

Nanotechnologie i struktury niskowymiarowe



Jacek.Szczytko@fuw.edu.pl
<http://www.fuw.edu.pl/~szczytko/NT>

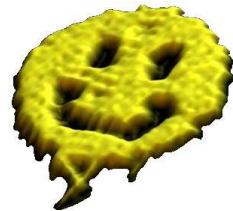
07.01.2010

Inżynieria
nanostruktur

Jacek.Szczytko@fuw.edu.pl
<http://www.fuw.edu.pl/~szczytko/NT>

Nanotechnologie i struktury niskowymiarowe

- Disruptive technologies
- Nanotechnologia w kulturze
- Nanotechnologia na co dzień
- Łanicuch pokarmowy
- Trendy – Prawo Moora
 - IC, THz, RFID,
- Niebieska elektronika
- bio/med nano
- Zagrożenia



Nanotechnologie

CO?

- Studnie, druty, kropki

JAK?

- Top-down, czyli (nano)technologia
- Bottom-up, czyli samoorganizacja

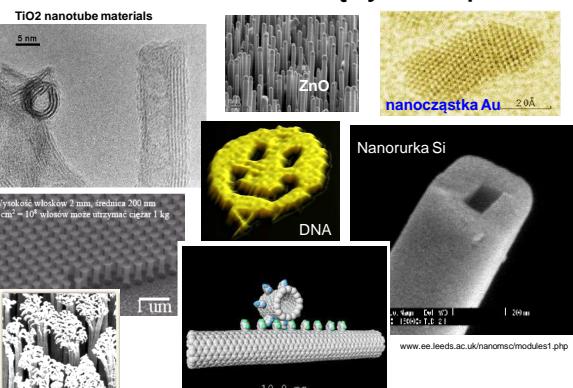
↑ Bottom-up



Wydział (nano)Chemii UW

<http://www.chem.uw.edu.pl/labs/elektrochemia/Nanogaleria/nanogaleria.htm>

Nanorurki, nanowąsy i kropki



Kropki kwantowe + bio

T2-MP EVITAGS
Non-heavy Metal - InP Based, Water Stabilized Quantum Dots

Tertiary III-V EvDot, Molecular Plate™ Shell, T2-MP EvITag - InGaP/ZnS with Lipid, CdSe Core EvDot, CdSe/ZnS Core-Shell EvDot.

A PbSe Quantum Dot as seen through a transmission electron microscope (TEM). 20 nm

<http://www.evidenttech.com/>

Kropki kwantowe + bio

Double duty. Green quantum dots cling to mitochondria in the cytoplasm; orange ones label proteins in the same cells' nuclei.

Science, Vol 300, Issue 5616, 80-81 , 4 April 2003

Kropki kwantowe + bio

Bull's-eye. Red quantum dots injected into a live mouse mark the location of a tumor.

Science, Vol 300, Issue 5616, 80-81 , 4 April 2003

Magnetyczne QD's

WYDZIAŁ FIZYKI
UNIWERSYTET WROCŁAWSKI

Jacek Szczytko

Michał Bystrzejewski, Andrzej Huczko, Hubert Lange

Magnetyczne QD's

nano-Co, 3.00 nm, 8.00 nm

WYDZIAŁ FIZYKI
UNIWERSYTET WROCŁAWSKI

Jacek Szczytko

Pracownia Fizykochemii Dielektryków i Magnetyków
Ewa Górecka, Paweł Majewski, Jadwiga Szydłowska, Adam Krówczyński

Ferrofluid

BOGDAN WŁASZAKOWSKI, JÓZEF WŁASZAK
wiedza i życie
EKSPŁORATORIUM
ZAPRASZAMY DO WIEDZY
PLANETY I CYBERWORLD
WIELOLETNI MATEMATYCZNY
DZIENNIK NAUKI I TECHNIKI
DZIENNIK NAUKI I TECHNIKI

Photograph by Felice Frankel
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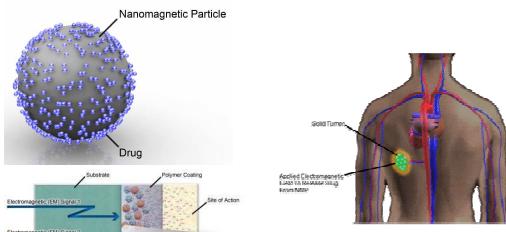
National Geographic
Volume 100 Number 5 November 2003

Ferrofluid



Akademia Górnictwo Hutnicza

Magnetyczne QD's



http://www.biophan.com/index.php?option=com_content&task=view&id=262&Itemid=426

Zagrożenia



Paul Karason

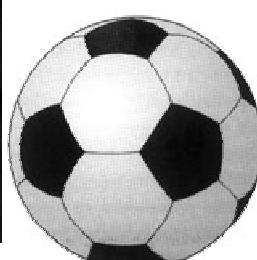
Argyria

inżynieria
nanostruktur

Węgiel

Uniwersytet Warszawski

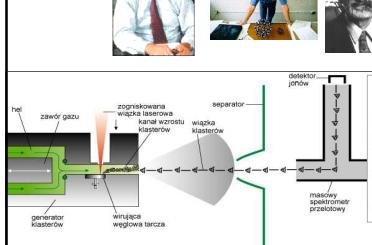
07.01.2010

 $0.71 \pm 0.007 \text{ nm}$ 

Miniaturyzujemy!

