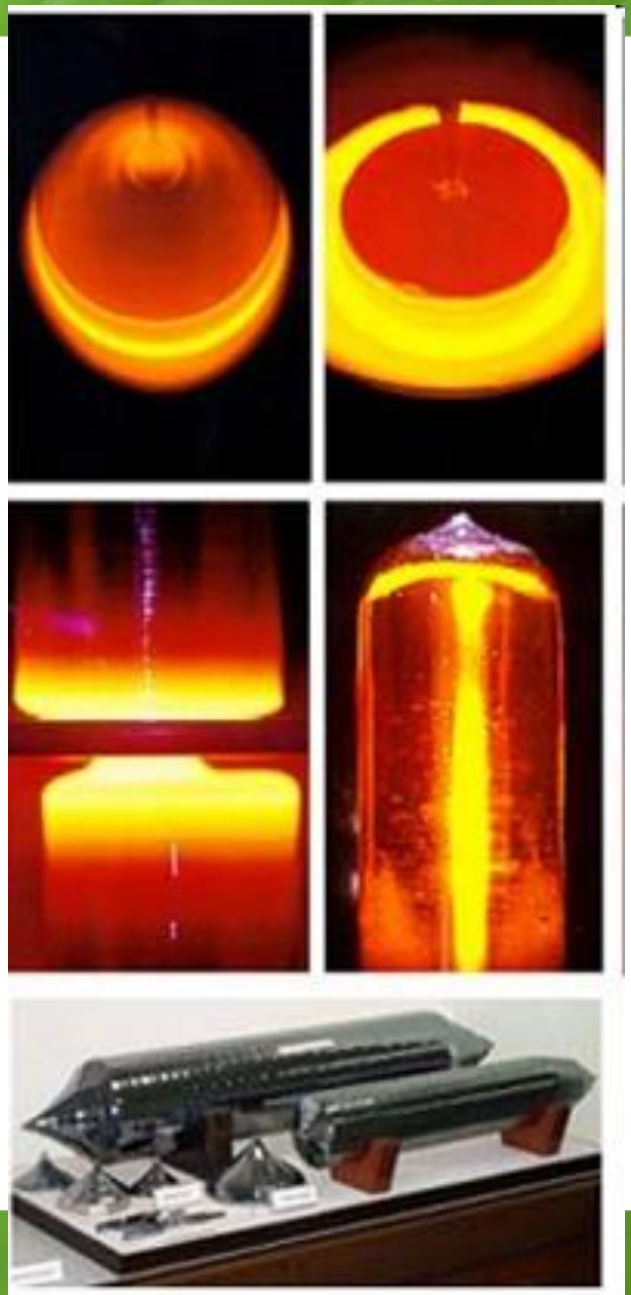


https://www.nrel.gov/pv/assets/pdfs/best-research-cell-efficiencies.20191106.pdf

Metoda Czochralskiego



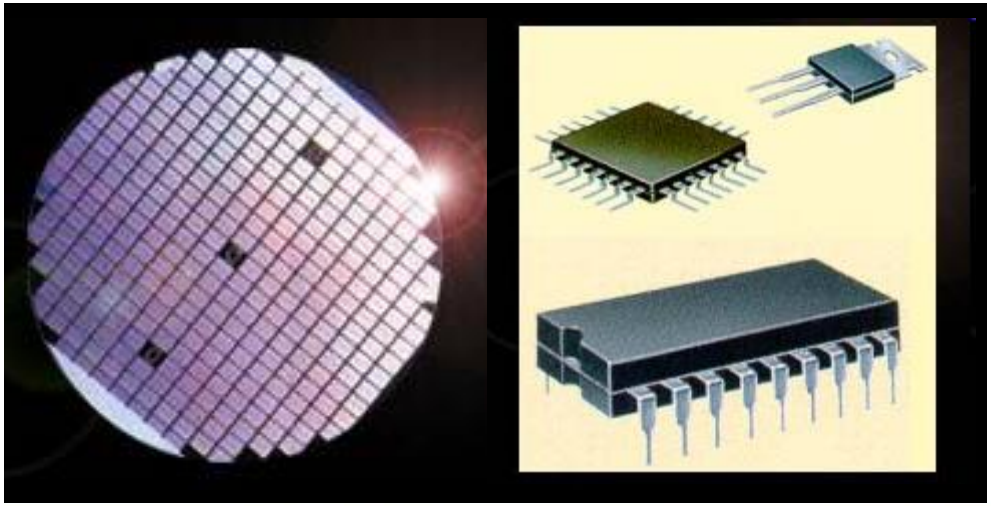
http://people.seas.harvard.edu/~jones/es154/lectures/lecture_2/materials/materials.html



http://www.sehmy.com/Product/abtWafers.htm

Metoda Czochralskiego

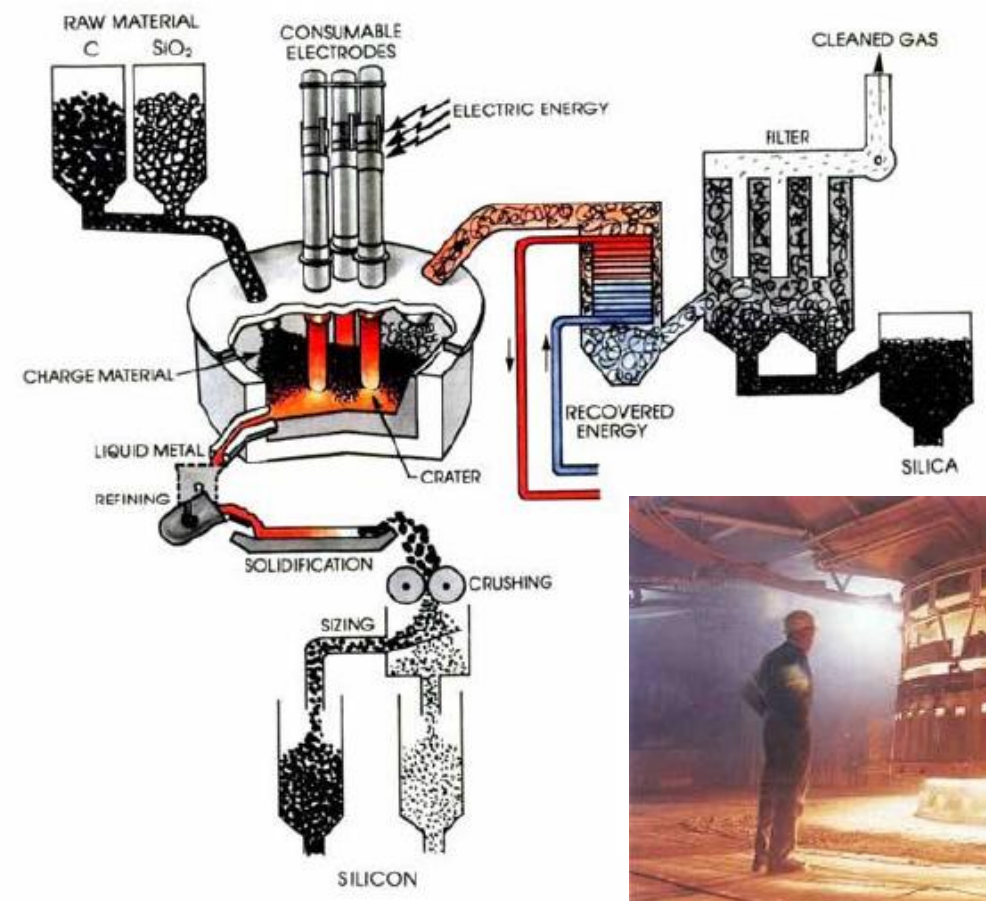
http://www.sehmy.com/Product/abtWafers.htm



Fotowoltaika

Fotowoltaika

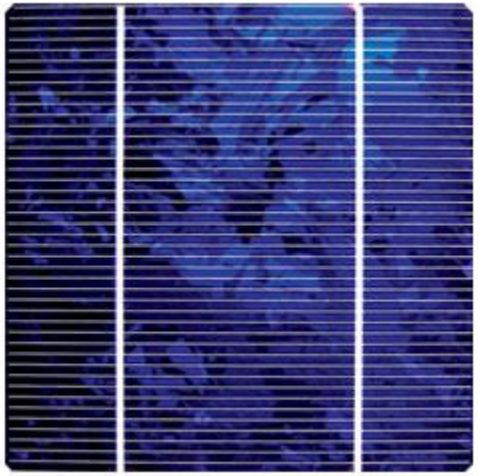
Fotowoltaika



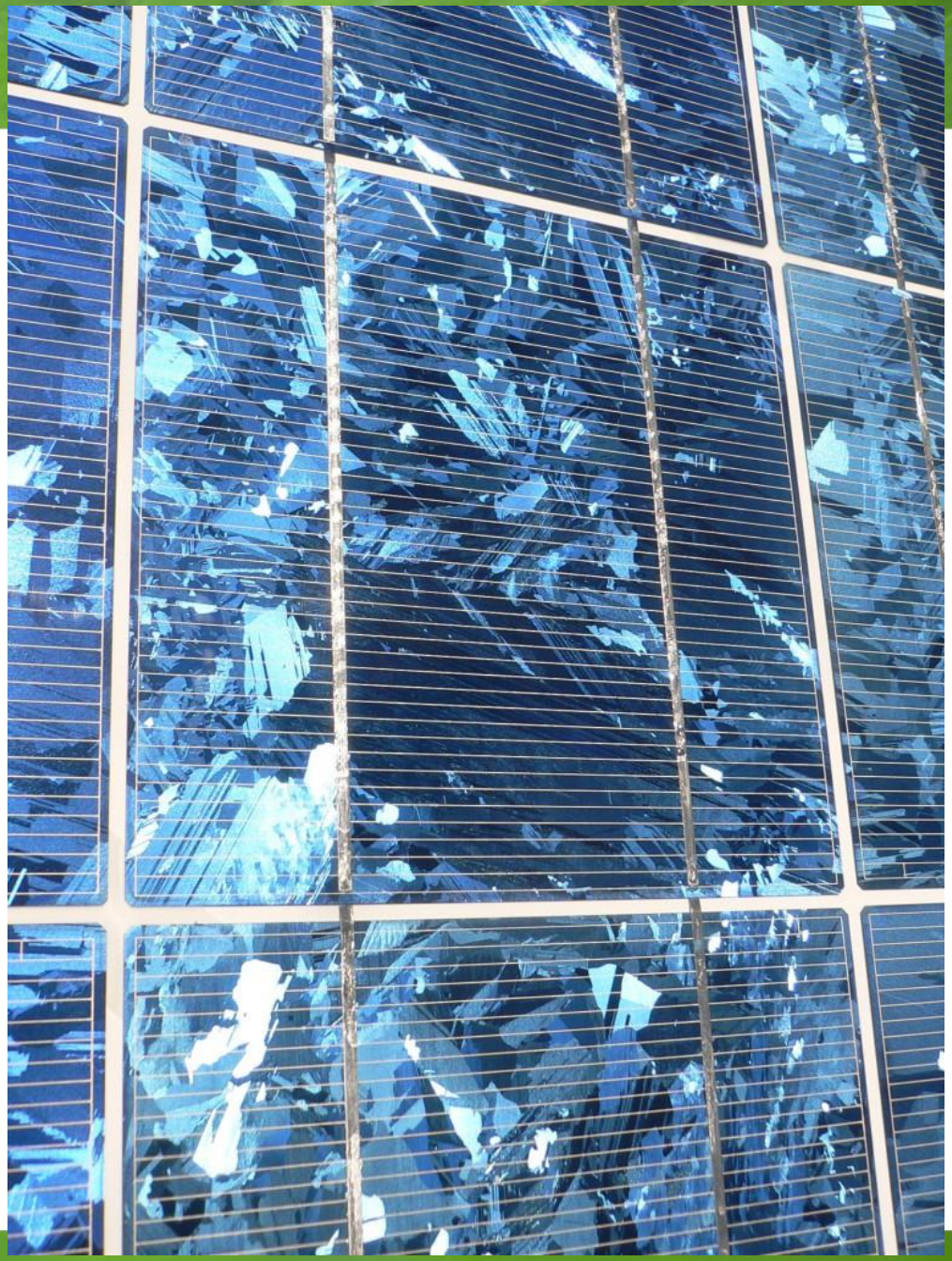
Metallurgical grade silicon is commercially prepared by the reaction of high-purity silica with wood, charcoal, and coal in an electric arc furnace using carbon electrodes. At temperatures over 1,900°C, the carbon in the aforementioned materials and the silicon undergo the chemical reaction:
$SiO_2 + 2\ C \rightarrow Si + 2\ CO$.

Figure 1: Schematic representation of a furnace for production of metallurgical grade silicon. Reproduced from Schei A, Tuset J, Tveit H, *Production of High Silicon Alloys*, Tapir forlag, Trondheim (1998).

Fotowoltaika



Komórka fotowoltaiczna z monokrystalicznego Si



Olmedilla, Spain

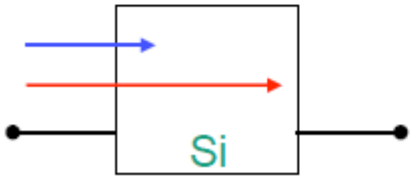
The efficiency limit for a single-material PV Cell

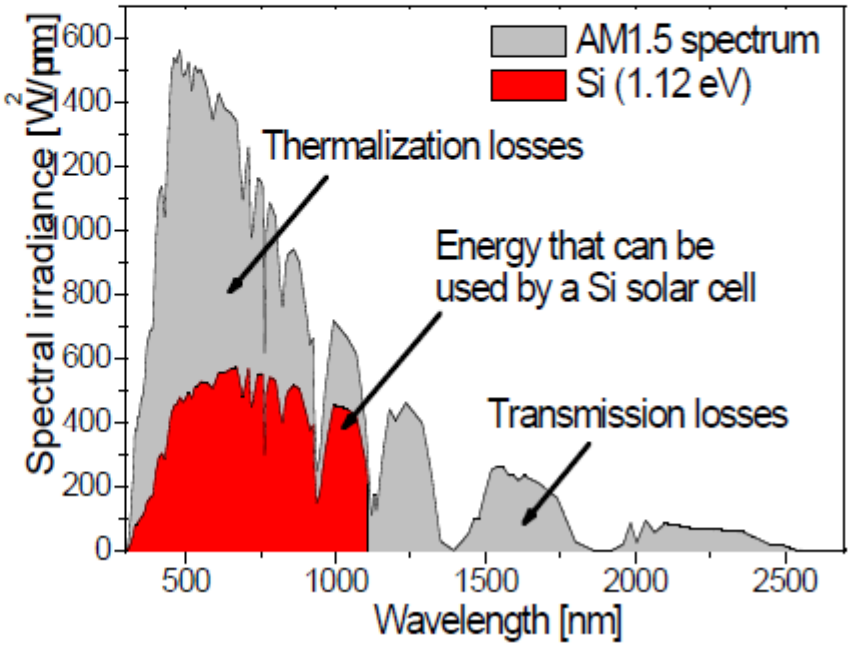
For Silicon:

(AM1.5g, 1000 W/m², 25°C)

$\eta_{max,\ theo}$ = 28 %

Lab cell = 24 %





http://microtec-career.com/wp-content/uploads/2012/10/Prof.-Dr.-Eicke-Weber-The-Fraunhofer-Institute-for-Solar-Energy-Systems-ISE.pdf

Fotowoltaika

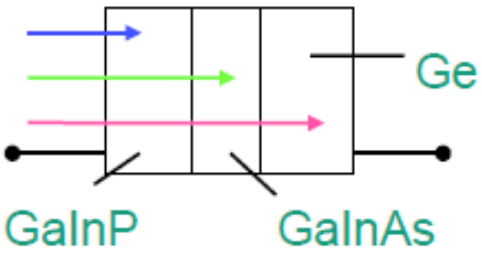
For triple-junction concentrator cells:

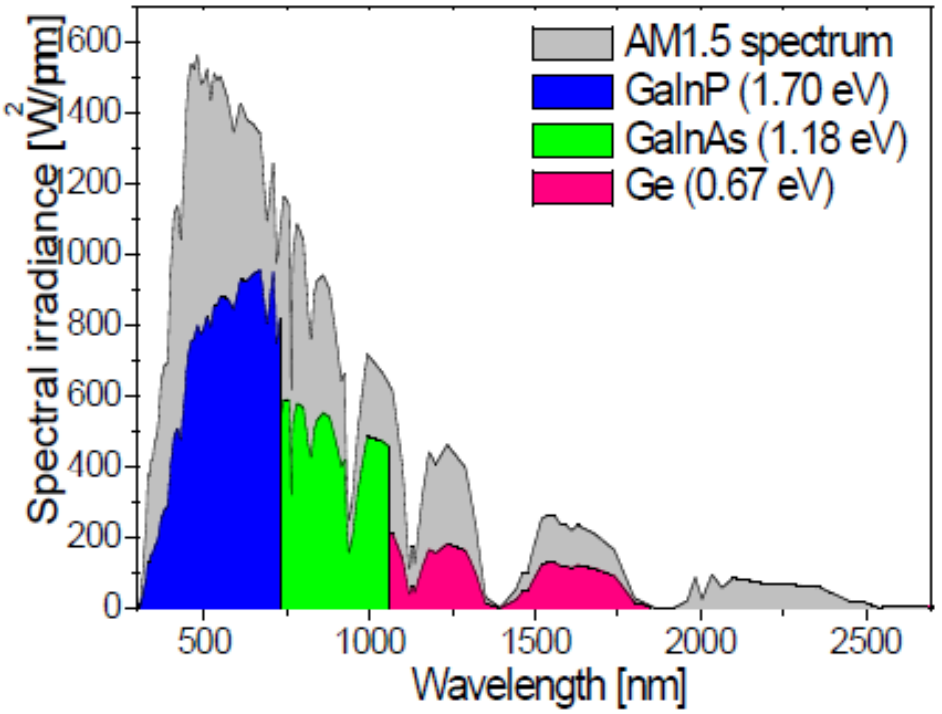
$\eta_{max,\ theo}$ = 61 %

(1000xAM1.5d, 1000 W/m²)

