

Smoke, Mirrors, and some Really Cool Science

**Current perspectives on
nanotechnology**

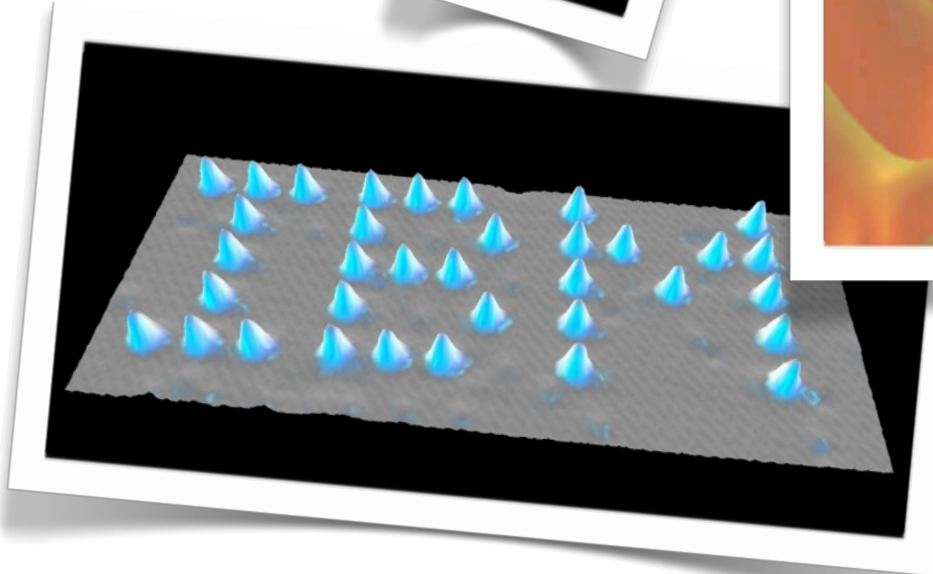
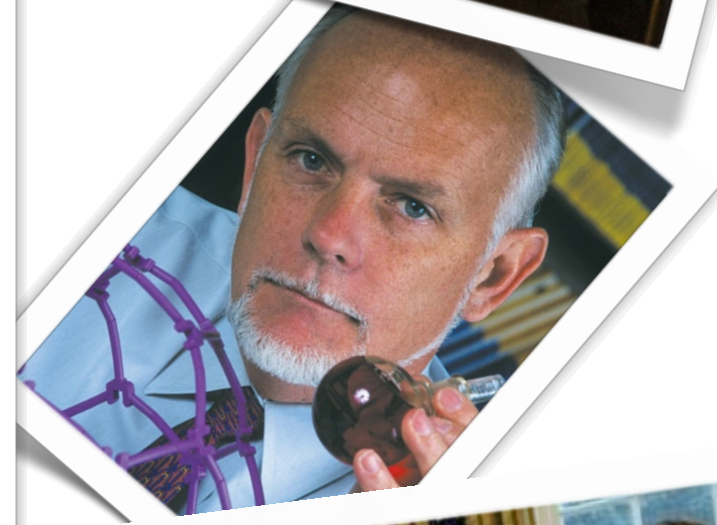
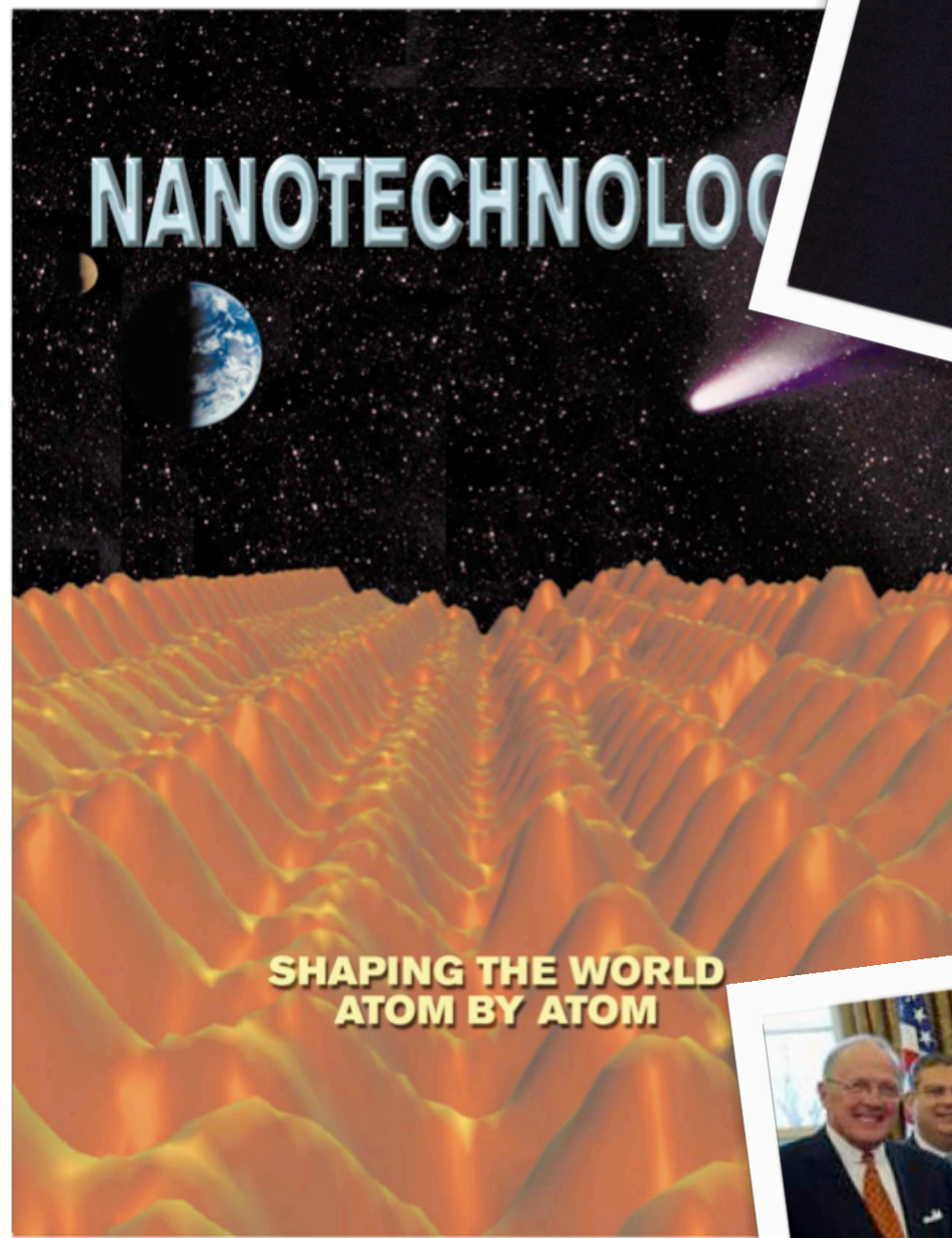
Andrew D. Maynard