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

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


 $\text{C}_{2n}, n \geq 16$


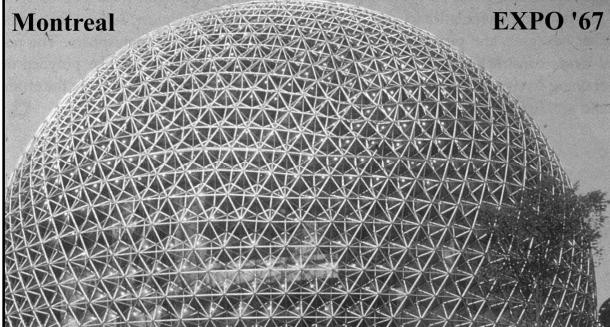
P. Yam Świat Nauki 11, 16, 1993

Widmo masowe

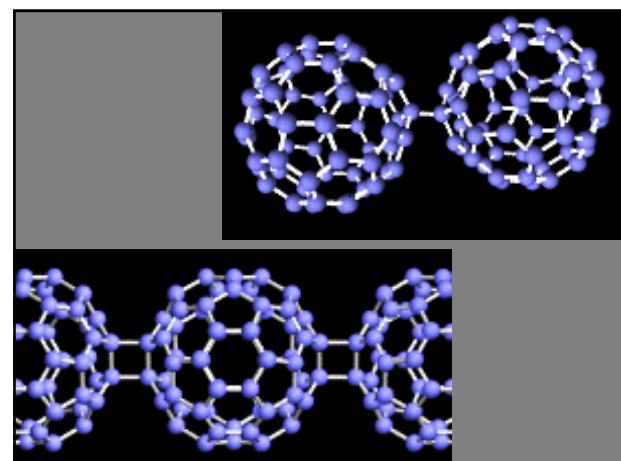
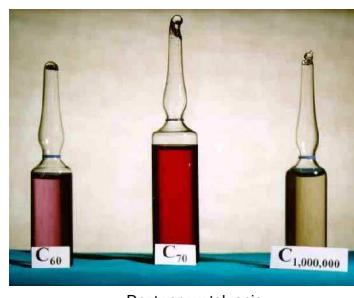
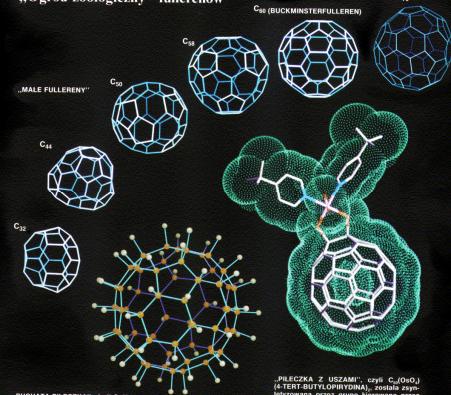
Paweł Tomasz Pęckowski

Miniaturyzujemy!

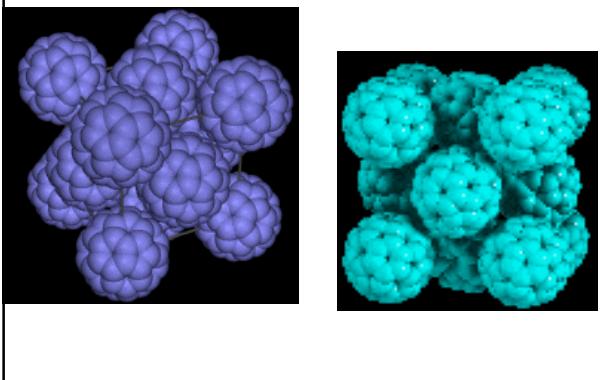
Buckminster Fuller pour un exposition en 1967 à Montréal



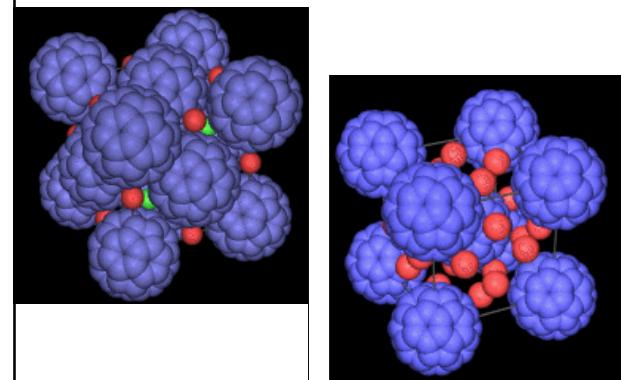
„Ogród zoologiczny” fullerenów

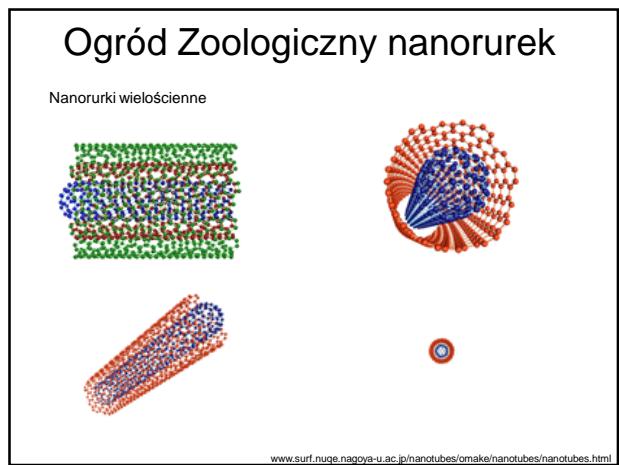
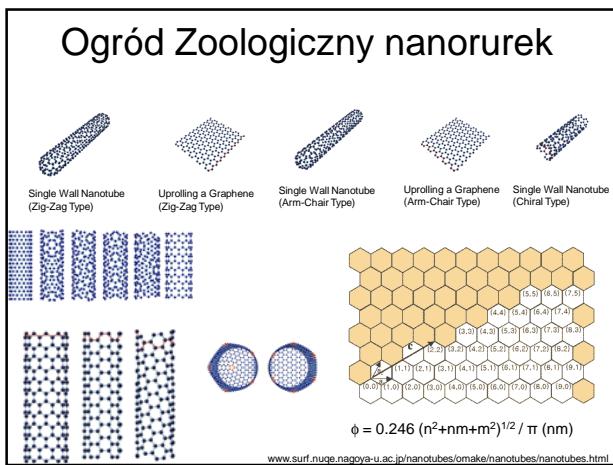
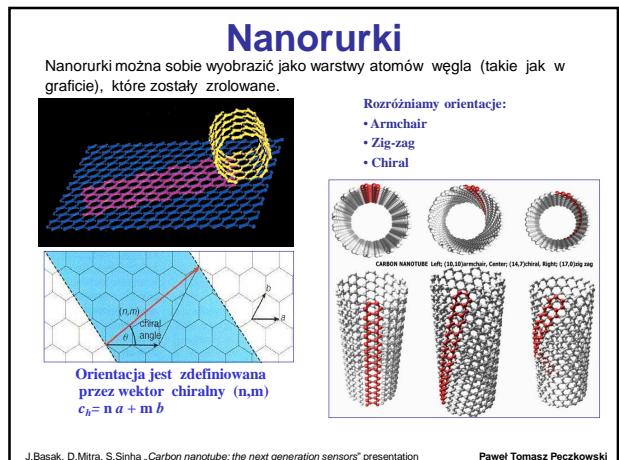
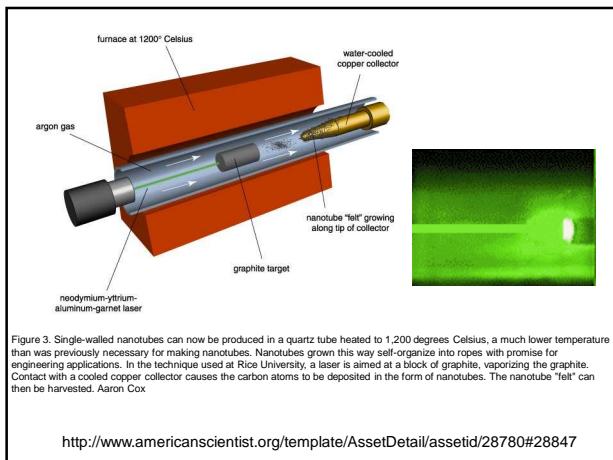
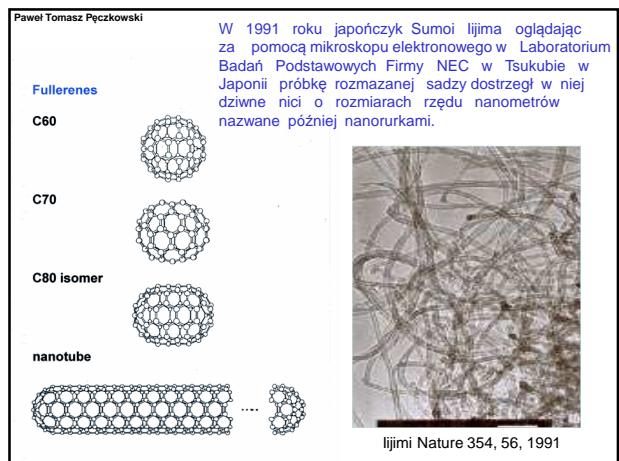
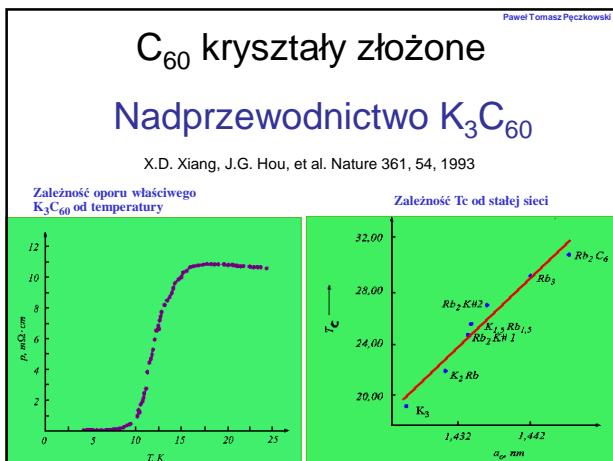