Lab. cell = 40.8 %

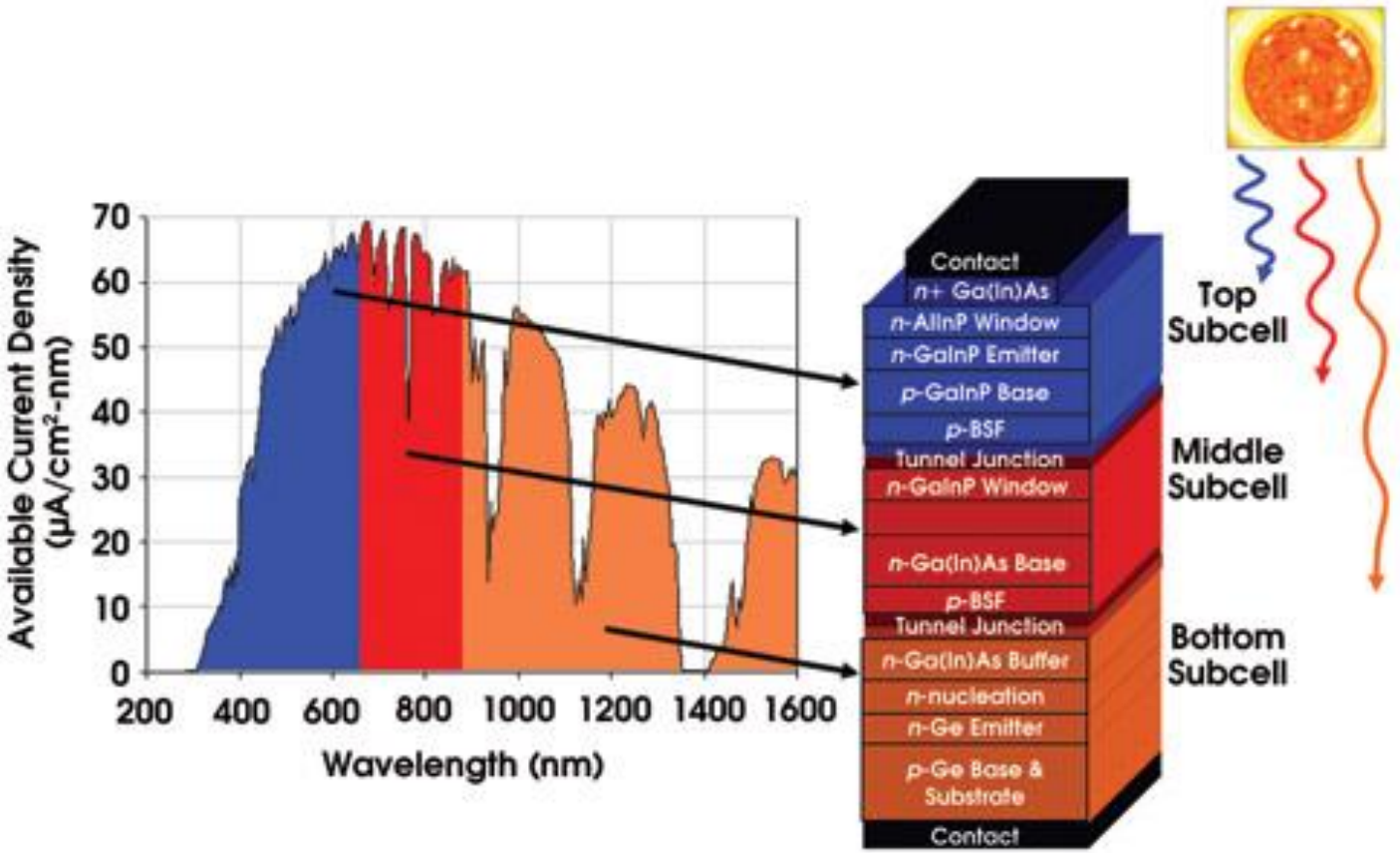
230xAM1.5d, 1000 W/m²)





http://microtec-career.com/wp-content/uploads/2012/10/Prof.-Dr.-Eicke-Weber-The-Fraunhofer-Institute-for-Solar-Energy-Systems-ISE.pdf

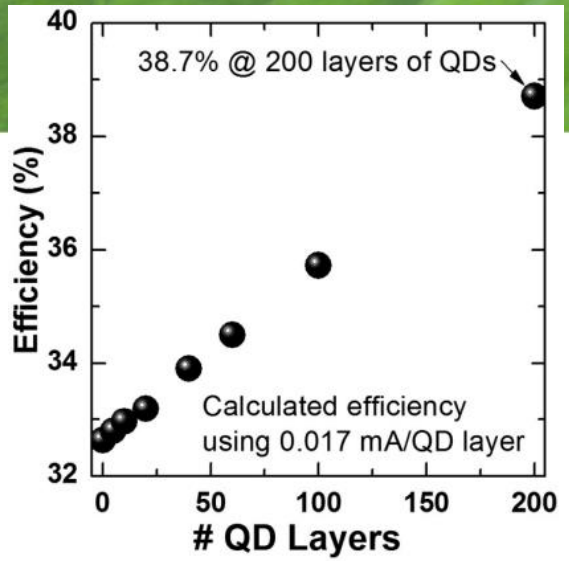
Fotowoltaika

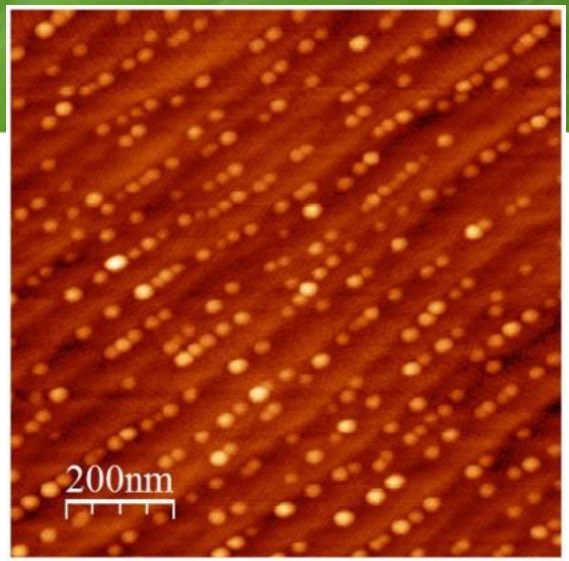


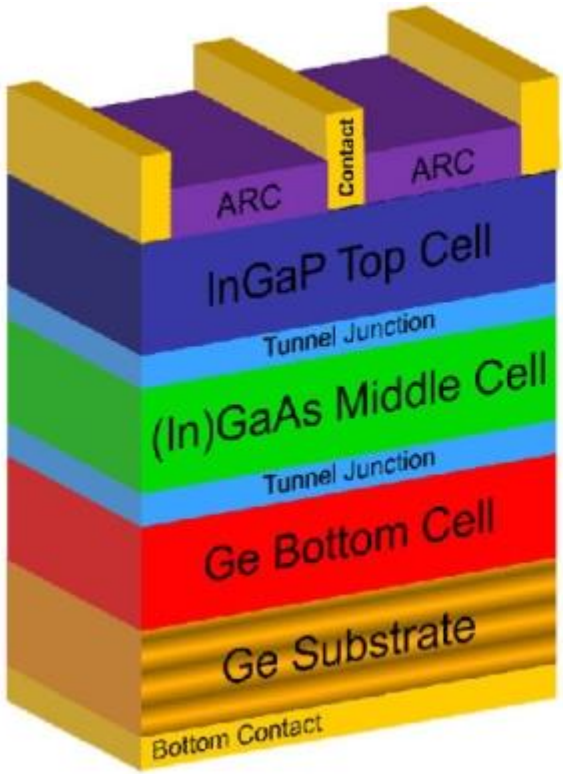
http://photonics.com/Article.aspx?AID=35235

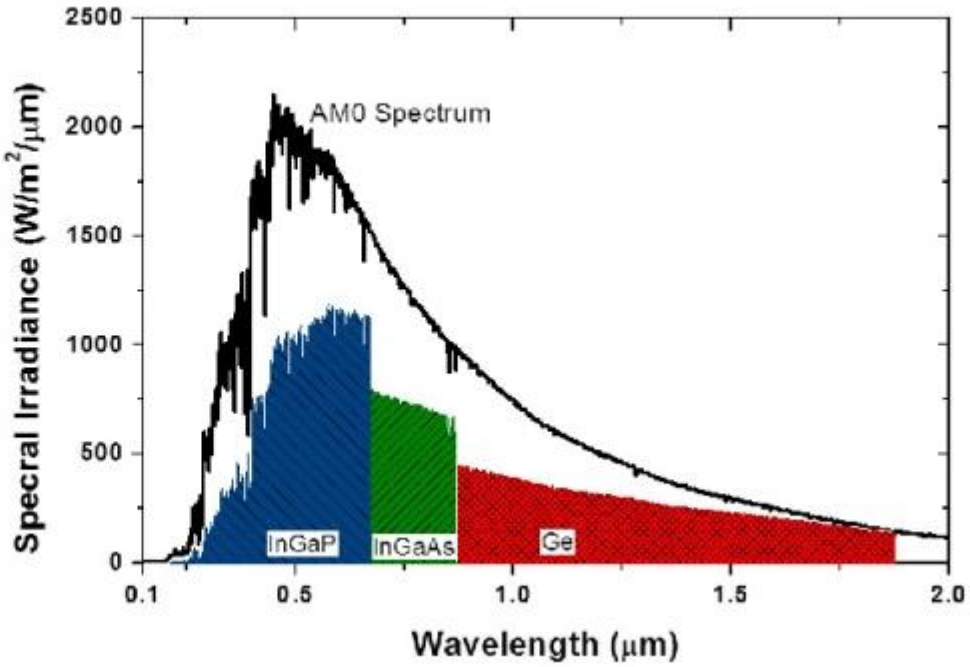
Fotowoltaika

Solar-cell-efficiency enhancement using nanostructures









//spie.org/x41195.xml

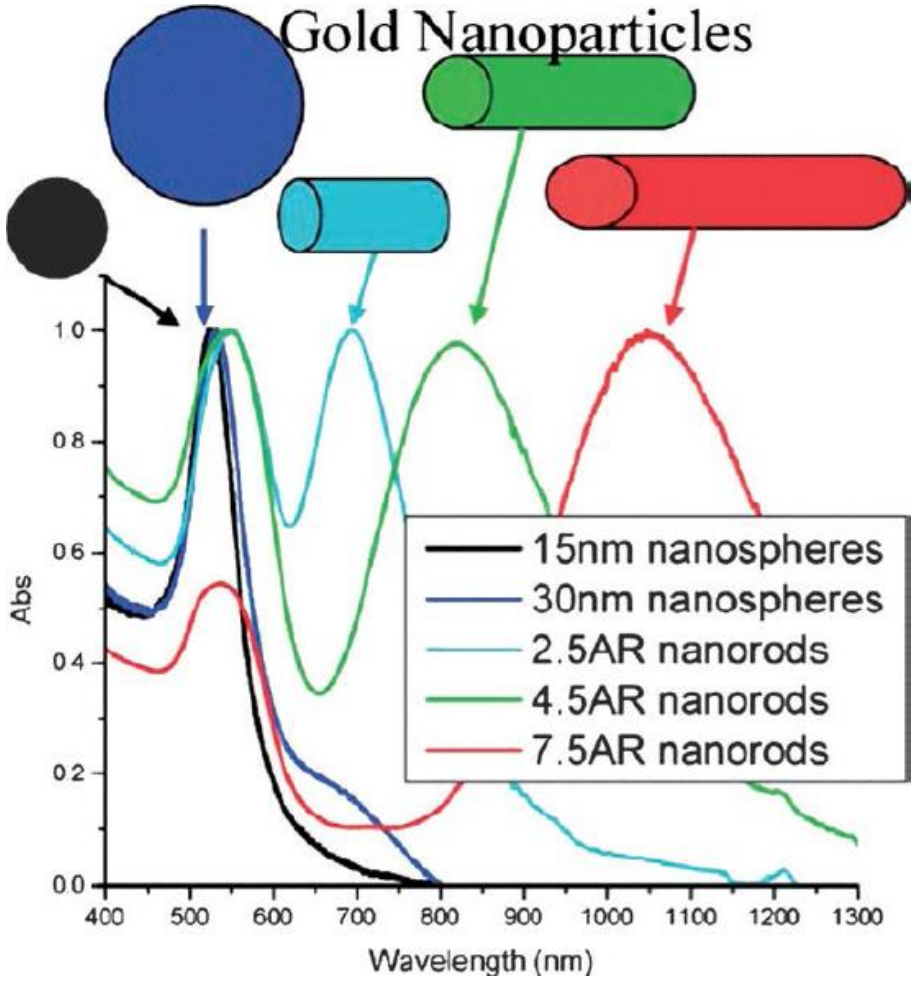
Plazmonika

The Lycurgus Cup (glass; British Museum; 4th century A. D.)

Au hydrosols prepared by M. Faraday, 1857, Royal Institution.

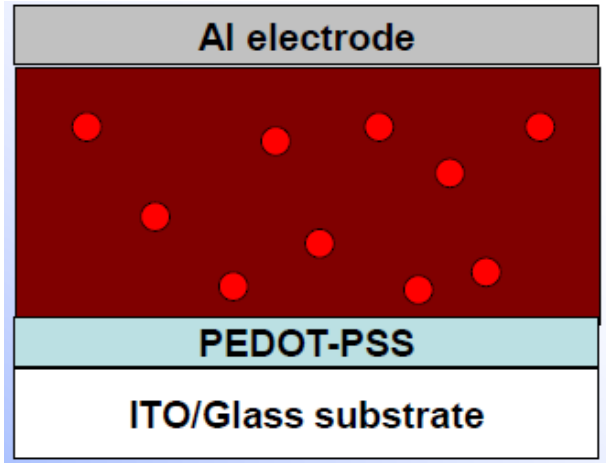
Working monk, 1480, Norwich, Anglie.