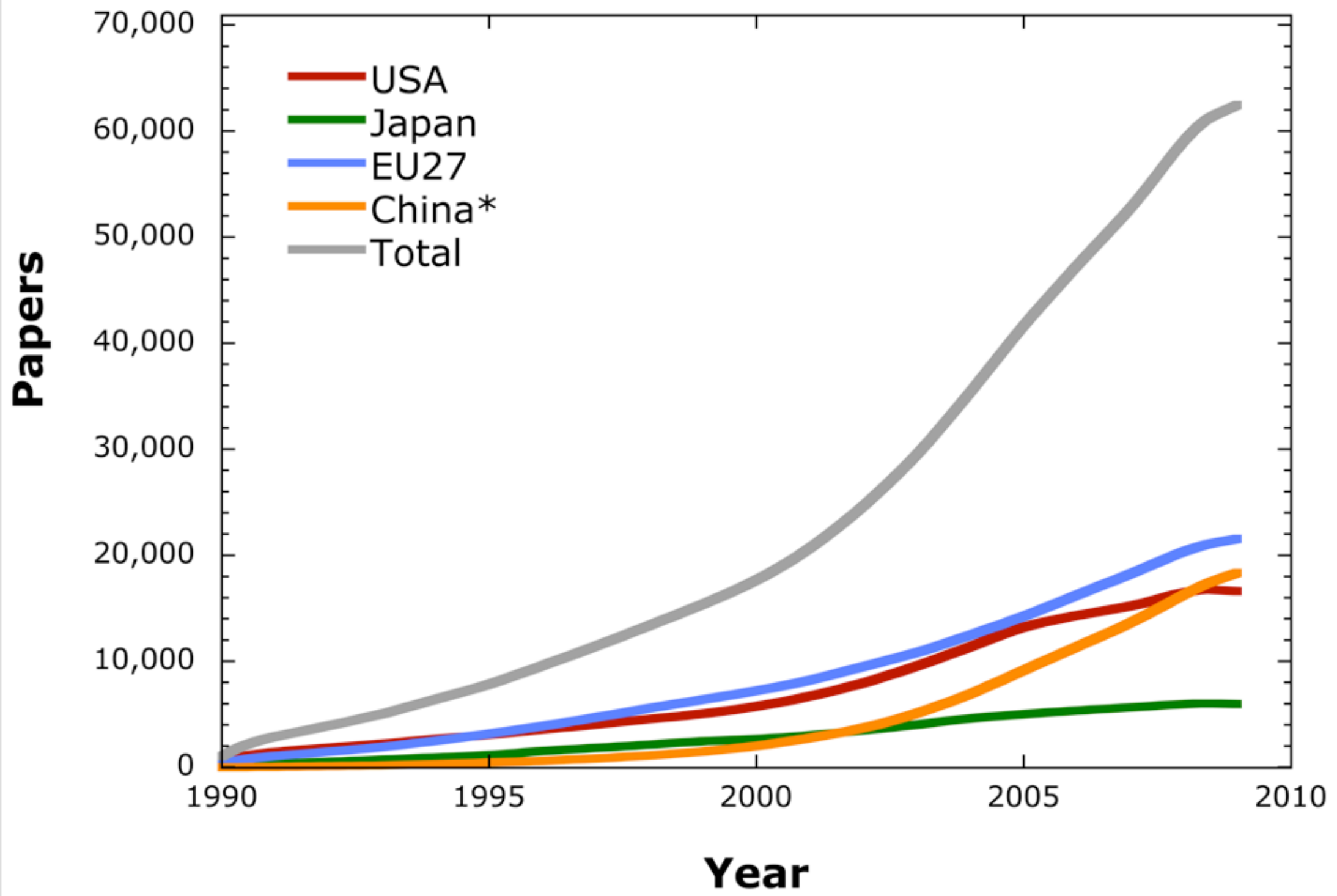
Director, Risk Science Center
University of Michigan School of Public Health