C₆₀ kryształy fcc

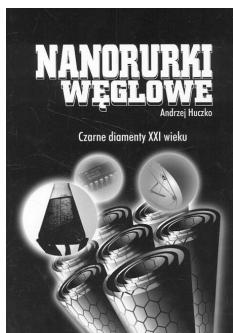


C₆₀ kryształy złożone





Ogród Zoologiczny nanorurek



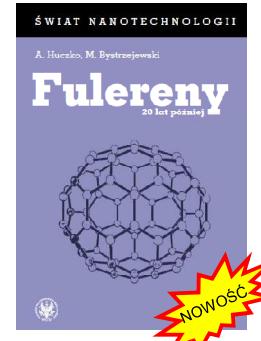
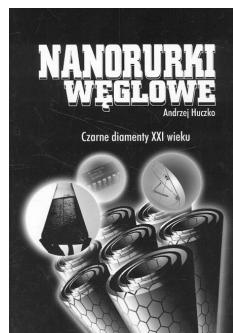
<http://www.chem.uw.edu.pl/>
Pracowni Fizykochemii Nanomateriałów
Dr hab. Andrzej Huczko

Wydział Chemiczny
UL. PASTEURA 1
02-093 WARSZAWA

"Wstęp do Nanotechnologii"
(15 godzin, wtorki, godz. 13.45-15.15, sala 118, Chemia Fizyczna, Wydział Chemiczny).
1 wykład 7 listopada



Ogród Zoologiczny nanorurek



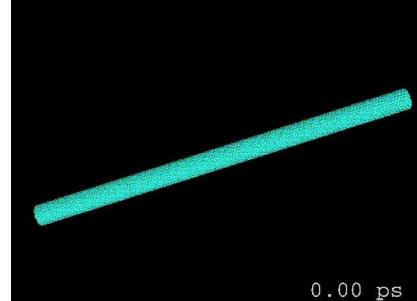
Nanomaszyny

1. Najsiłniejsze u najbardziej giętkie wiązanie molekularne (wiązanie kowalencyjne C-C)
2. Moduł Younga ponad 1TPa (w porównaniu do 70 GPa dla Al, 700 GPa dla włókien węglowych)
3. Odporność na rozciąganie 45 GPa (najbardziej odporna stal pęka przy 2GPa)
4. Stosunek wytrzymałości do wagi 500 większy niż Al, podobnie dla stali i tytanu. Jeden rzad wielkości więcej niż dla grafitu / żywic epoxy
5. Maksymalne naprężenie ok. 10% większe niż dla znanych materiałów
6. Przewodnictwo cieplne ok. 3000 W/mK wzdłuż osi (i małe w poprzek)
7. Przewodność elektryczna 1.000.000 większa niż Cu!