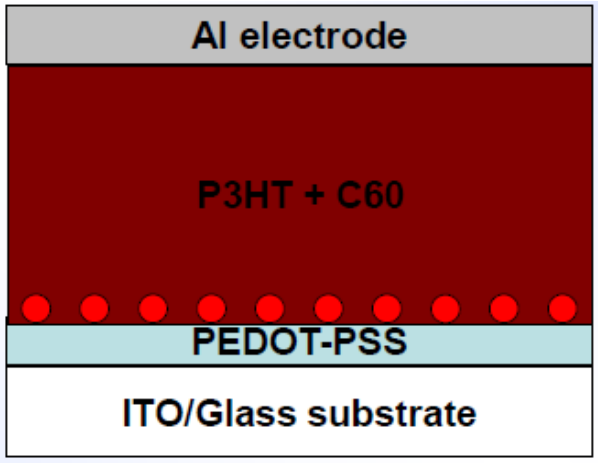
Plazmonika

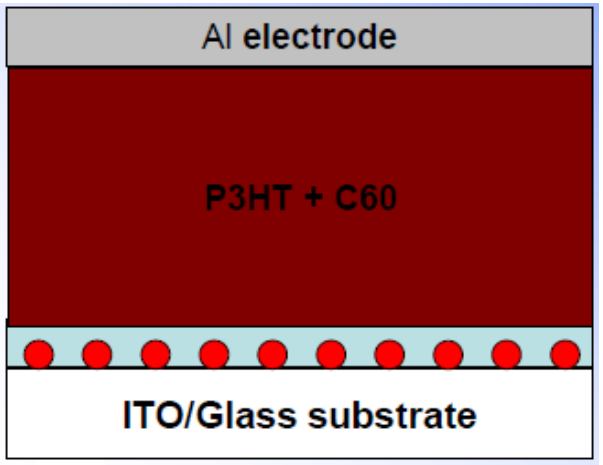


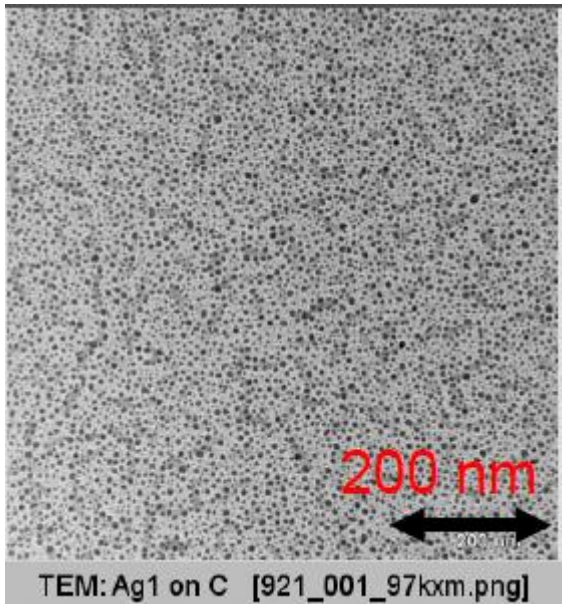
G. Walters et al. , J. Mater. Chem.2009

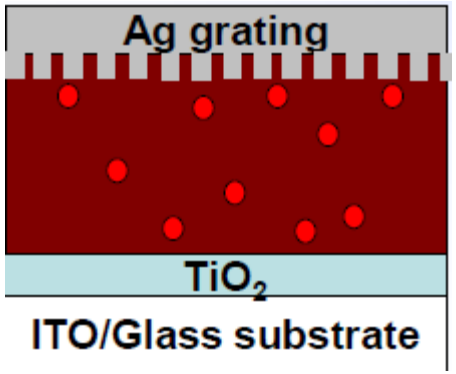
Plazmonika

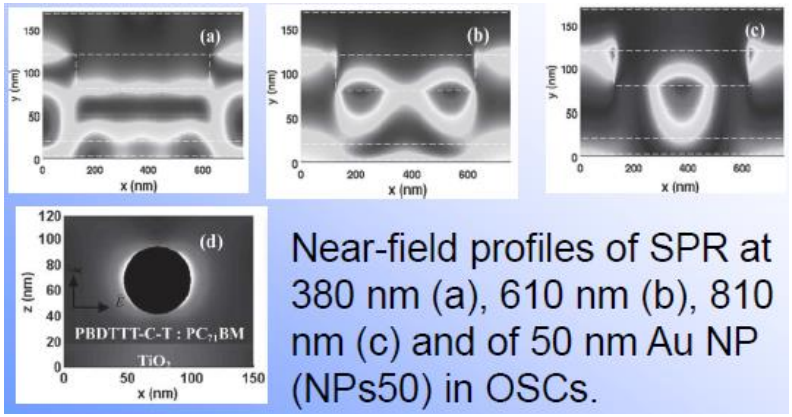










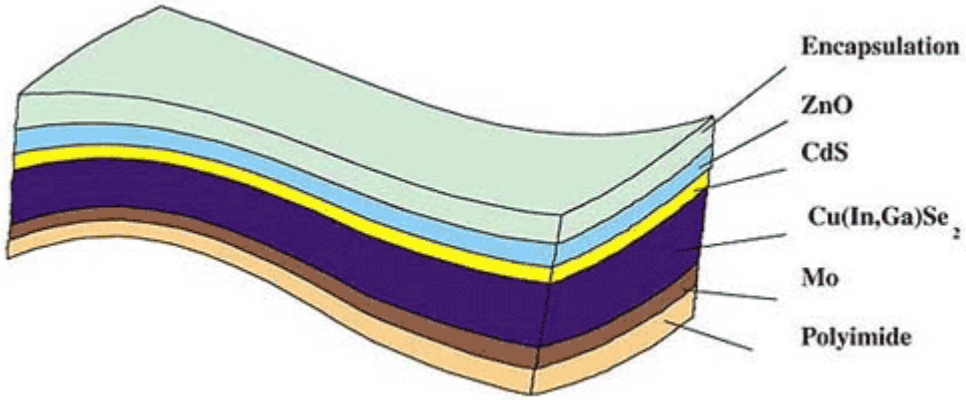


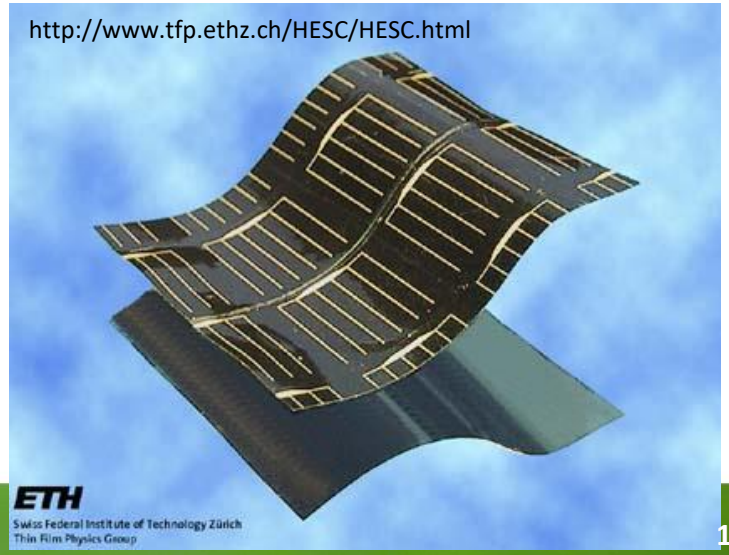
Jiří Pfleger Institute of Macromolecular Chemistry AS CR Prague, Czech Republic

Energia

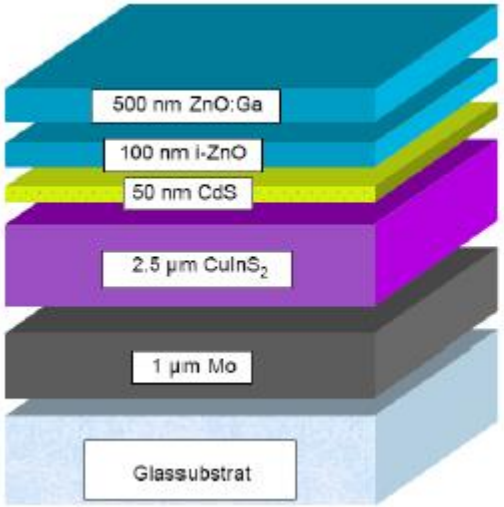
http://www.daystartech.com/lightfoil.cfm

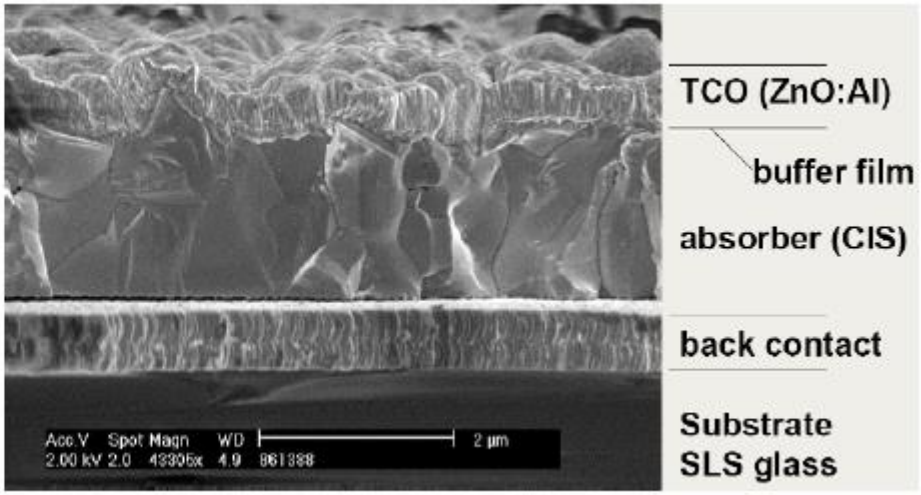
$Cu(In,Ga)Se_2$ (also called CIGS) compound semiconductor solar electricity conversion efficiency of 12.8%

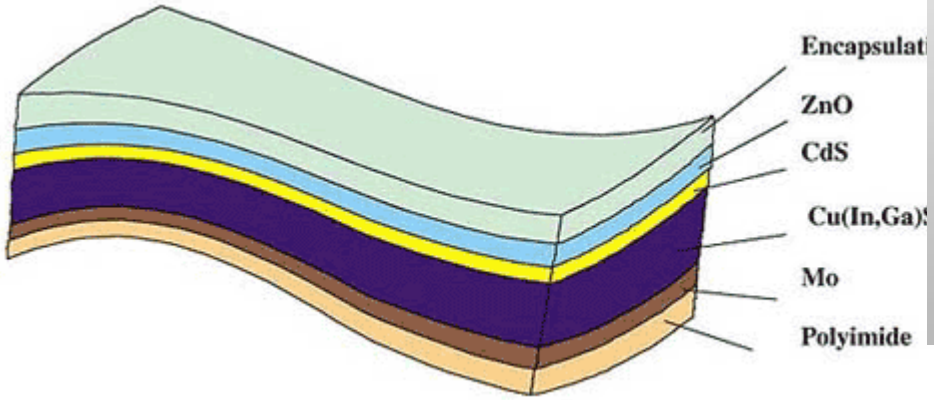


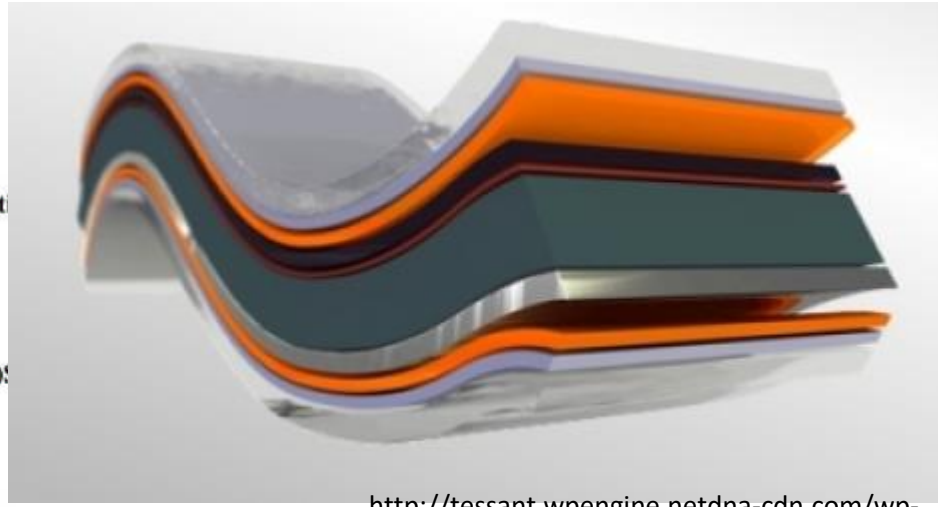


Energia









http://tessant.wpengine.netdna-cdn.com/wp-content/uploads/2013/01/cigs-flexible.jpg

Koncentratory słoneczne

Concentrator receivers from Solar Systems Pty. Ltd. of Hawthorn, Australia, are designed for utility application at 400× to 500×. Courtesy of Solar Systems Pty. Ltd., Australia.

OSC – Organic Solar Cells

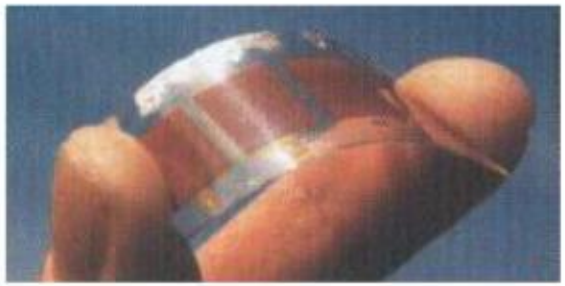
Inorganic vs. Organic Solar Cell

Inorganic Solar Cell

- Power conversion efficiency up to 24% in lab
- High energy consumption at fabrication
- Cost-intensive fabrication

Organic Solar Cell

- Only 6% achieved in lab
- Low energy consumption at fabrication
- Cheap fabrication
- Mechanical flexible on appropriate substrates



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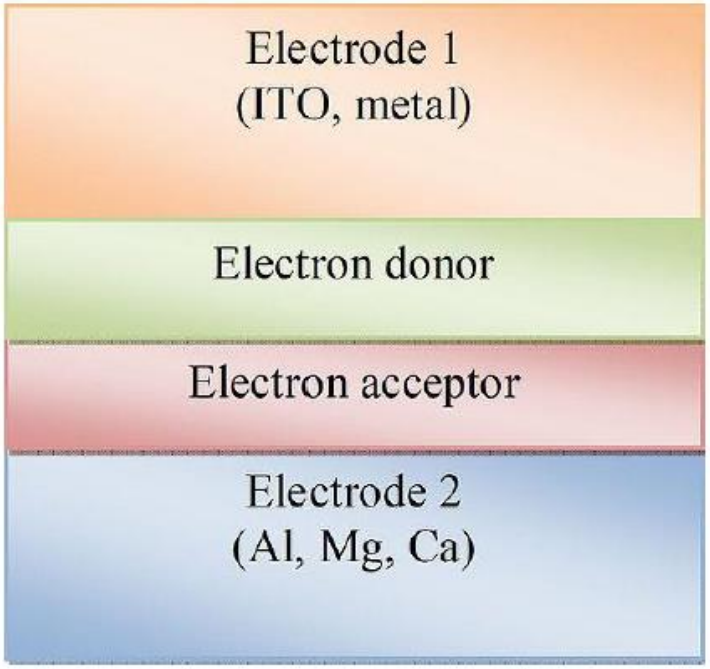
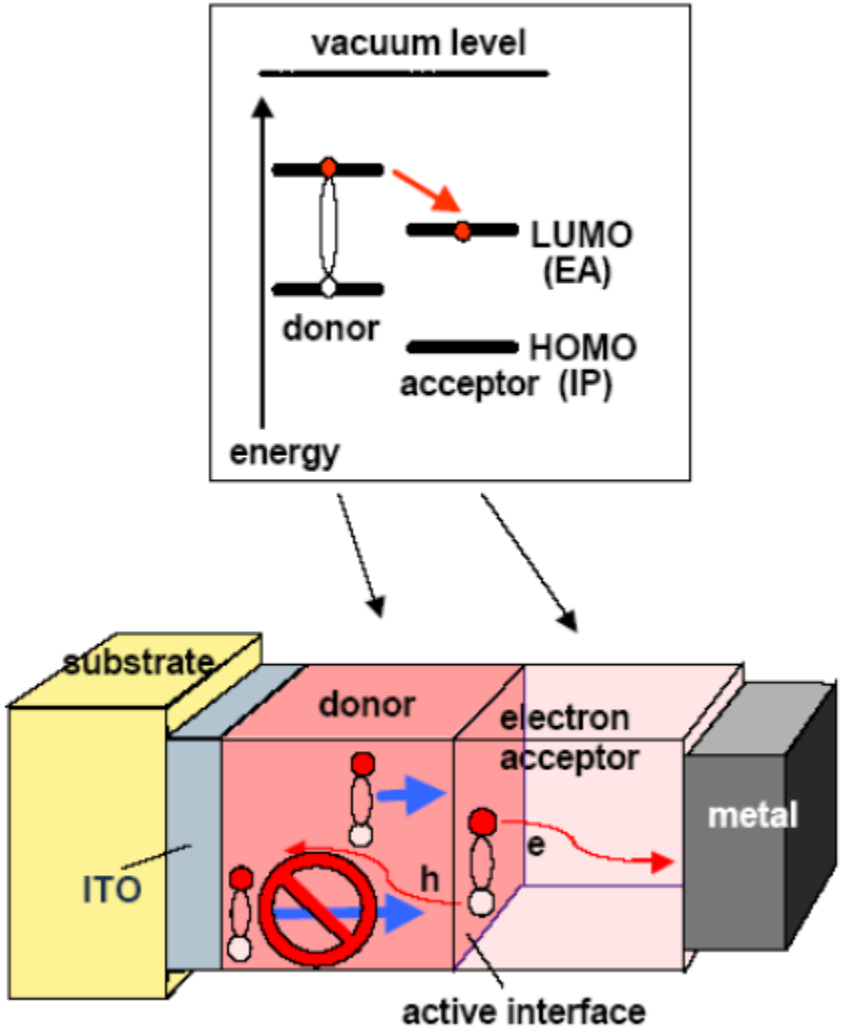
OSC – Organic Solar Cells

Bilayer organic photovoltaic cells





Problems

The diffusion length of excitons in organic electronic materials is typically on the order of 10 nm. In order for most excitons to diffuse to the interface of layers and break up into carriers, the layer thickness should also be in the same range with the diffusion length.