An outline:

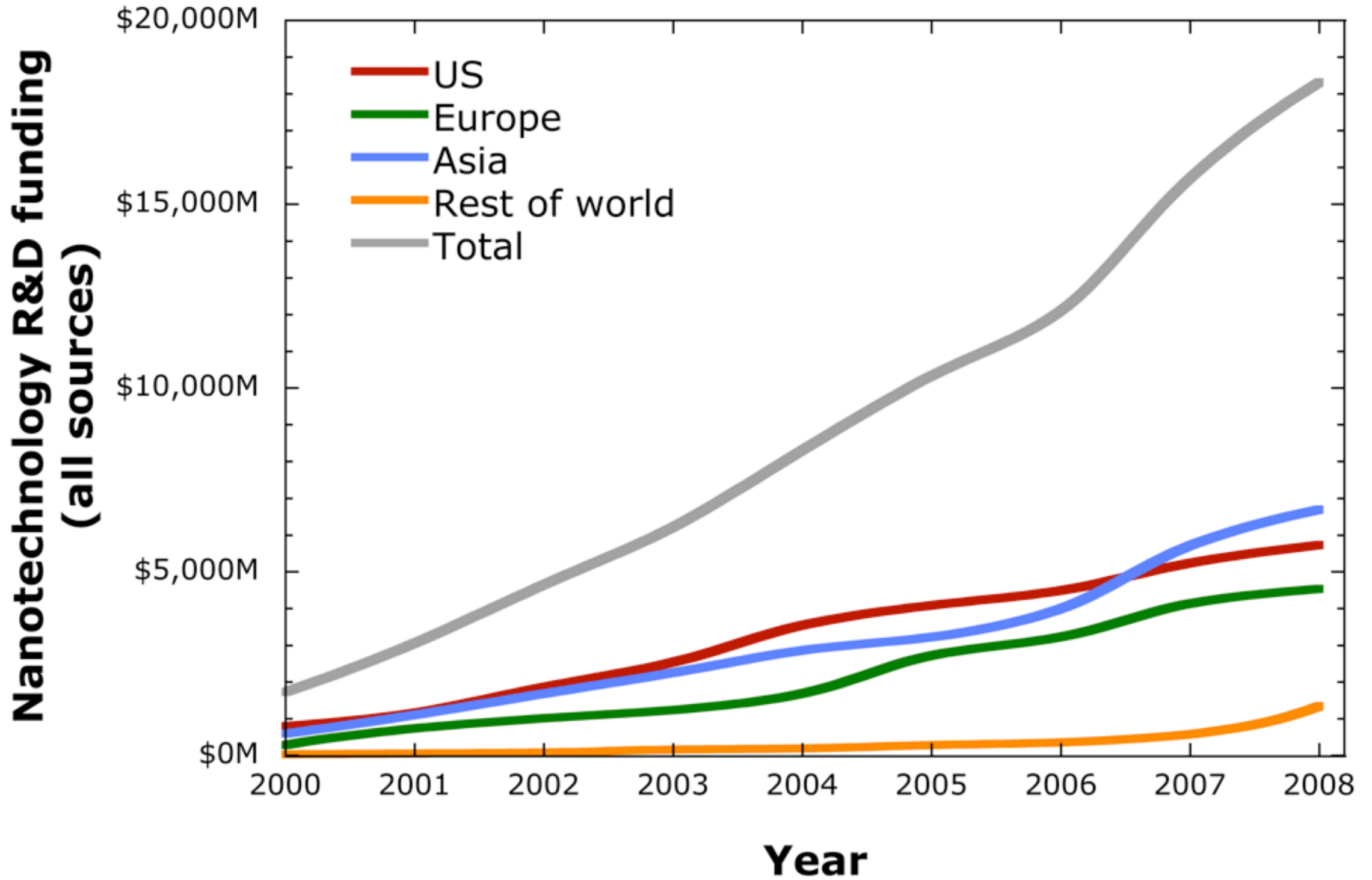
- **Nano is fab**
- **Nano is rubbish**
- **Nano is real**