<http://www.ipt.arc.nasa.gov>

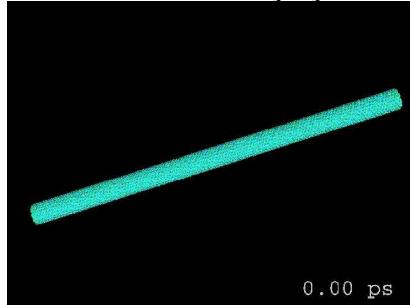
Nanomaszyny



Single – twist

<http://www.ipt.arc.nasa.gov>

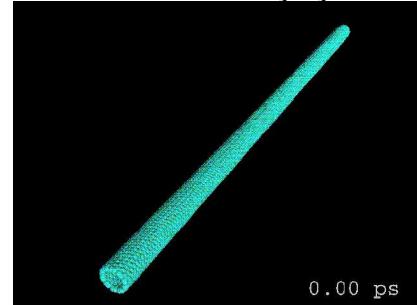
Nanomaszyny



Single – bend

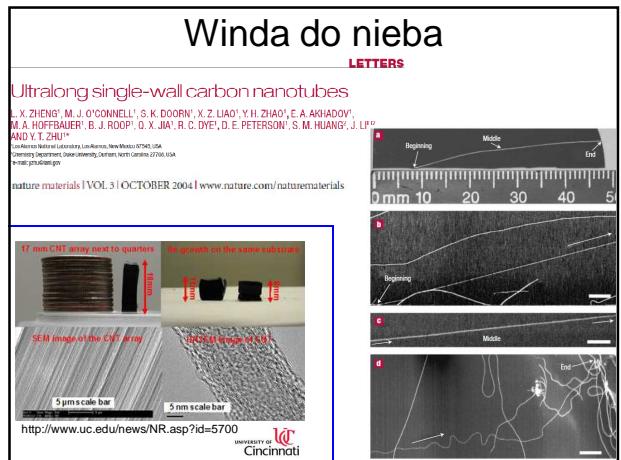
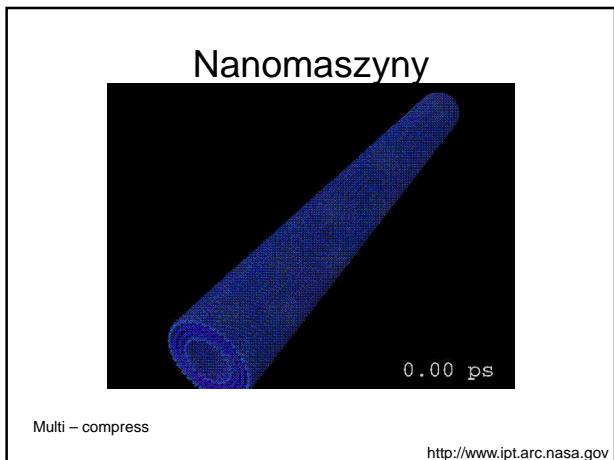
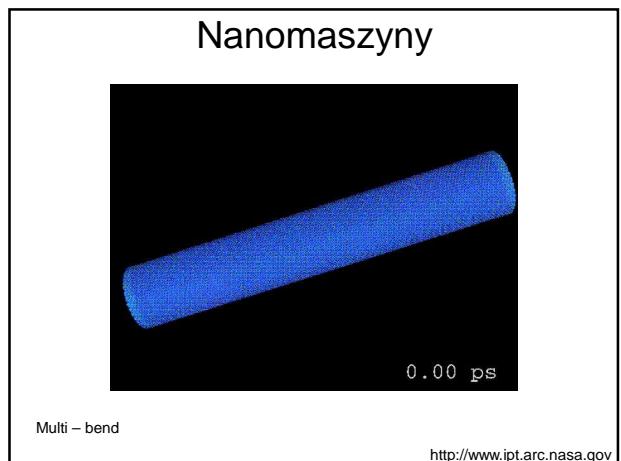
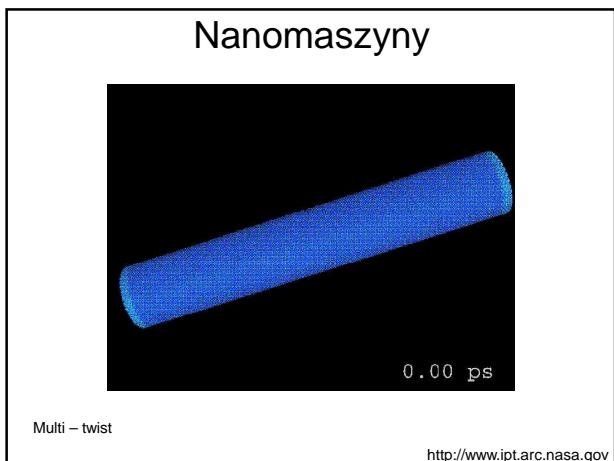
<http://www.ipt.arc.nasa.gov>

Nanomaszyny



Single – compress

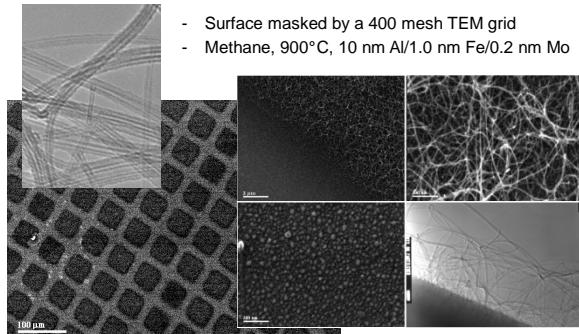
<http://www.ipt.arc.nasa.gov>



Wzrost kontrolowany

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Director, Center for Nanotechnology
NASA Ames Research Center
Moffett Field, CA 94035
meyya@orbit.arc.nasa.gov
web: <http://www.ipt.arc.nasa.gov>

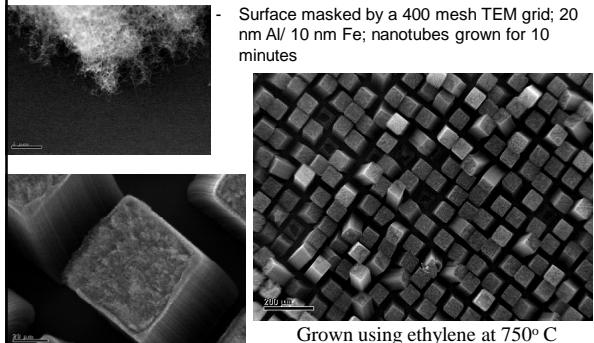
- Surface masked by a 400 mesh TEM grid
- Methane, 900°C, 10 nm Al/1.0 nm Fe/0.2 nm Mo



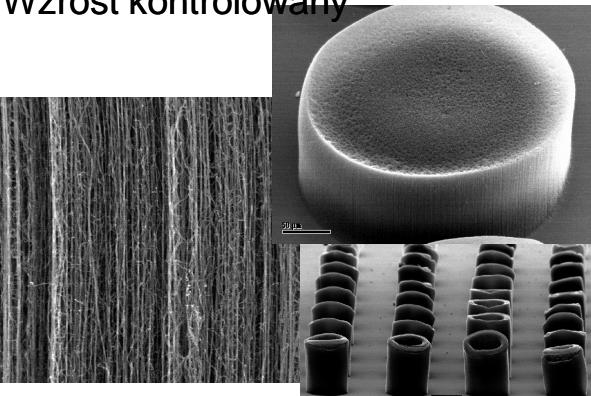
Wzrost kontrolowany

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Director, Center for Nanotechnology
NASA Ames Research Center
Moffett Field, CA 94035
meyya@orbit.arc.nasa.gov
web: <http://www.ipt.arc.nasa.gov>

- Surface masked by a 400 mesh TEM grid; 20 nm Al/ 10 nm Fe; nanotubes grown for 10 minutes

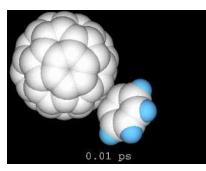


Wzrost kontrolowany

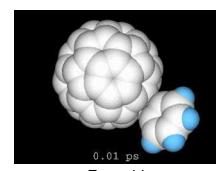


Nanomaszyny

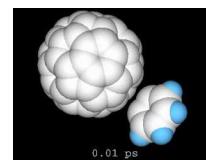
Benzen + C₆₀



Za wolno



Za szybko

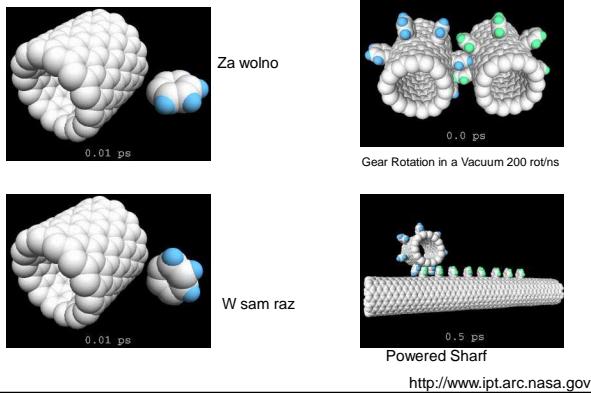


W sam raz

<http://www.ipt.arc.nasa.gov>

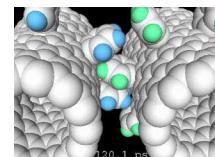
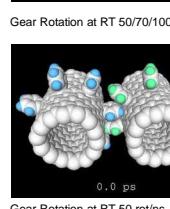
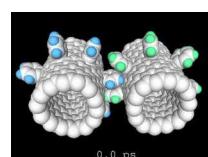
Nanomaszyny