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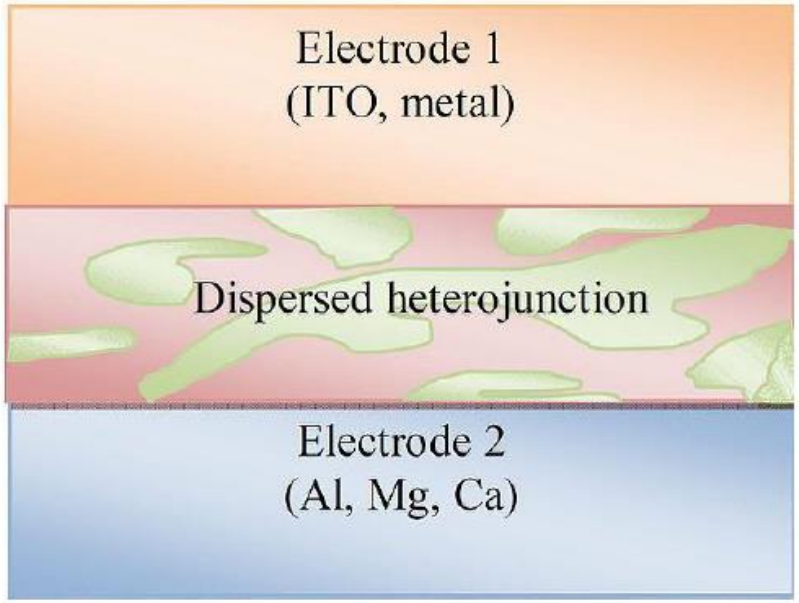
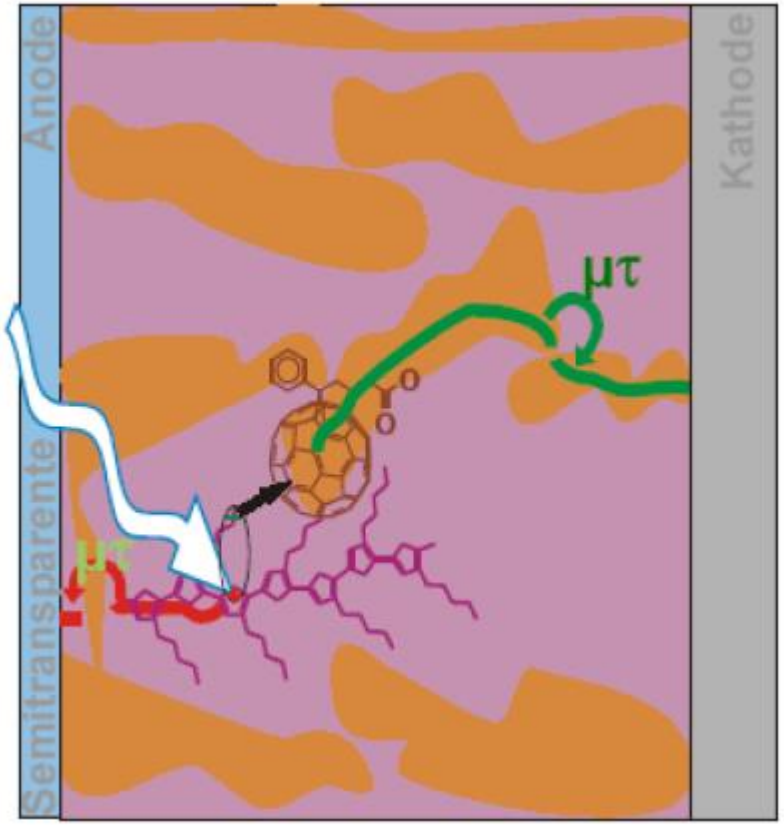
OSC – Organic Solar Cells

Bulk heterojunction photovoltaic cells





Electrons move to the acceptor domains then were carried through the device and collected by one electrode, and holes were pulled in the opposite direction and collected at the other side

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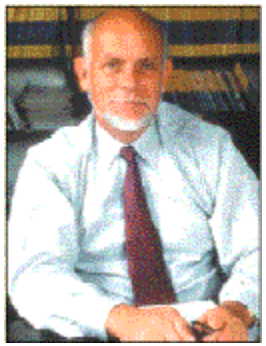
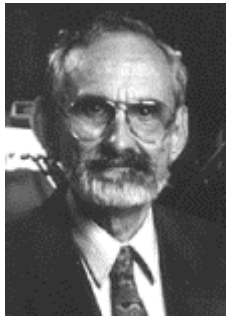
OSC – Organic Solar Cells

W latach 1975-1978, w zimnej przestrzenie międzygwiezdnej odkryto molekuły opisane formułą $HC_{2n+1}N$ (n = 2, 3, 4 i 5)

W 1985 r. Richard Smalley, Harry Kroto i Bob Curl odkryli fulereny (Nobel 1996)