Benzen + CN



<http://www.ipt.arc.nasa.gov>

Nanomaszyny



<http://www.ipt.arc.nasa.gov>

Nanomaszyny

Large Gear Drives Small Gear

0.5 ps 0.5 ps

Gear and Shaft Operation

Powered Shaft Powered Gear

<http://www.ipt.arc.nasa.gov>

Nanomaszyny

Rotation of Gears with Two Off-line Rows of Teeth

0.0 ps 30.2 ps
Zbyt szybko

150.3 ps 202.2 ps
Startup Rotating

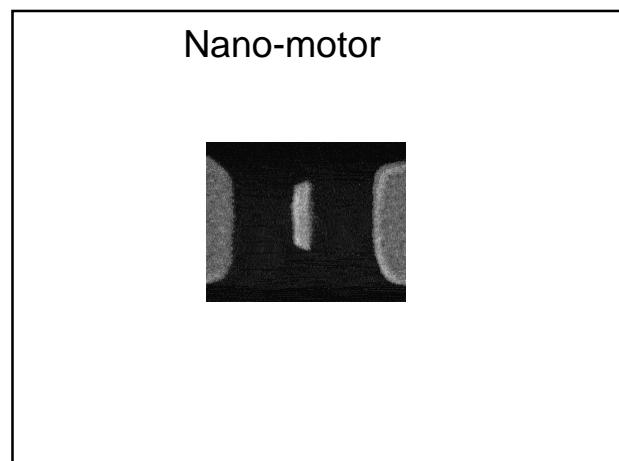
<http://www.ipt.arc.nasa.gov>

First Synthetic Nanomotor

Top view: a, b, c, d
Side schematic: a, f, g, h
300 nm

SEM images showing the rotation of the rotor actuated by applying appropriate voltage sequences to the stator pads MWNT base assembly. The schematic diagrams located beneath each SEM image illustrate a cross-sectional view of the position of the nanotube/rotor-plate assembly. The rotor can rotate through a full 360 degrees for thousands of cycles without apparent degradation or wear.

Schematic (top) from: Zettl, A., et al. (2003). A synthetic nanomotor. *Nature*, 425, 77-80. doi:10.1038/nature01892. SEM images (bottom) from: Zettl, A., et al. (2003). A synthetic nanomotor. *Nature*, 425, 77-80. doi:10.1038/nature01892. http://www.lbl.gov/msd/PIs/Zettl/03/07_nanomotor/03_7_nanomotor.html Alex Zettl 03.7



Model for the Kinesin Mechanism

[mov-muscmvovinmotrev6.mov](#)
[mov-procmotconvkinrev5.mov](#)

Kinesin is a dimeric motor protein that travels processively towards the microtubule plus end by taking 8 nm steps, which corresponds to the distance between adjacent alpha/beta tubulin binding sites. We have sought to define the structural changes in the motor that explain the direction of movement and the basis of head-head coordination during processive motility.

http://valelab.ucsf.edu/research/res_mec_over.html

http://www.sns.gov/workshops/nni_05/presentations/050617_pincus_philip_nni05.pdf

Bio-nano-silnik (ATPaza)

A

80 nm

<http://www.linkclub.or.jp/~hiikosy/ryohei/papers.html>

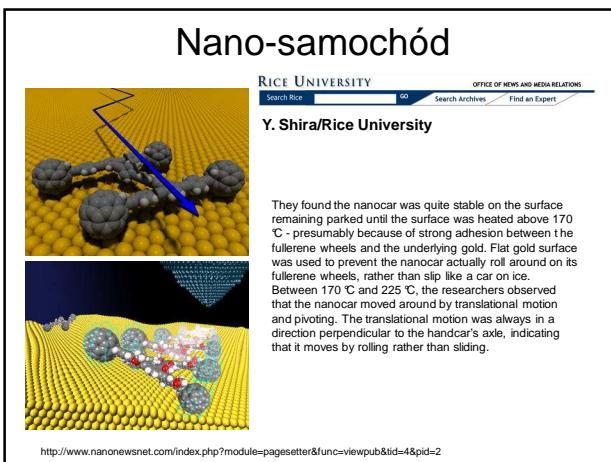
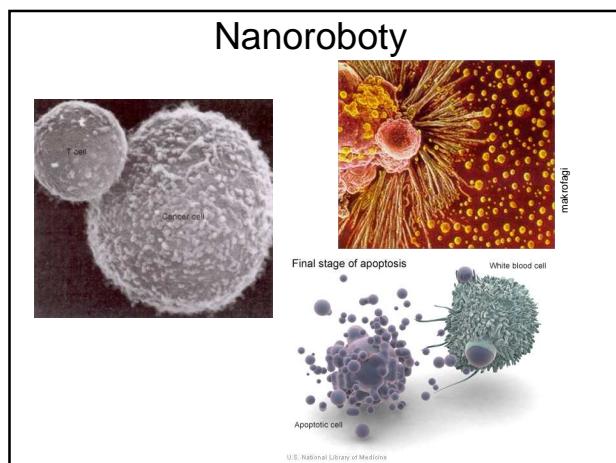
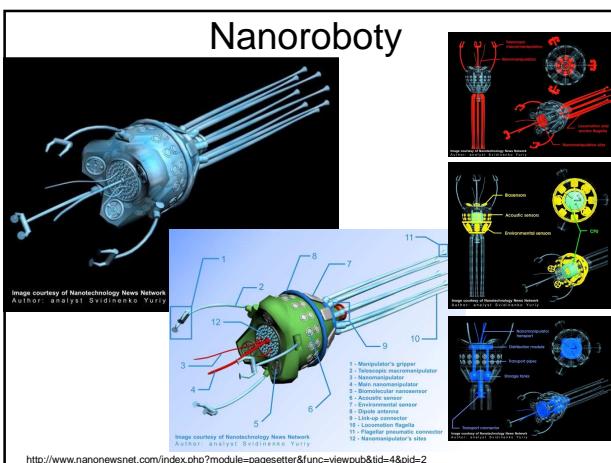
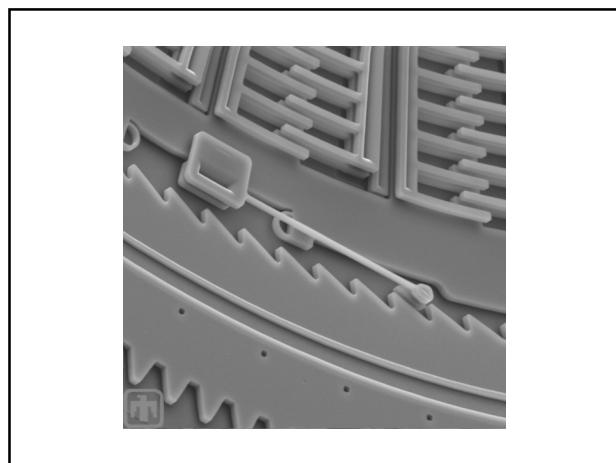
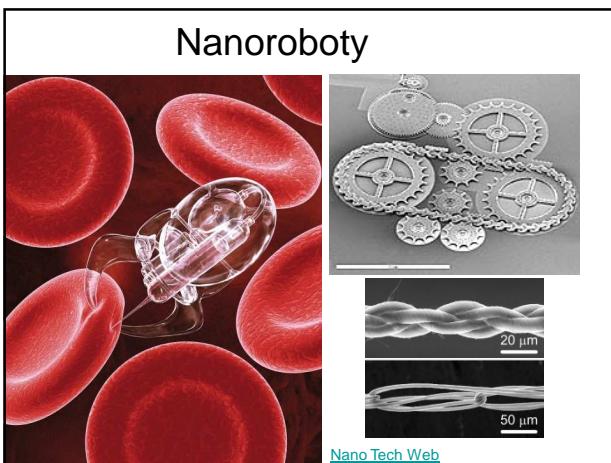
B

Biotinylated cysteine
β - Histidine tags

C

D

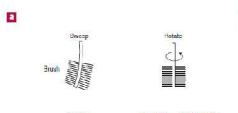
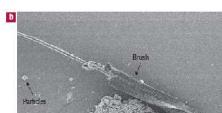
<http://www.foresight.org/Conferences/MNT6/Papers/Montemagno/index.html>

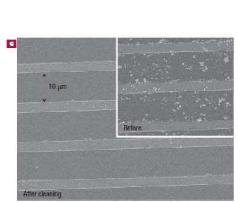
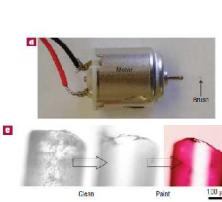


Nano-manipulowanie CN

nature materials | VOL.4 | JULY 2005 | www.nature.com/naturematerials

LETTERS
Multifunctional brushes made from carbon nanotubes
ANTHAN GAO, JIANG D. WEIWEI, XUEMING LIU, ZHAOLUW YAO, MEHRDAD N. GHASEMI-NE, HAO-YU LIN, CHENG-ZHENG LIU, XIAO-SING LIU*, ZHAOLUW YAO*, MEHRDAD N. GHASEMI-NE, HAO-YU LIN, CHENG-ZHENG LIU, XIAO-SING LIU*

A  **B** 

C  **D** 

inżynieria nanostruktur

Nano+bio

Uniwersytet Warszawski 07.01.2010

Nano i bio (gekon)



Nano i bio (gekon)

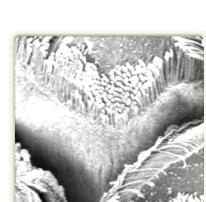
50x



<http://www.microscopy.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html>

Nano i bio (gekon)

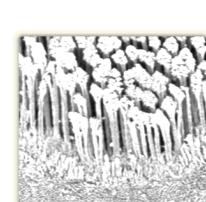
200x



<http://www.microscopy.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html>

Nano i bio (gekon)

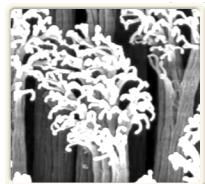
800x



<http://www.microscopy.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html>

Nano i bio (gekon)

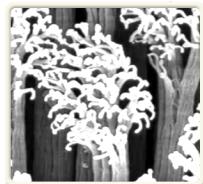
6000x



<http://www.microscopy.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html>

Nano i bio (gekon)

6000x



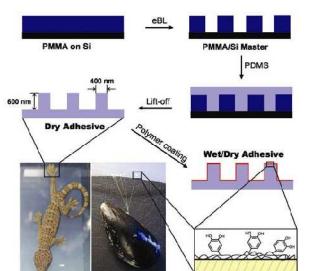
Wysokość włosów 2 mm, średnica 200 nm
 $1 \text{ cm}^2 = 10^8$ włosów może utrzymać ciężar 1 kg

1 μm

Paweł Tomasz Pęczkowski

<http://www.microscopy.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html>

Nano i bio (gekon)



Nature 448, 338-341 (19 July 2007)



Nano i bio (gekon)

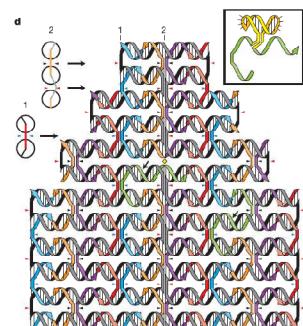


Nano i bio (DNA)

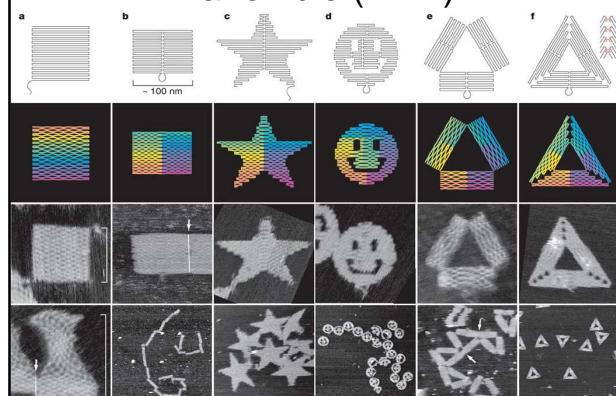
Vol 440 | 16 March 2006 doi:10.1038/nature04586