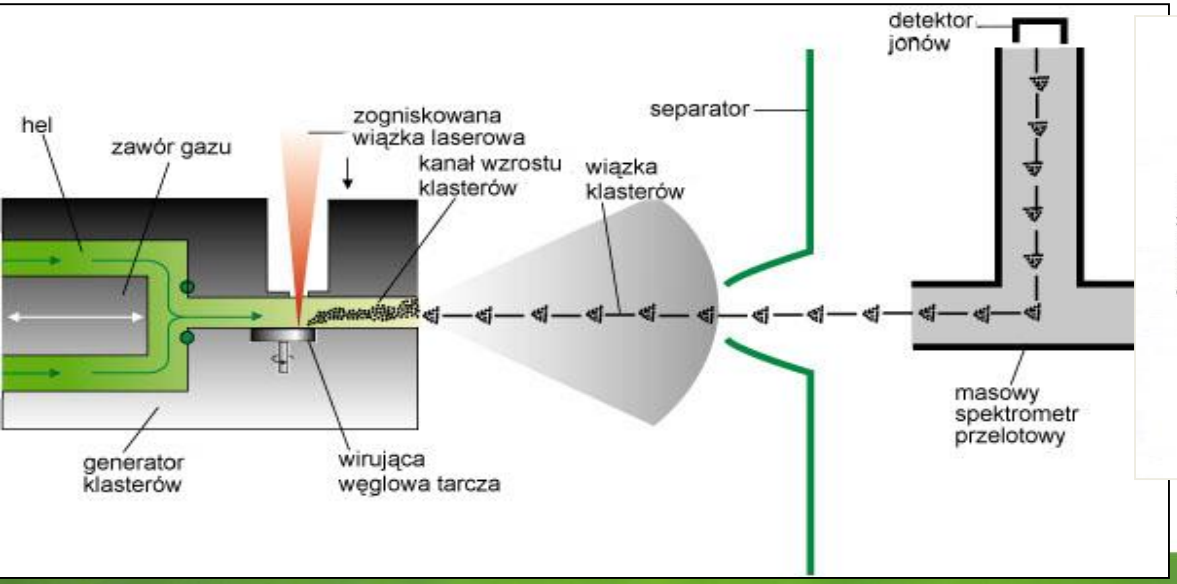


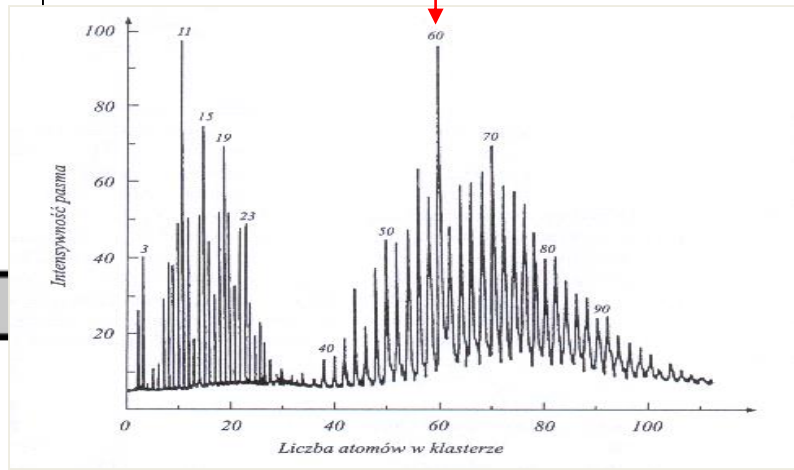


C_{2n}, n≥16

60

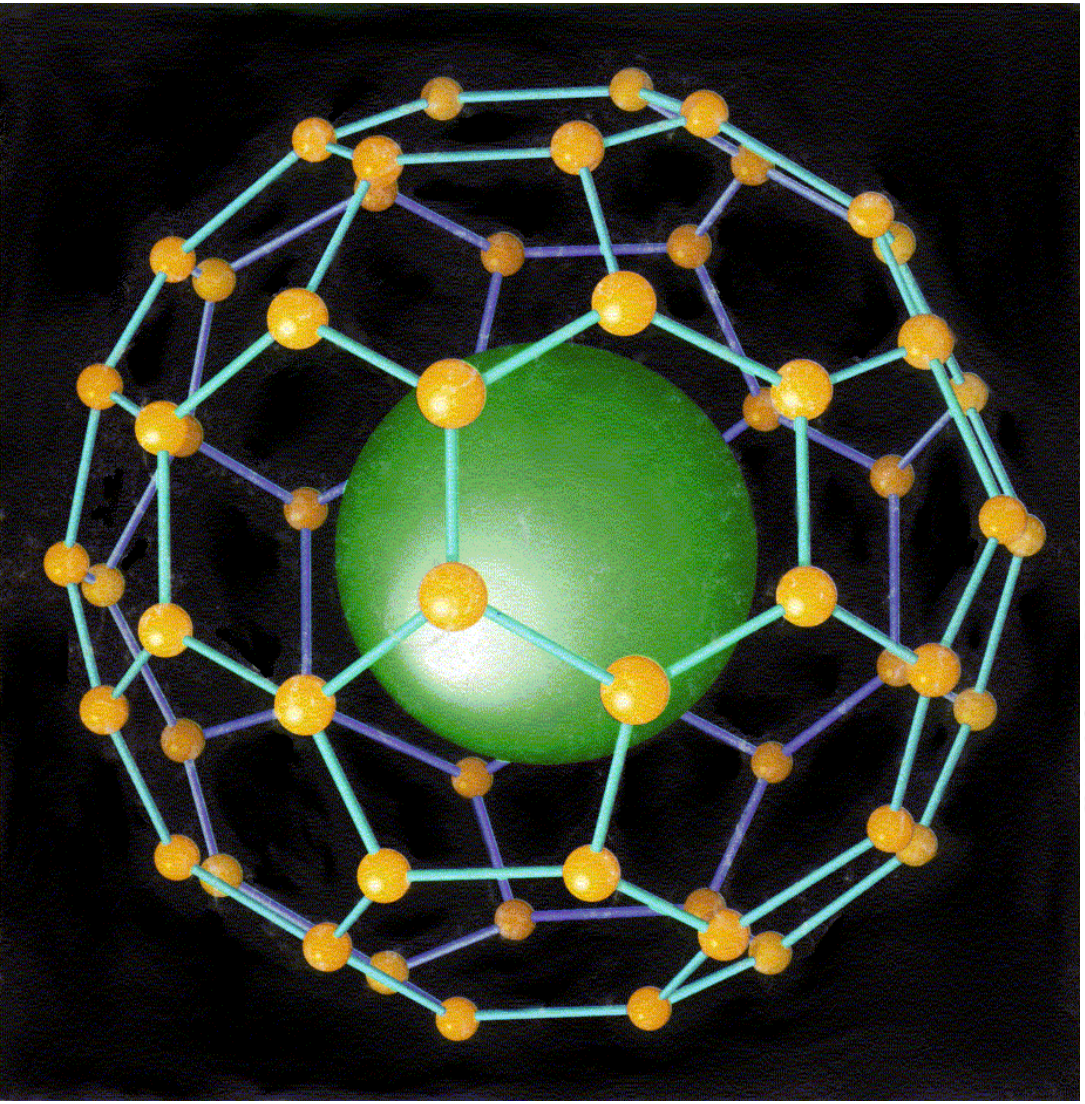
Widmo masowe





Paweł Tomasz Pęczkowski

OSC – Organic Solar Cells

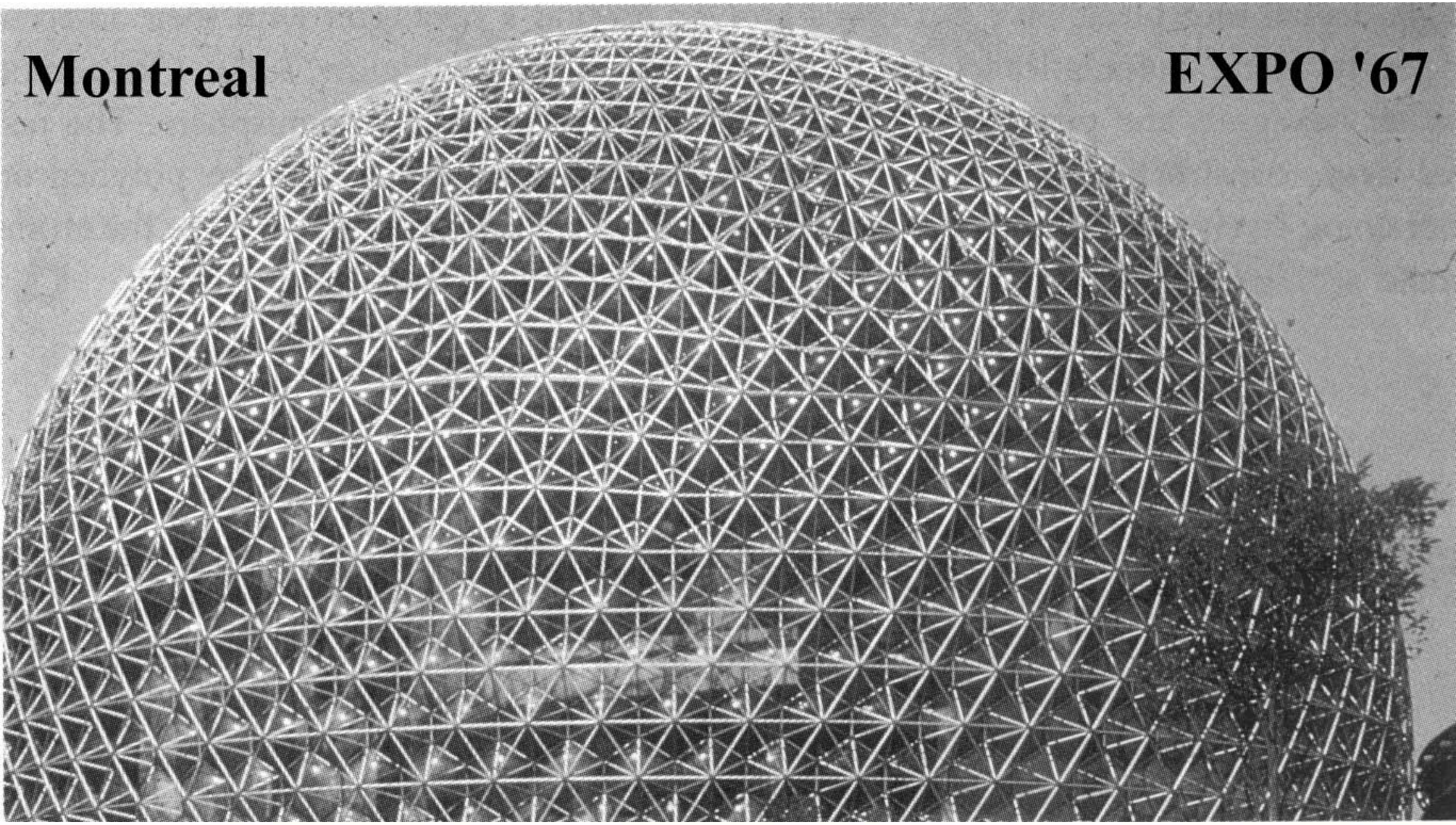


C_{60}

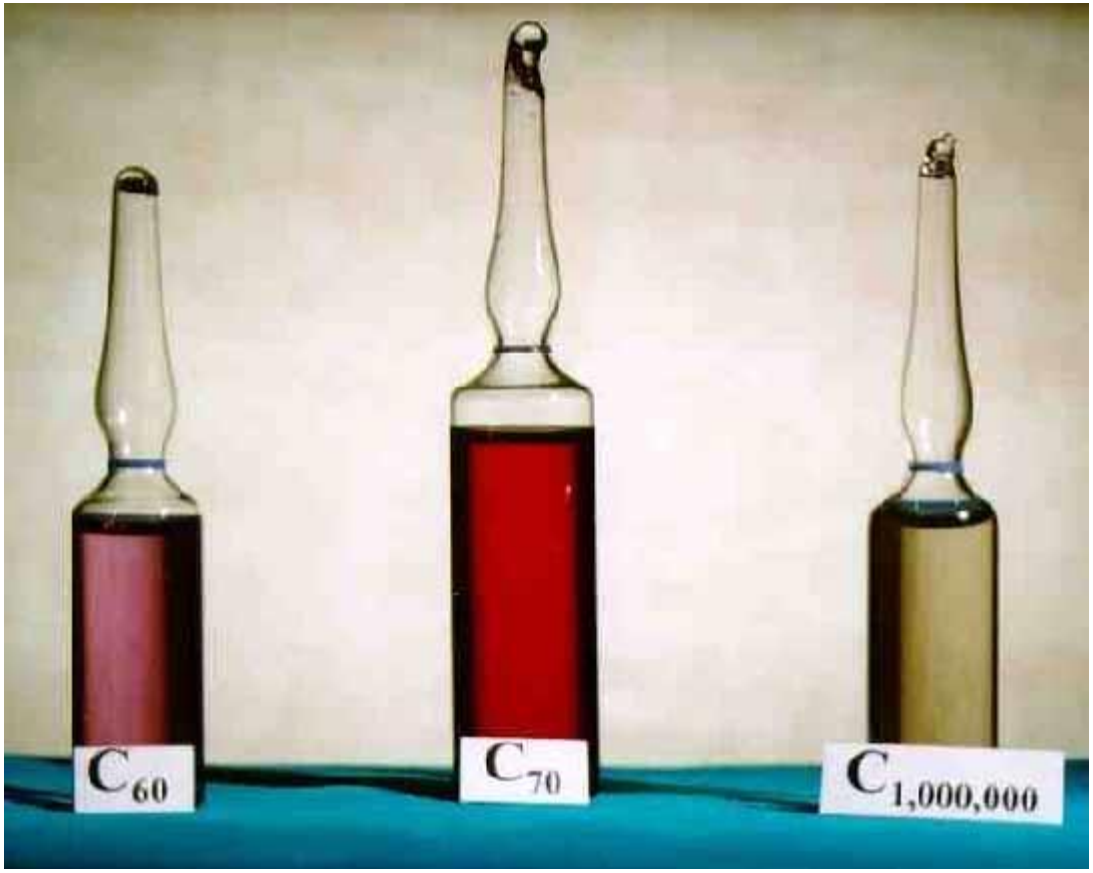
0,71 ± 0,007 nm

OSC – Organic Solar Cells

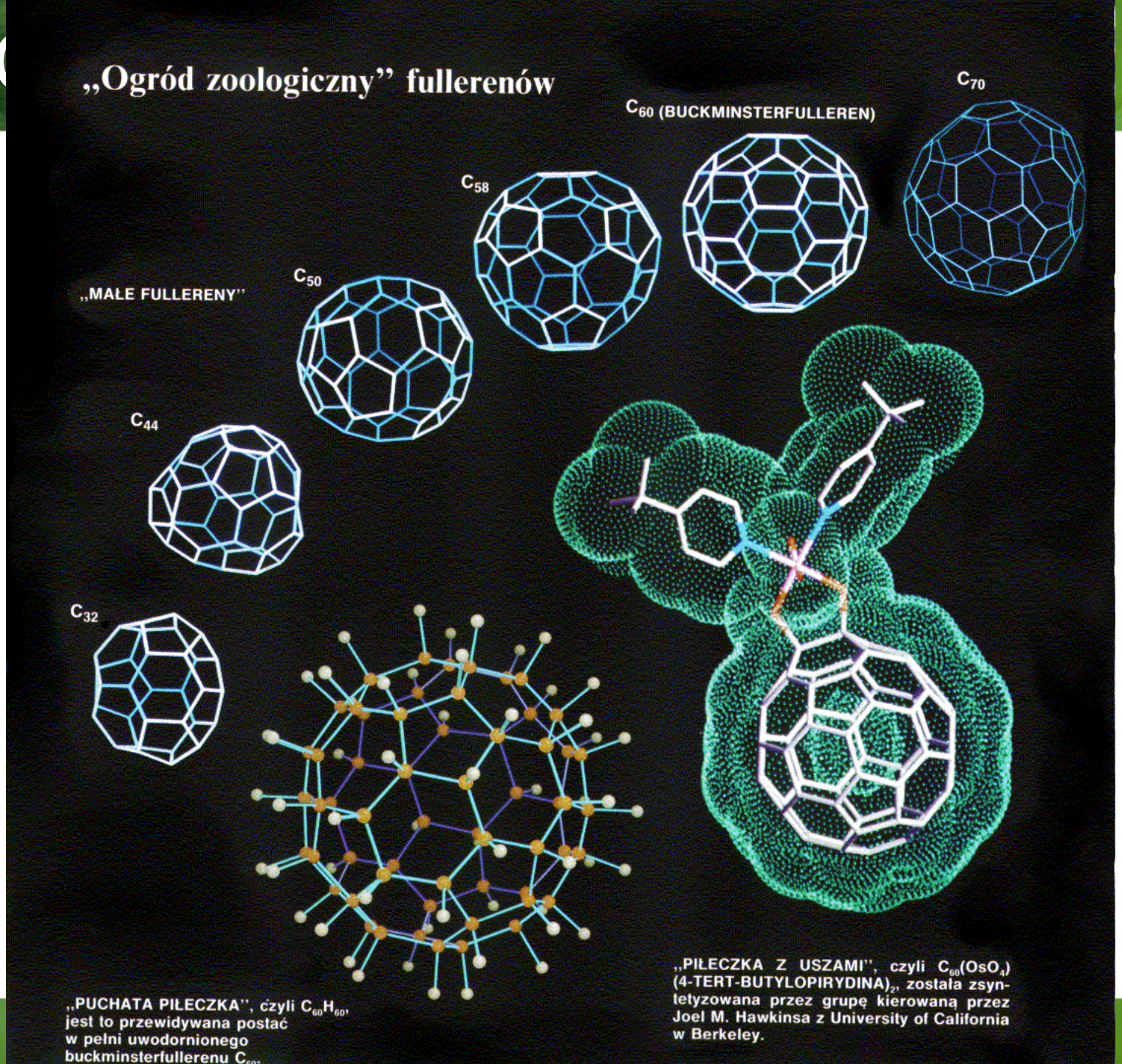
Buckminster Fuller pour un exposition en 1967 à Montréal



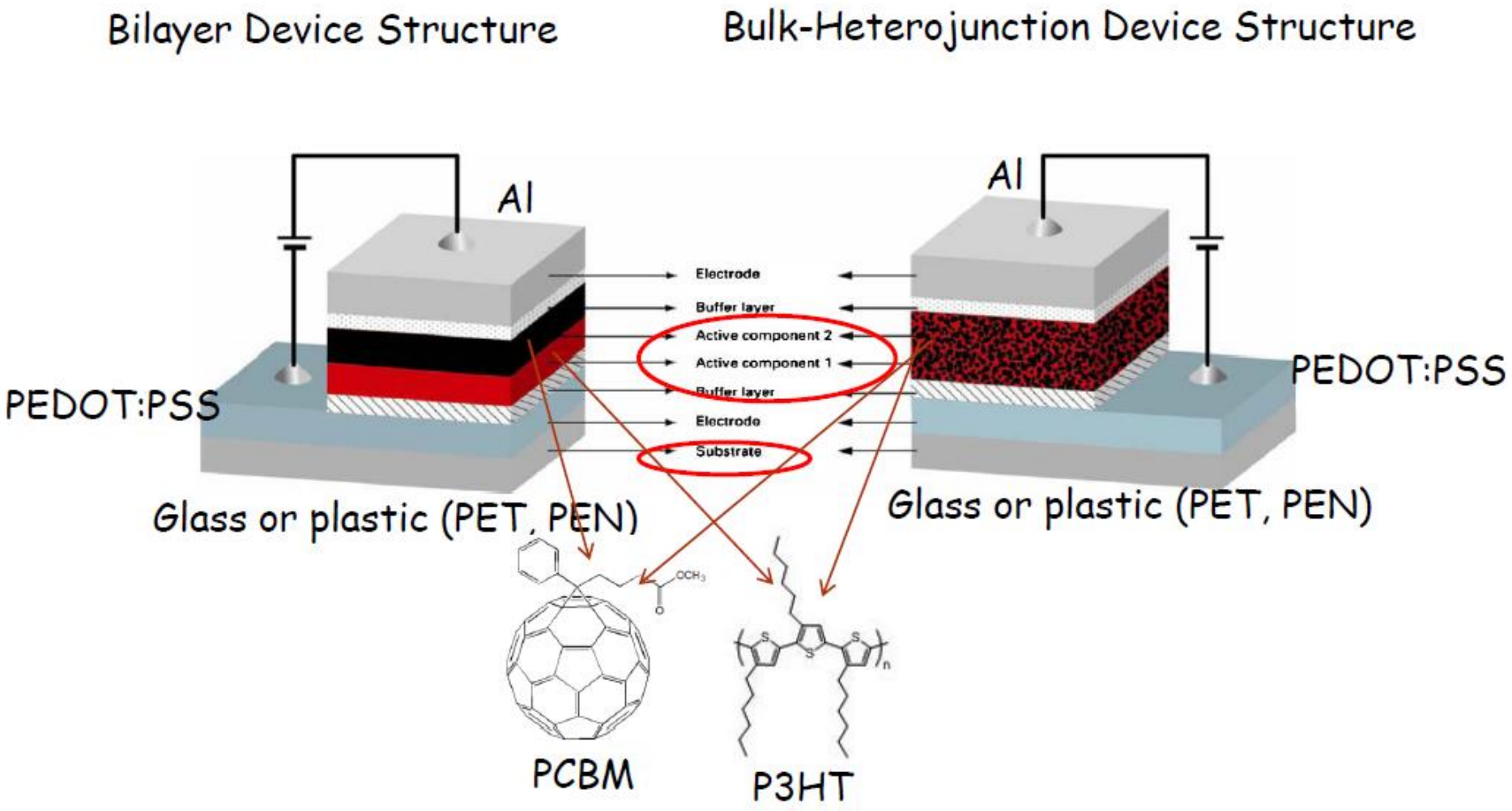
OSC – Organic Solar Cells



Roztwory w toluenie


„Ogród zoologiczny” fullerenów
C70
C60 (BUCKMINSTERFULLEREN)
C58
C50
„MAŁE FULLERENY”
C44
C32
„PUCHATA PIŁECZKA”, czyli C60H60, jest to przewidywana postać w pełni uwodornionego buckminsterfullerenu C60.
„PIŁECZKA Z USZAMI”, czyli C60(OsO4)(4-TERT-BUTYLOPIRYDINA)2, została zsyntetyzowana przez grupę kierowaną przez Joel M. Hawkinsa z University of California w Berkeley.

OSC – Organic Solar Cells



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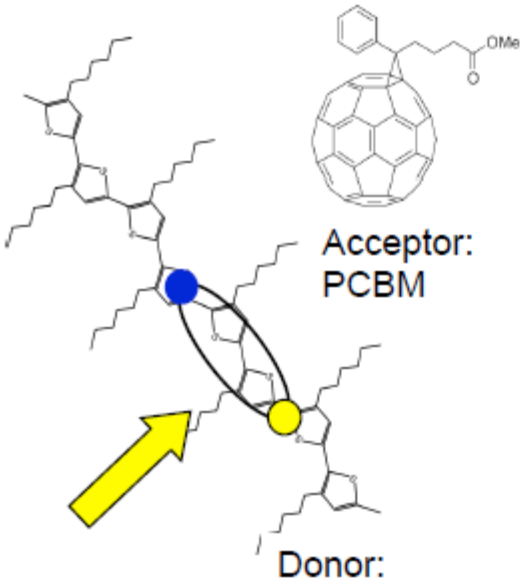
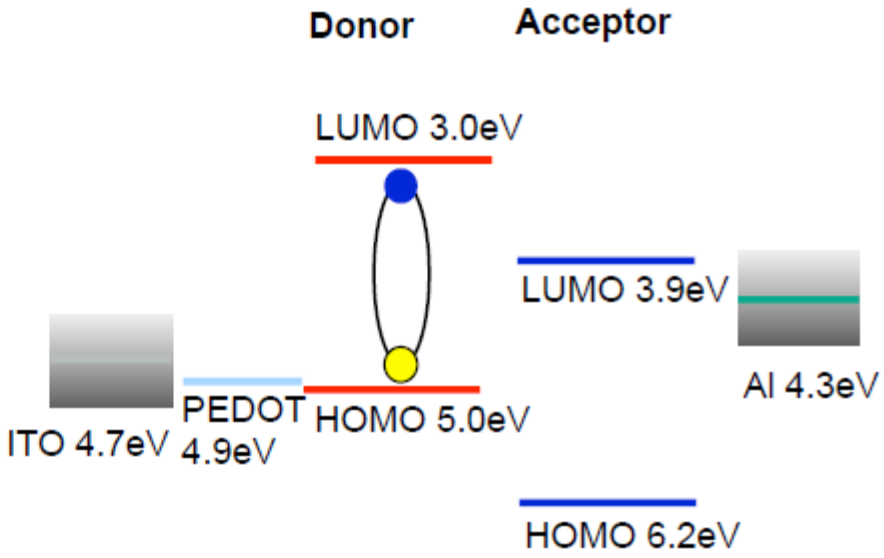
OSC – Organic Solar Cells

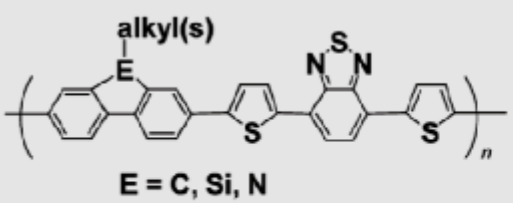


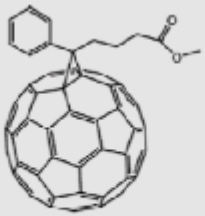


Polymer Donor + Acceptor

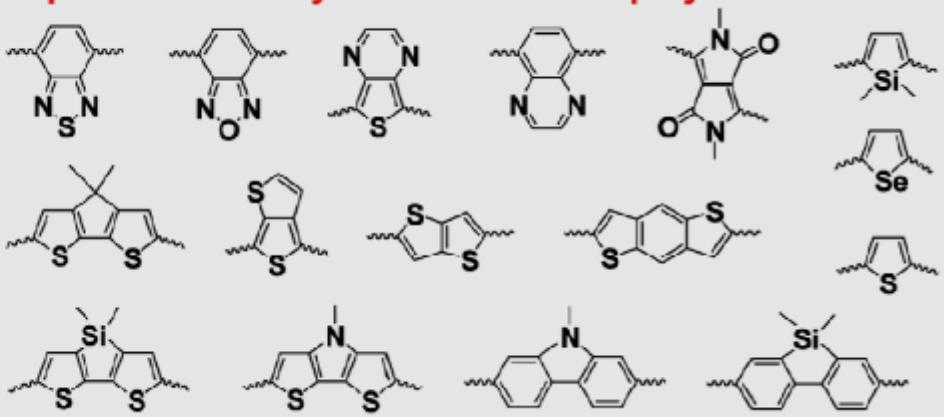
↓

Polymeric Bulk-Heterojunction Solar Cell



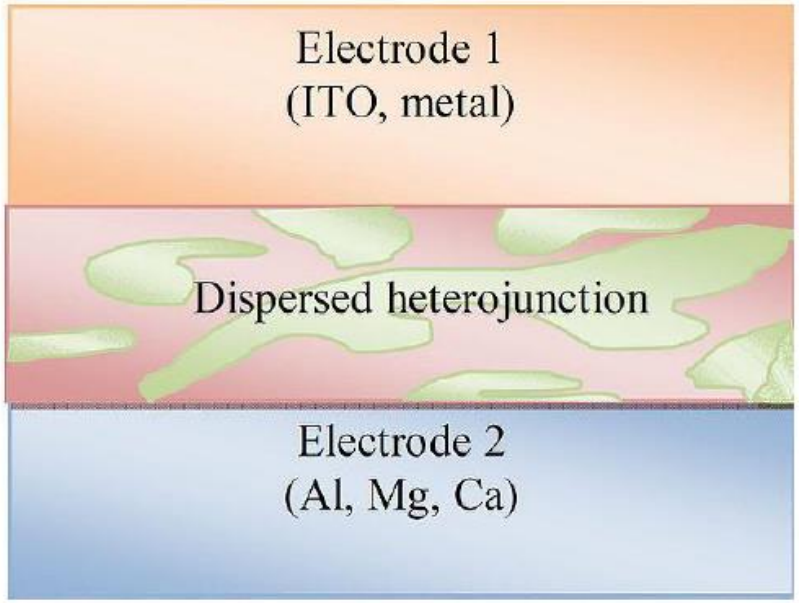


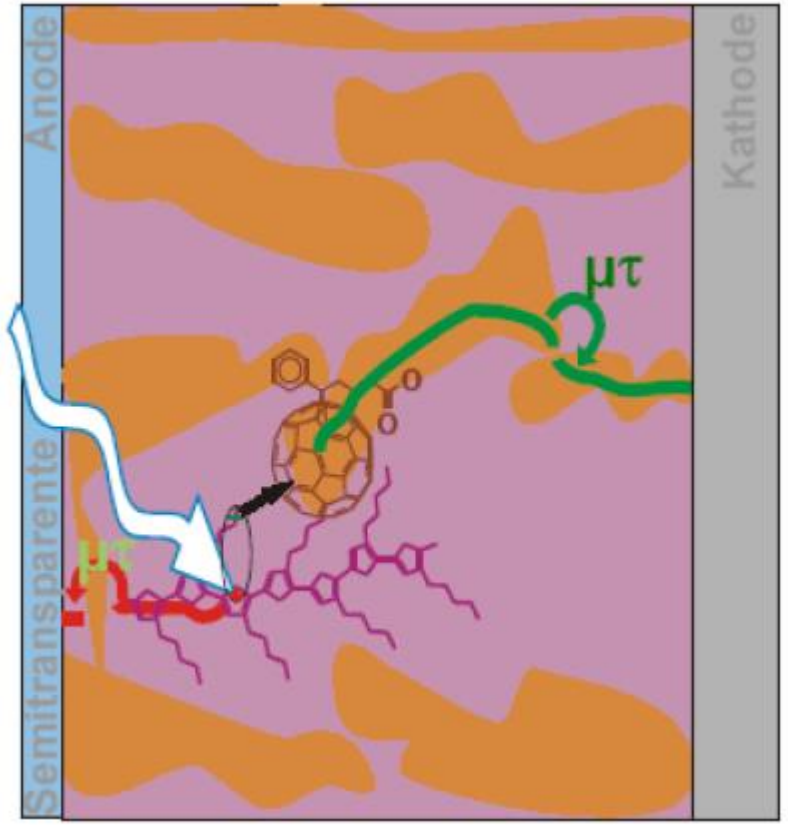
Important heterocycles to construct polymer donors:



OSC – Organic Solar Cells

Bulk heterojunction photovoltaic cells





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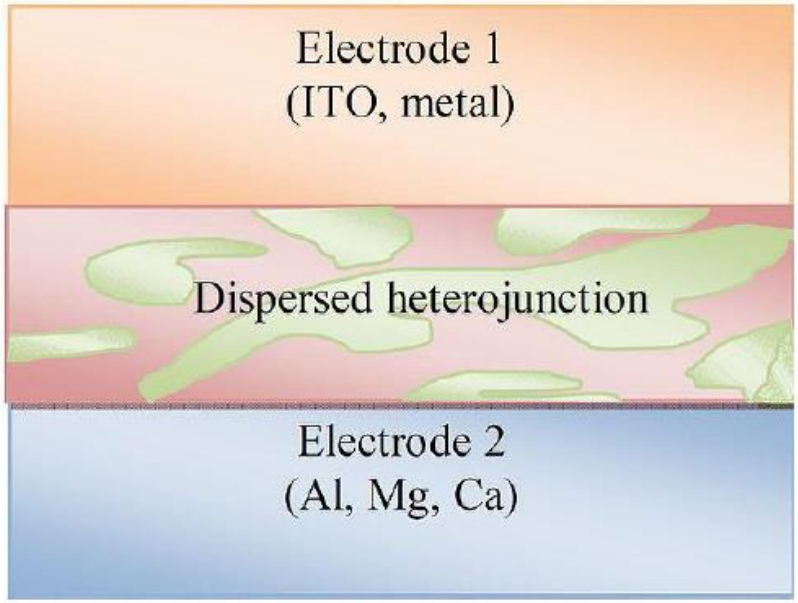
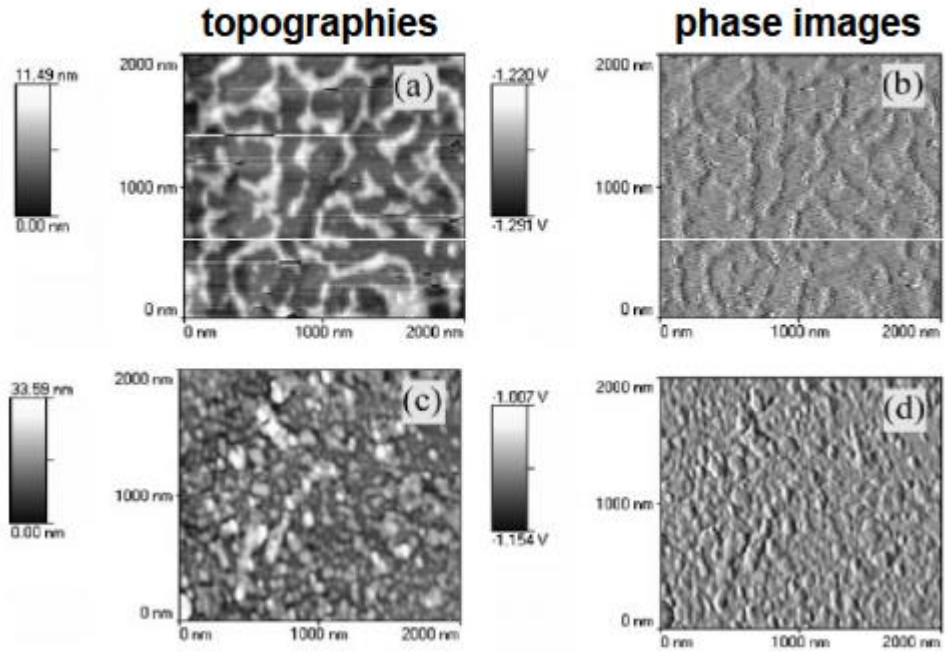
OSC – Organic Solar Cells

Bulk heterojunction photovoltaic cells



Tapping mode AFM



Electrons move to the acceptor domains then were carried through the device and collected by one electrode, and holes were pulled in the opposite direction and collected at the other side

X. Chen, B. Gholamkhass, X. Han, G. Vamvounis, S. Holdcroft
Macromol. Rapid Commun. 2007, 28, 1792–1797

OSC – Organic Solar Cells

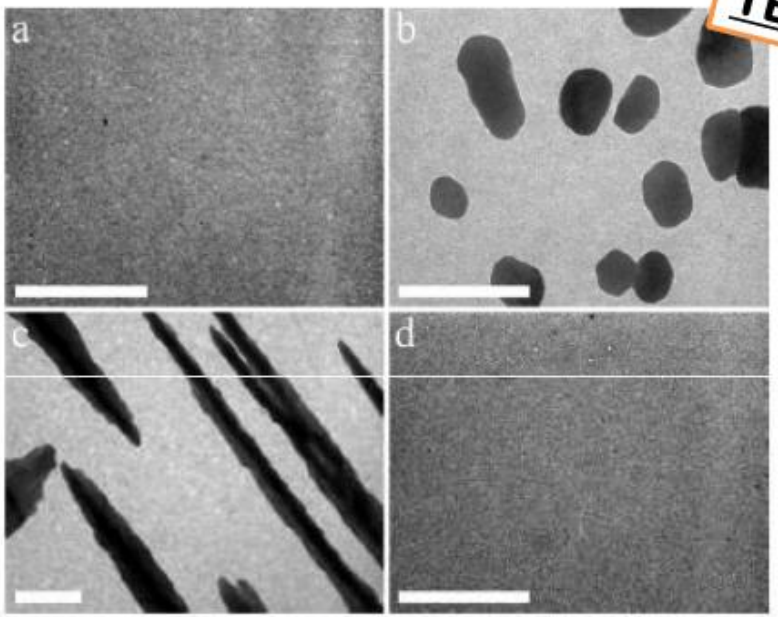
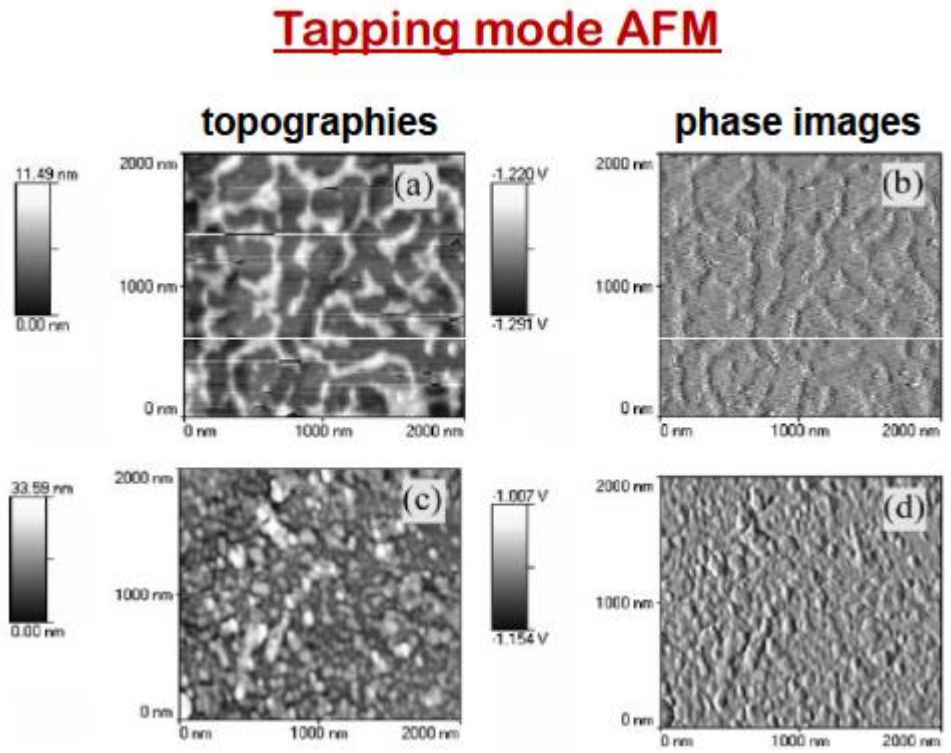


Figure 1. TEM image of a thin film of a) 1:1 P3HT/PCBM blend before annealing, and b) after annealing for 1 h at 140 °C. c) 1:1 P3HT/PCBM + 5 wt.-% poly(**1**)-*block*-poly(**2**) after annealing (140 °C). d) 1:1 P3HT/PCBM + 17 wt.-% poly(**1**)-*block*-poly(**2**) after annealing (1 h, 140 °C). The white scale bars are 2 μm. Solutions of the blends were spin-cast onto NaCl. After annealing, the films were floated onto water and placed on a 400-mesh copper grid. Images were obtained without stain; dark areas indicate fullerene-rich regions.

K. Sivula, Z. T. Ball, N. Watanabe, J. M. J. Frechet, Adv. Mater. 2006, 18, 206.

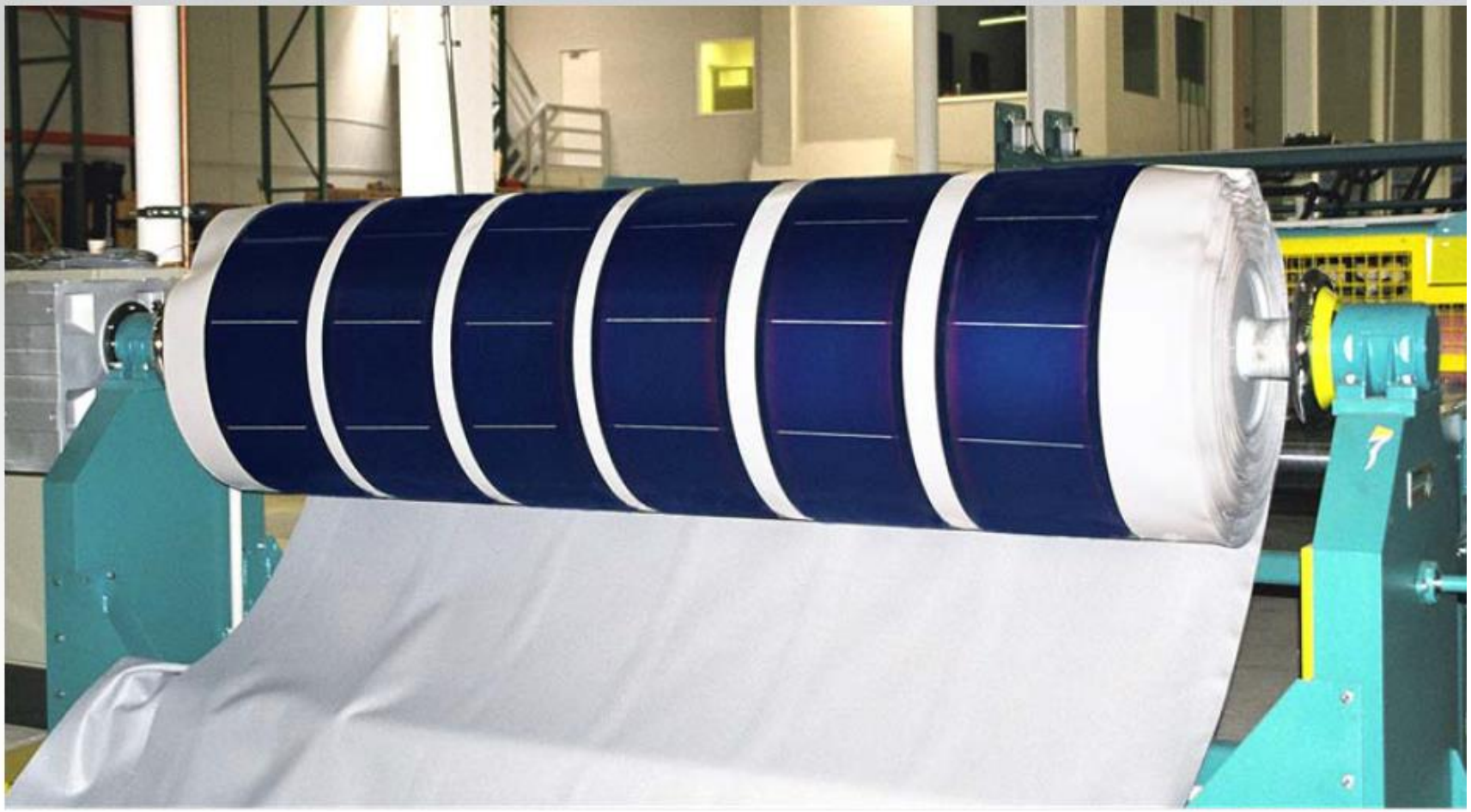


X. Chen, B. Gholamkhass, X. Han, G. Vamvounis, S. Holdcroft
Macromol. Rapid Commun. 2007, 28, 1792–1797

Dr. C. Gravalidis Aristotle University of Thessaloniki

OPV – Organic Photovoltaic

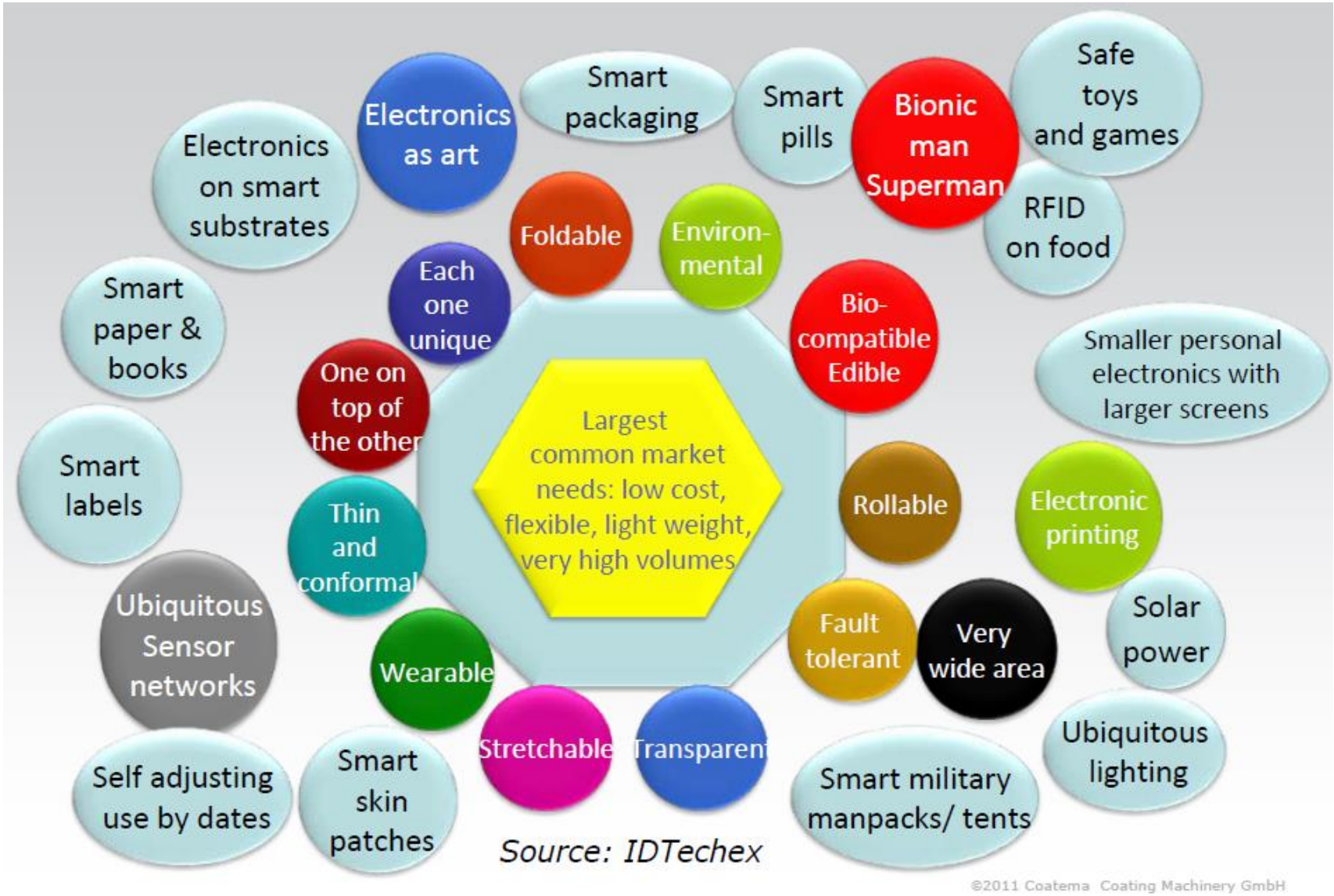
Solar cells on a roll, it´s real!