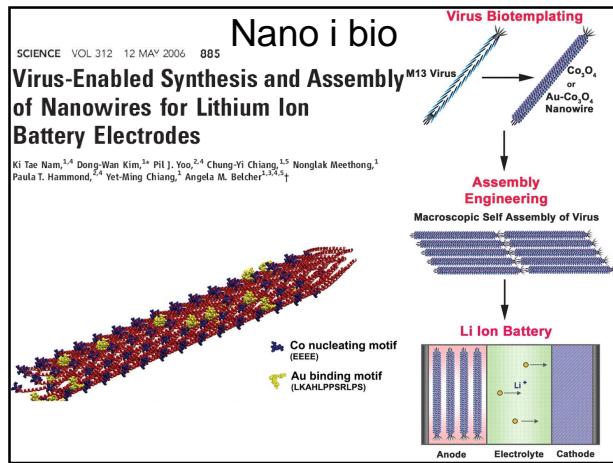
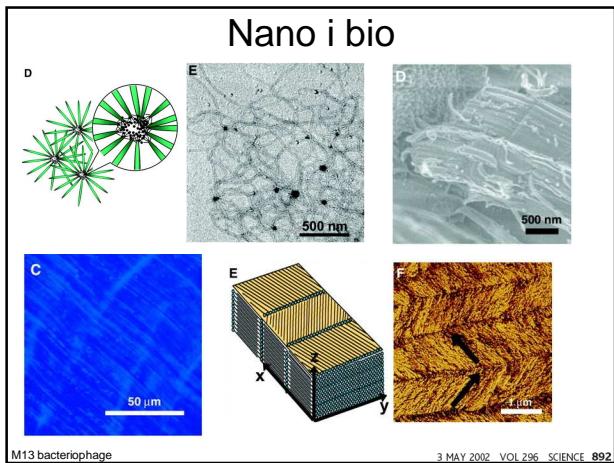
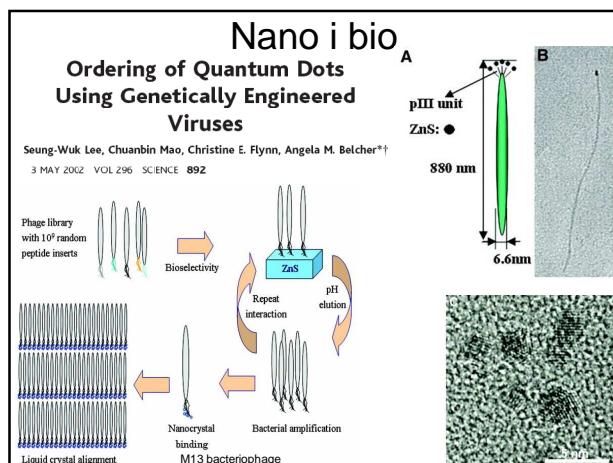
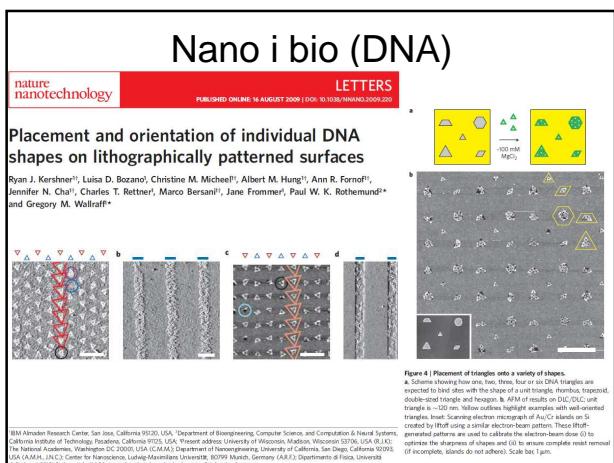
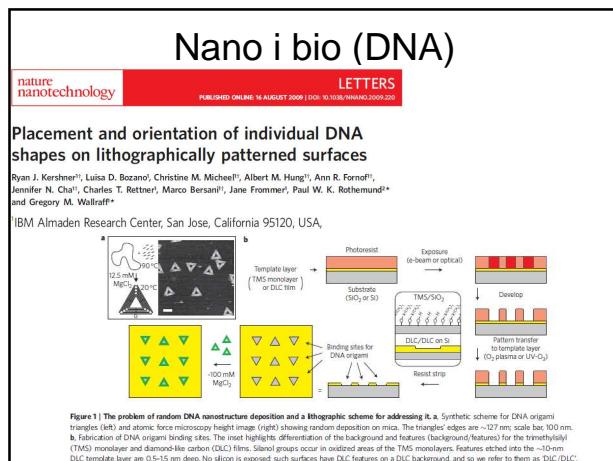
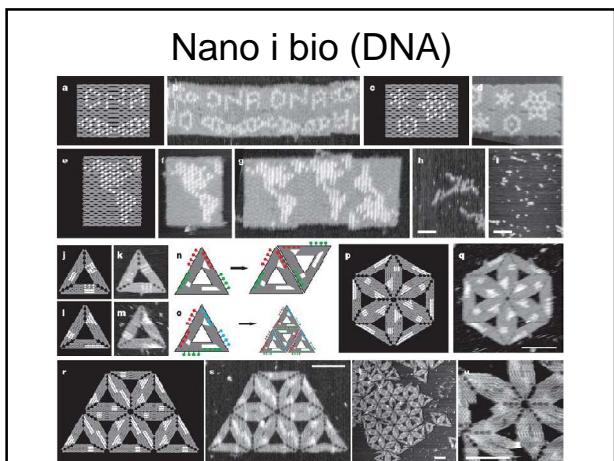
Folding DNA to create nanoscale shapes and patterns