OPV – Organic Photovoltaic

Flexible solar cells on a roof!

Printed electronics



Koncentratory słoneczne

Concentrated Solar Thermal Technologies: CST

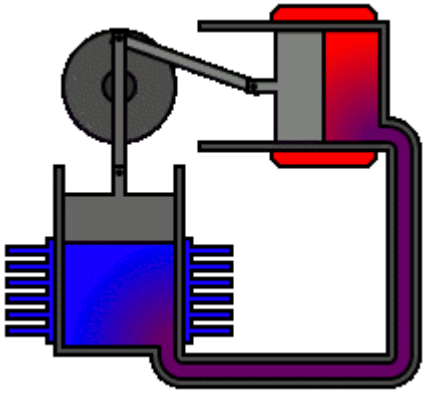
			
C ~ 70-90 commercial η_a ~ 12%-14% LEC_{2020} ~ 5ct/kWh	C ~ 60-120 demo η_a ~10%-12% LEC_{2020} ~ 5ct/kWh	C ~ 300-4000 demo η_a ~ 14%-18% LEC_{2020} ~ ?	C ~ 500-1000 comm. demo η_a ~ 10%-15% LEC_{2020} ~ 5ct/kWh

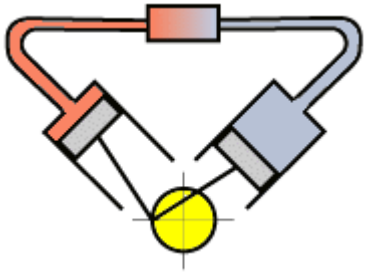
http://www.mpifr-bonn.mpg.de/1192452/Weber.pdf

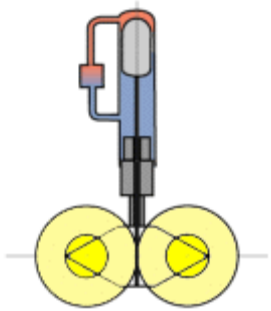
Koncentratory słoneczne

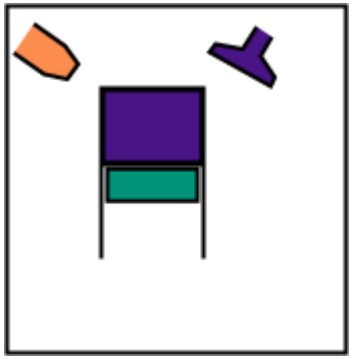
http://www.solarcurator.com/2013/05/23/power-of-concentration/

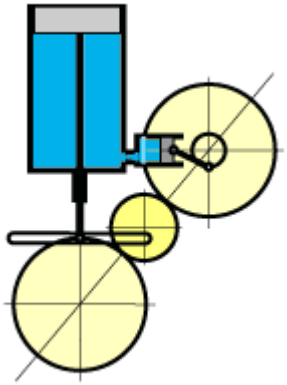
Koncentratory słoneczne

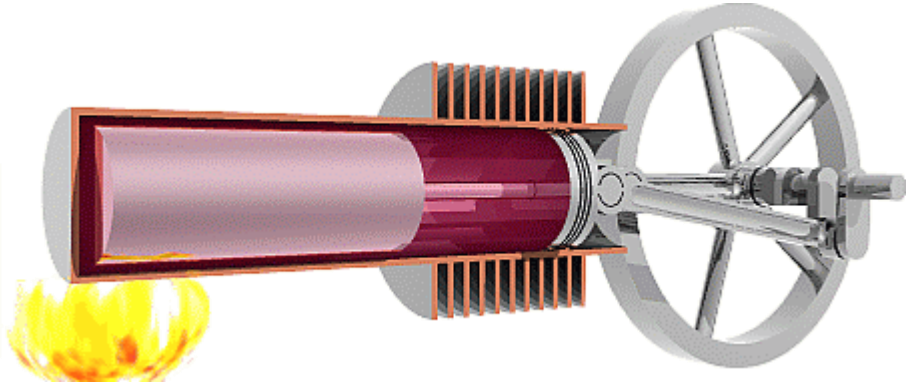












http://pl.wikipedia.org/wiki/Silnik_Stirlinga

Zjawiska termoelektryczne

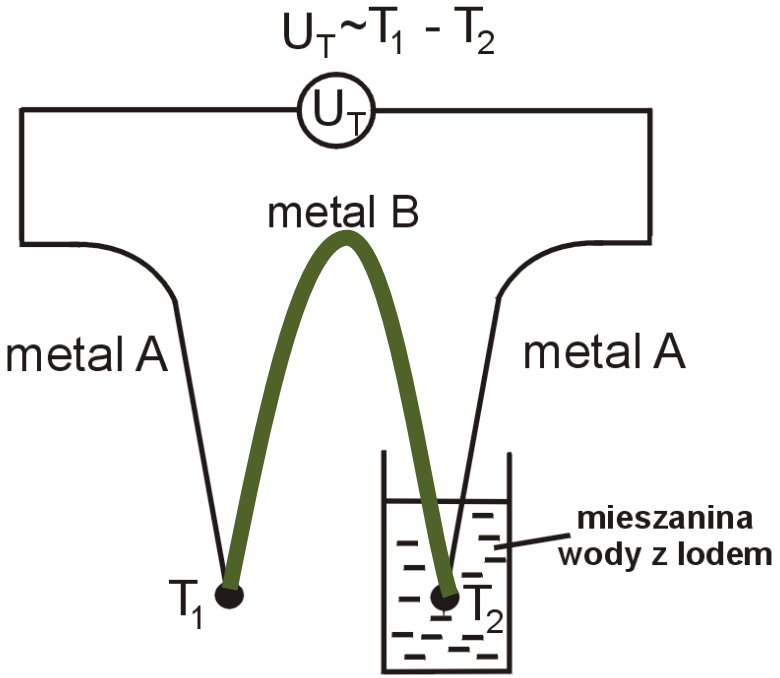
Siła termoelektryczna

$$\alpha(T) = -\frac{k_B}{q}\left[\frac{\langle \varepsilon\tau \rangle}{\langle \tau \rangle} - \eta\right]$$

Siła termoelektryczna (współczynnik Seebecka):

$$\frac{dV_{12}}{dT} = \alpha_{ab} = \alpha_a - \alpha_b$$

$$V_{12} = \int_{T_1}^{T_2} \alpha_{ab}(T)dT$$



podczas pomiarów należy jeden materiał uznać za wzorcowy, i badać siłę termoelektryczną względem takiego wzorca (idealnie – względem nadprzewodnika)

znak siły termoelektrycznej zależy od rodzaju nośników: dla elektronów $q < 0$ i $\alpha > 0$ (znak zimnego końca – ujemny) ⇒ metoda gorącej sondy

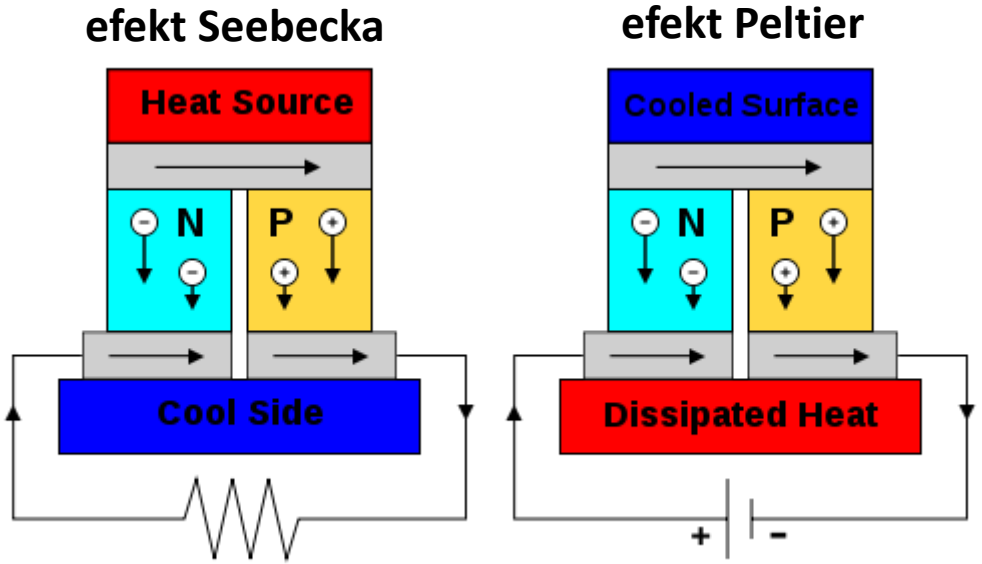
$$\frac{k_B}{e} = 85\,\frac{\mu V}{K}$$

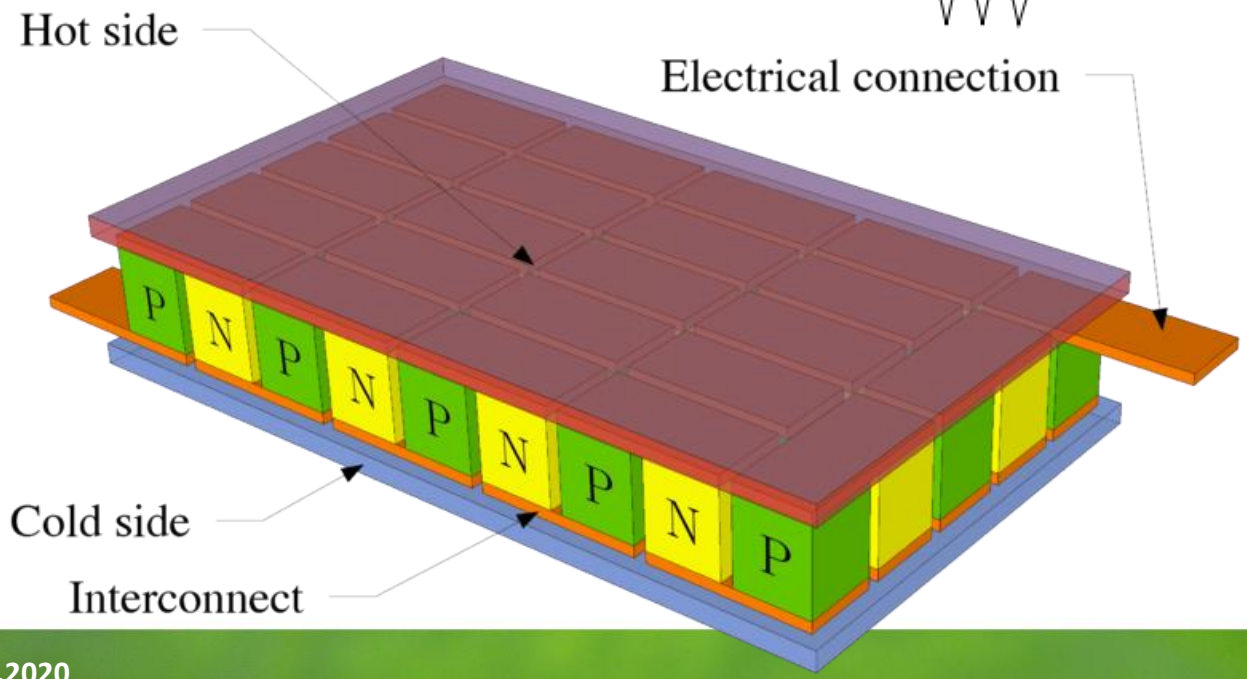
siły termoelektryczne niezdegenerowanych półprzewodników są rzędu kilkuset μV/K

Zjawiska termoelektryczne

Efekt Peltier

efekt odwrotny do efektu Seebecka – powstawanie różnicy temperatury pomiędzy złączami *a*–*b* i *b*–*a* dwóch różnych materiałów przez które przepuszczany jest prąd elektryczny:





http://en.wikipedia.org/wiki/Thermoelectric_cooling

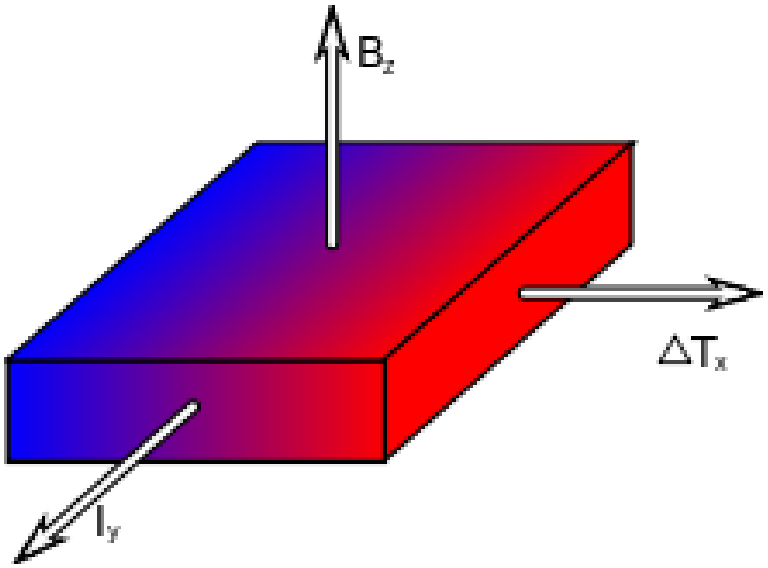
Zjawiska termomagnetyczne

Przykład: poprzeczne i podłużne zjawisko Nernsta-Ettingshausena (pole magnetyczne + gradient temperatury)

Istnieje szereg zjawisk termomagnetycznych (gradient temperatury, pole elektryczne, pole magnetyczne ⇒ możliwe przepływy prądu i ciepła); szczegóły – patrz np.: B.M. Askerov, „Electron transport phenomena in semiconductors”, World Scientific 1994

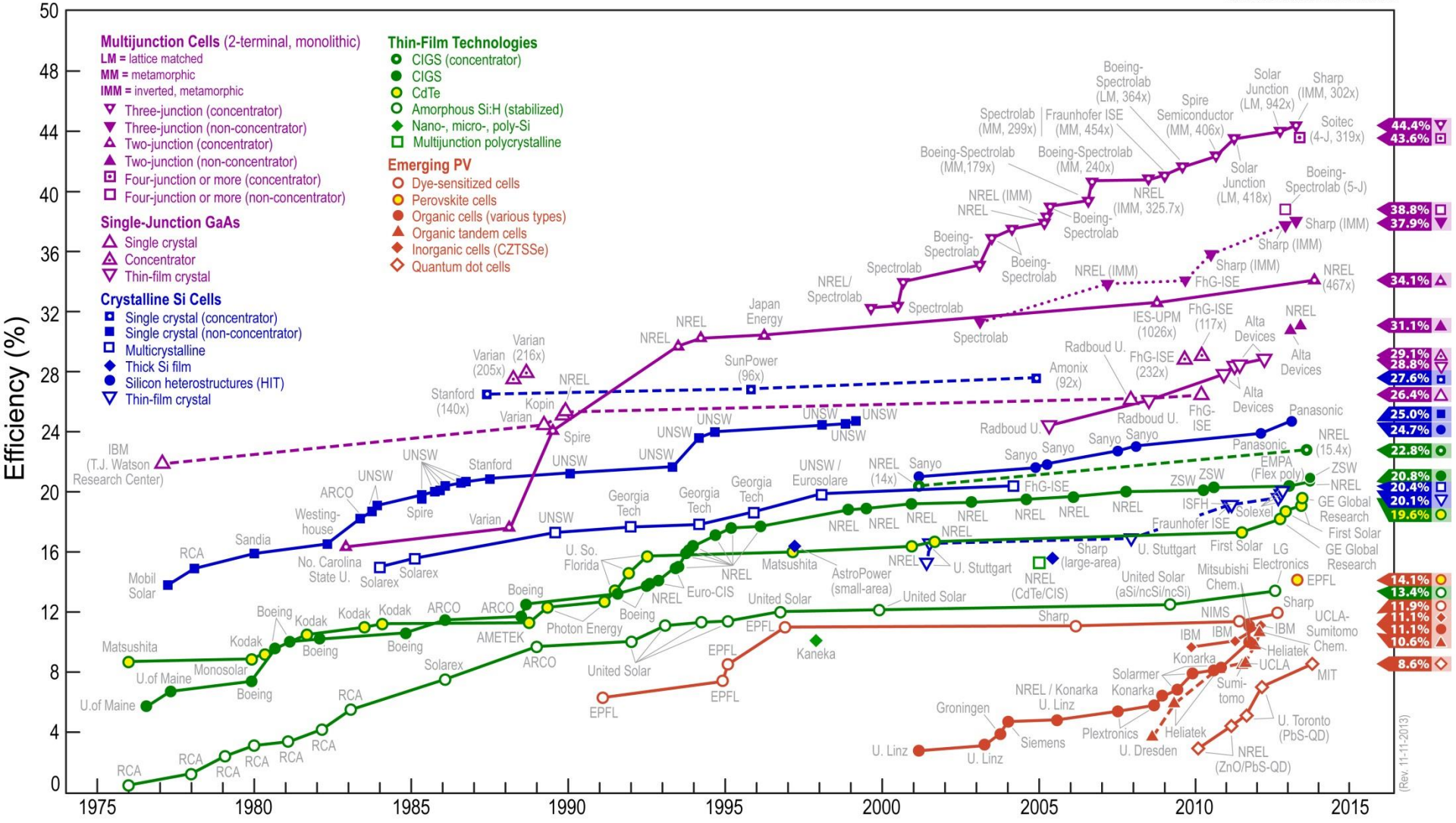
$$E_y = 1\frac{1}{B}\frac{dT}{dx}$$ **poprzeczne**

$$\frac{dT}{dy} = PI_xB_z$$ **podłużne**



podłużny (zmiana siły termoelektrycznej w polu B) i poprzeczny efekt Nernsta-Ettinghausena

Best Research-Cell Efficiencies



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FT.com / Companies / IT - Sharp breaks the blue laser duopoly - Mozilla Firefox
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Sharp breaks the blue laser duopoly
By Leo Lewis in Tokyo
Published: December 20 2006 00:43 | Last updated: December 20 2006 00:43
Sharp has begun mass production of blue laser diodes – the critical component in rival next-generation DVD systems – in a move that is expected to escalate the "format war" between Blu-ray Disc and HD-DVD players.
The LEDs are used by both competing formats to read and write data on to discs, but production has been dogged by bottlenecks, seriously delaying the availability of the players.
The new standards are expected to generate billions in revenue for the technologies' backers – led by Sony in the case of Blu-ray and Toshiba for HD-DVD – as well as Hollywood studios, the consumer electronics industry and retailers.
Early manufacturing problems with blue LEDs were blamed for the acute pre-Christmas shortages in the US and Japan and delays in the European launch of Sony's PlayStation3 games console, which incorporates a Blu-ray Disc player.
Sharp began production of blue LEDs at its electronic components factory in Hiroshima in late November.
The line is able to make 150,000 units a month but Sharp expects to increase that to 500,000 units a month by the end of next calendar year.
EDITOR'S CHOICE
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The line is able to make 150,000 units a month but Sharp expects to increase that to 500,000 units a month by the end of next calendar year.