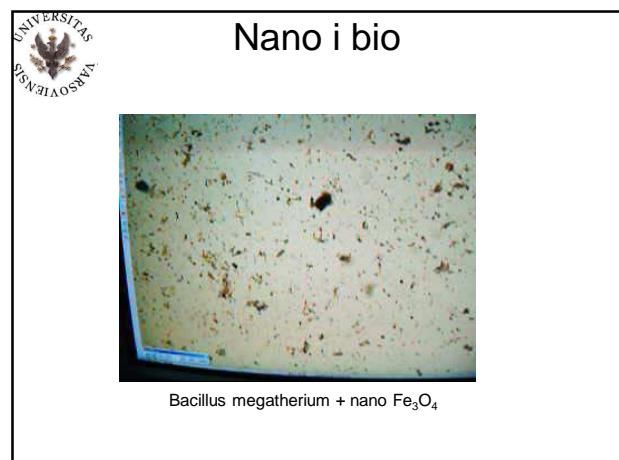
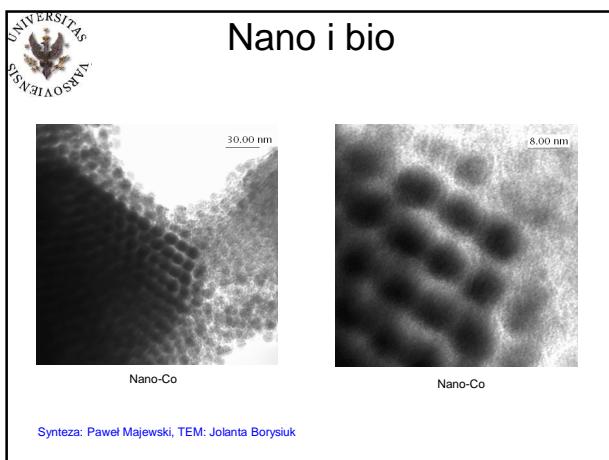
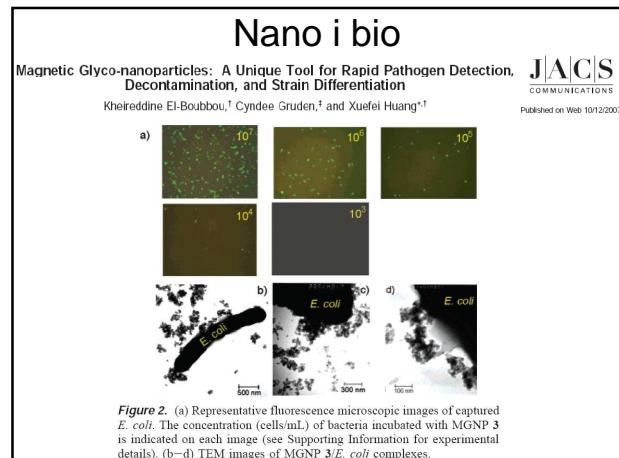
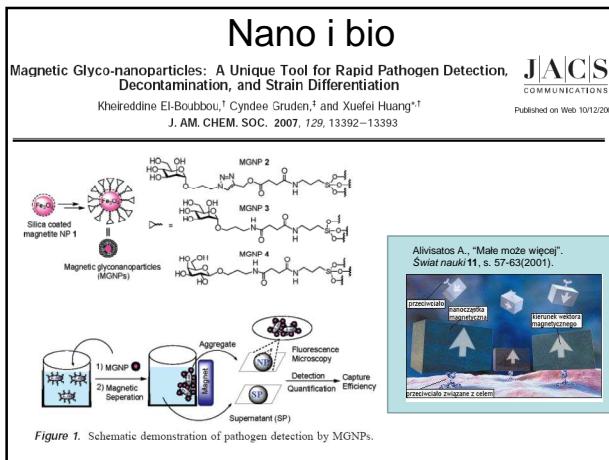
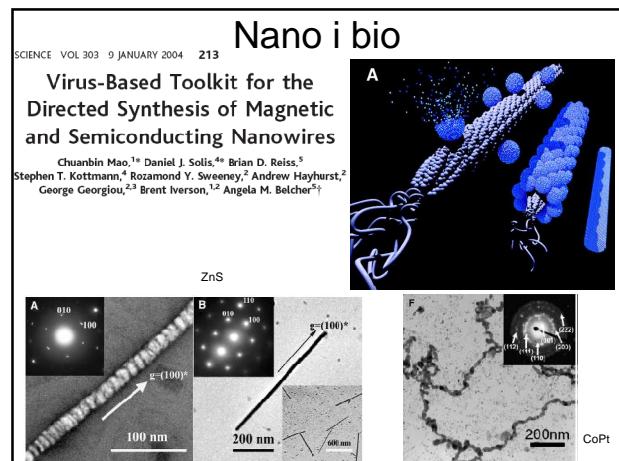
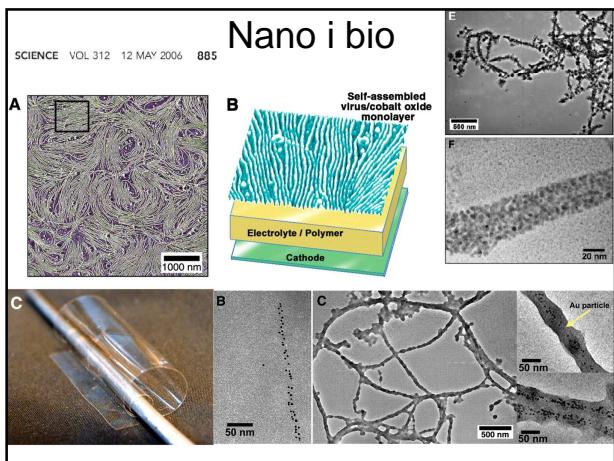
Paul W. K. Rothemund¹



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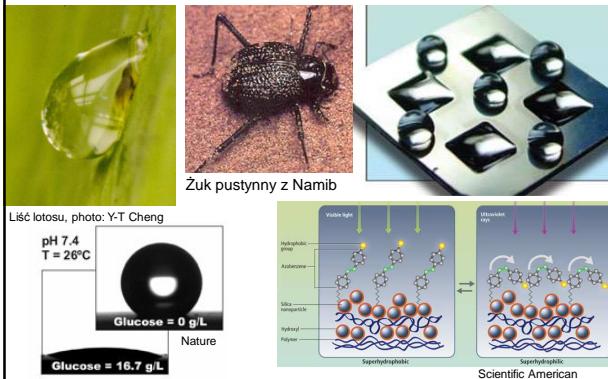


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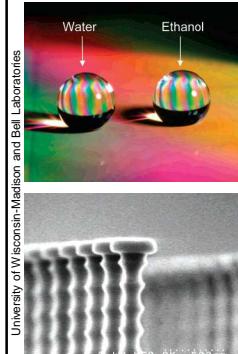
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Pokrycia nano - NanoNed

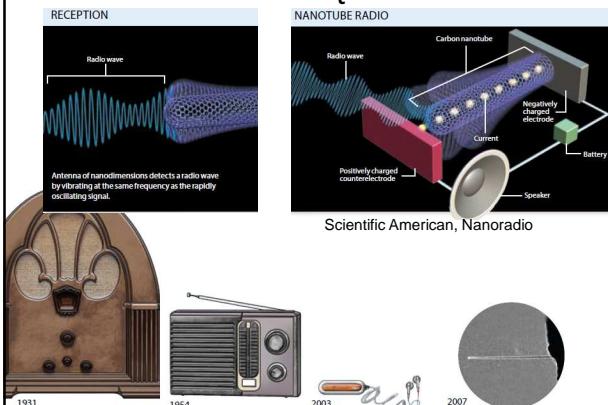


Pokrycia nano - NanoNed

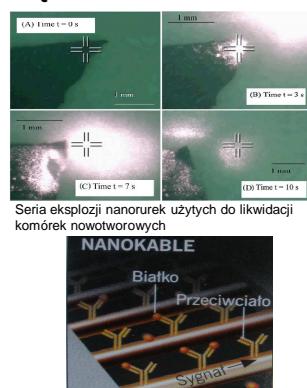
http://www.nanowerk.com/spotlight/?sp0id=3032.php

Nan-Rong Chiu, Chunmeng Lu, Jingjiao Guan, L. James Lee & Arthur J. Epstein
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07.01.2010