Sharp has invested "several billions of yen" in the blue LED plant and, although it does make its own Blu-ray Disc recorder, it initially expects to use only a small proportion of the LED output for its own purposes.

"Most of the diodes will be available and sold on the open market to producers of both the Blu-ray Disc and HD-DVD formats," the company said.

The blue LED market has been dominated by Nichia, which produces about 1m diodes a month.

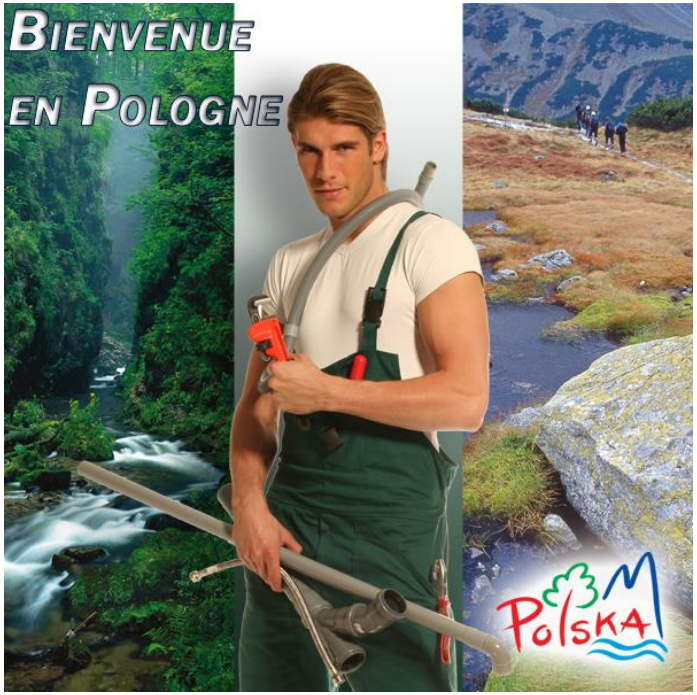
Sony has its own production facilities capable of churning out 1.3m units a month, but the entire line is currently being used to meet the needs of its PS3 production, a situation expected to last well into next year.

Toshiba, which with **Microsoft** is leading the battle against Blu-ray, does not produce blue LEDs of its own and has been relying on Nichia's.

Industry observers said that Sharp's move, which smashes the blue LED duopoly of Sony and Nichia, would probably spark a price war in the technology. Prices have already dropped from Y8,000 ($68) a diode to about Y3,000 since January and could, say analysts, halve again by the end of 2007.

By forcing blue LED prices lower, said one analyst, the next-generation machines that use them could be produced more cheaply and should enter consumers' homes more quickly.

Sharp is a member of the Blu-ray Disc consortium but it admitted that its move could be a boon to competitor members of the HD-DVD group.



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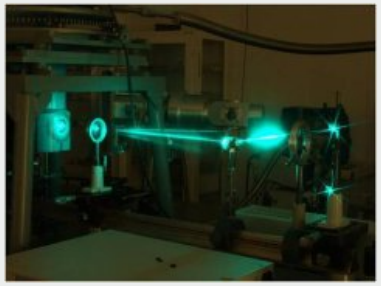

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Laser diode type	Unit price Euro
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TGL415-200PMG	200 mW	1000 mW	50 ns	415 nm

Module name	Output power (peak value)	Output power average (100kHz)	Pulse length	Repetition	Beam type	Polarization	Wavelength
VLMA1	50 mW	0.25 mW	50 ns	1,10,100 kHz	elliptical	100% TE, multimode	415 nm
VLMB1	200 mW	1 mW	50 ns	1,10,100 kHz	elliptical	100% TE, multimode	415 nm
VLMC1	500 mW	0.25 mW (at 10 kHz)	50 ns	1,10 kHz	elliptical	100% TE, multimode	415 nm

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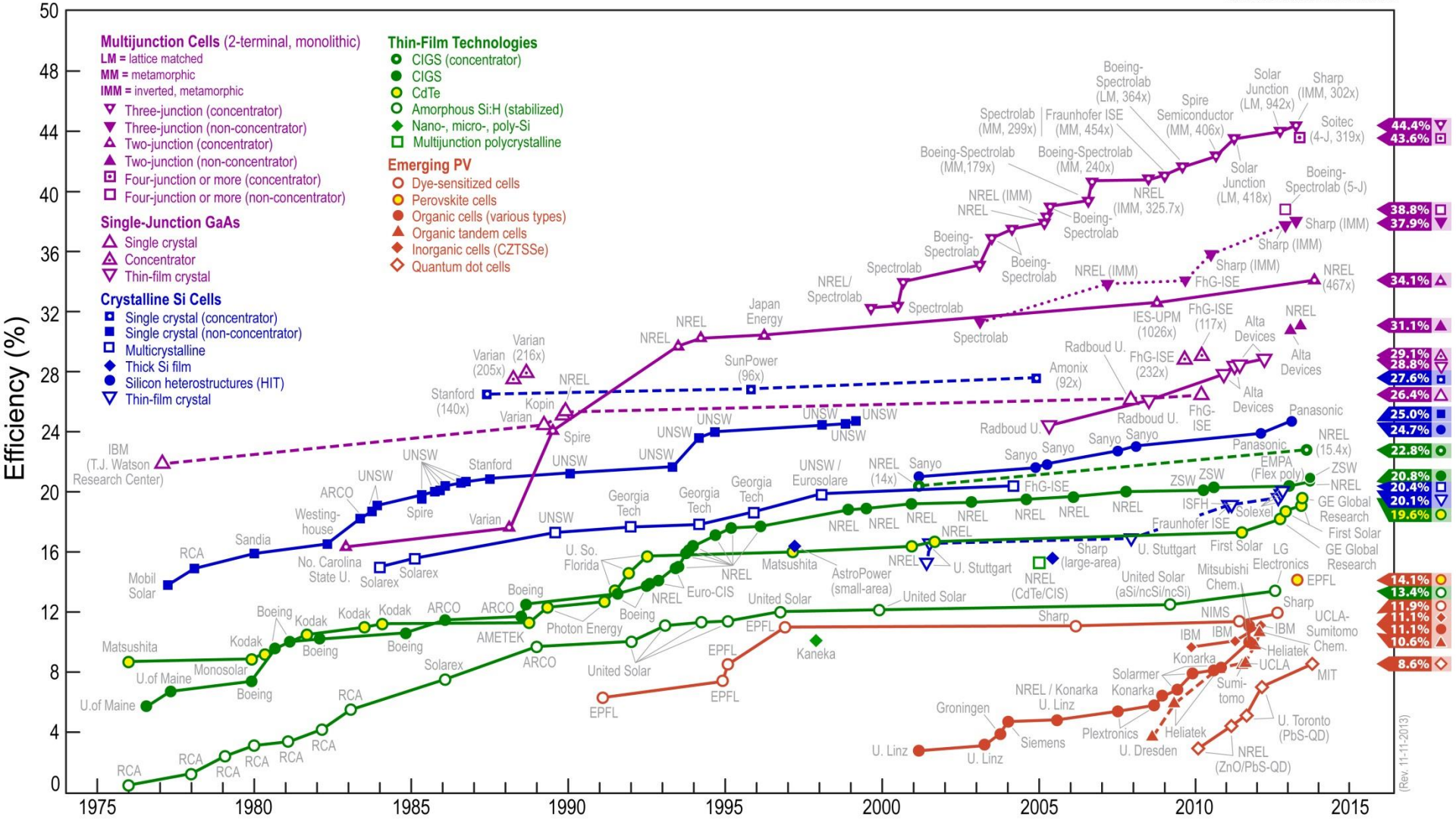

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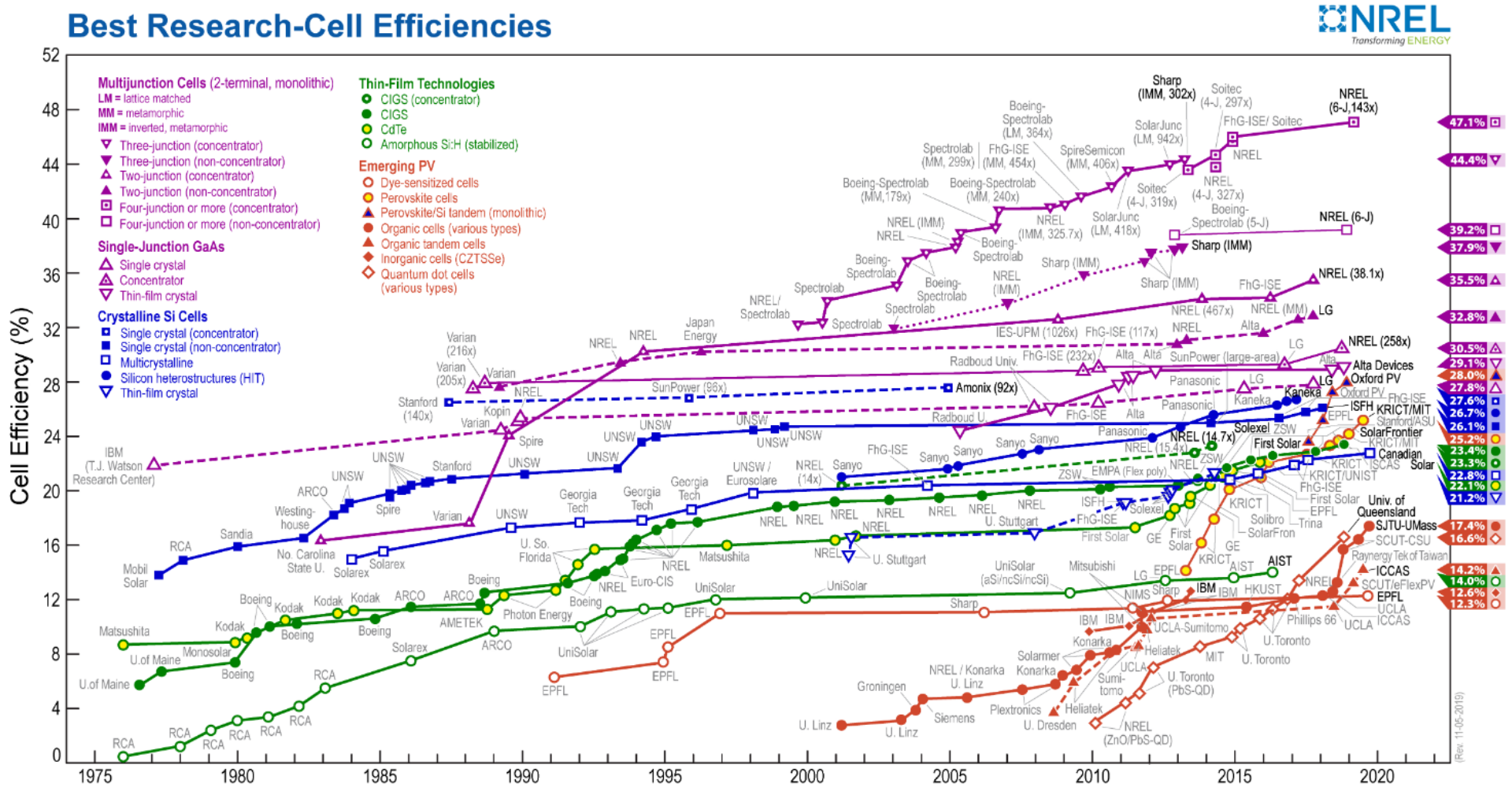

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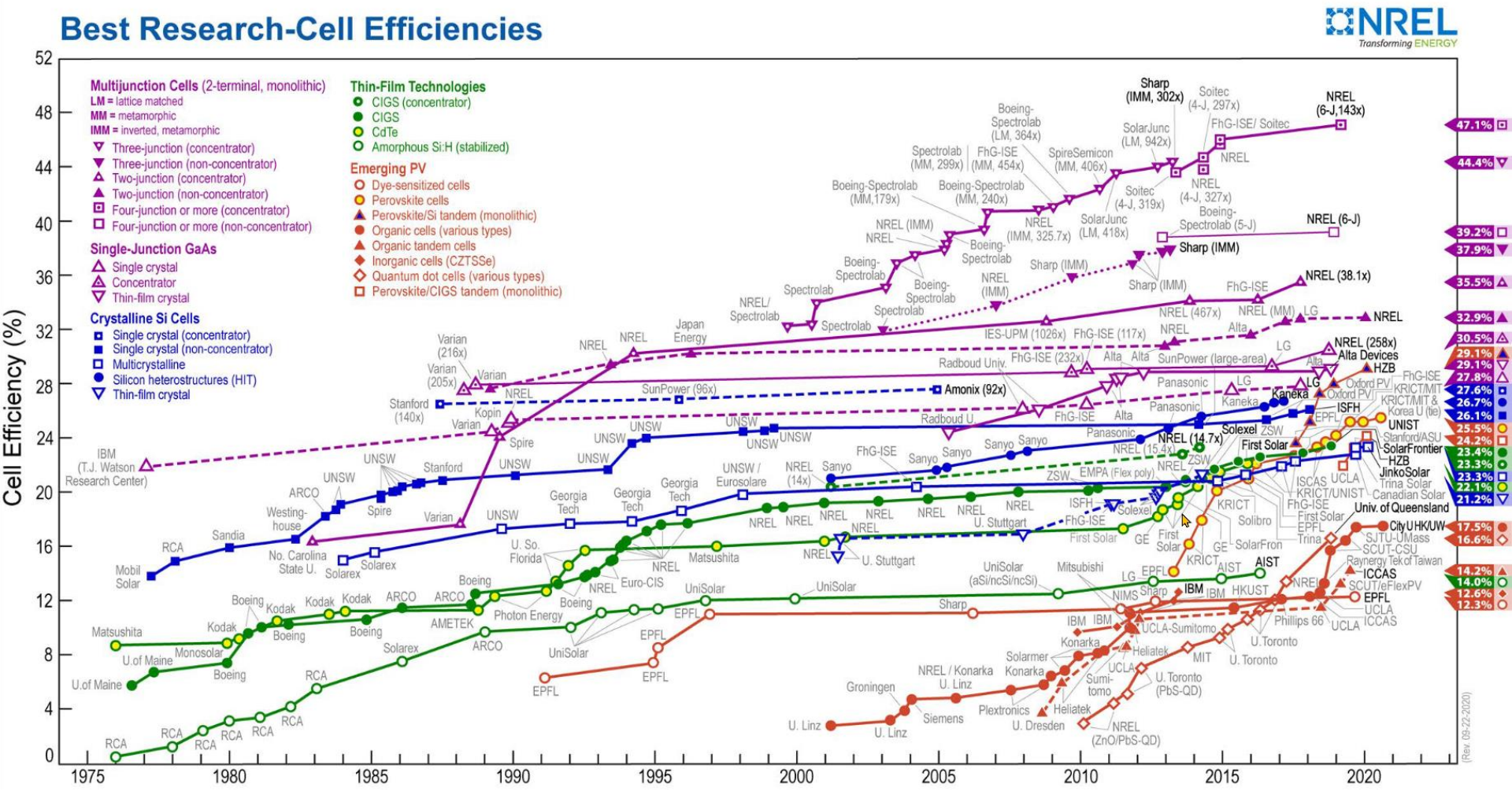

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