Nano is fab

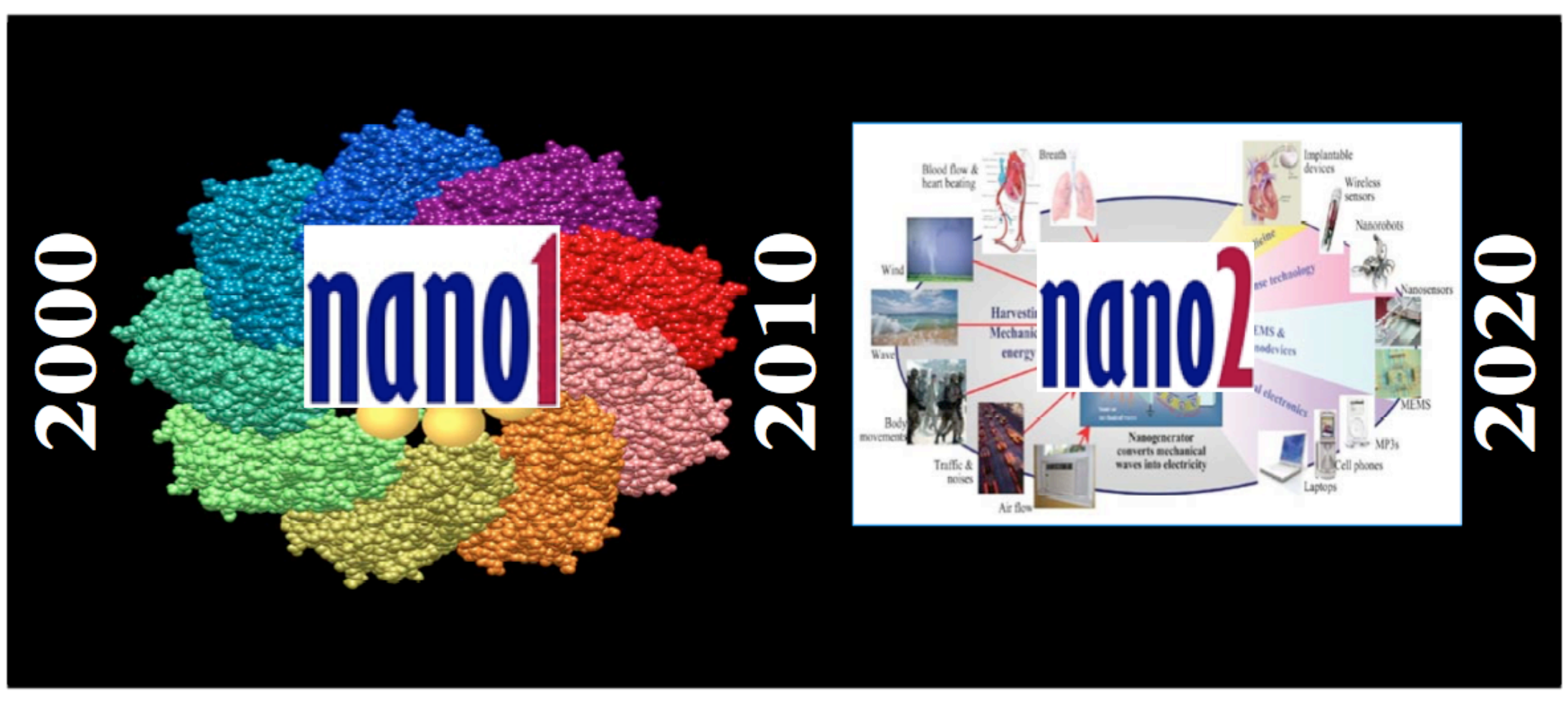




Source: PCAST (2010) Report to the President and Congress on the Third Assessment of the National nanotechnology Initiative. Washington DC:President's Council of Advisors on Science and Technology.



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450 pages of stuff!

Nano2: *The next ten years of nanotech*

Nano-bio interfaces

Biology inspired technologies

Understanding interactions in complex nanosystems

Molecular understanding of biological processes

Interactions of nanostructures with external fields

Powerful, compact batteries

Interactive electronic books

Cognitive technologies

Next generation electronics

Artificial organs

Better disease treatment

Novel computing systems

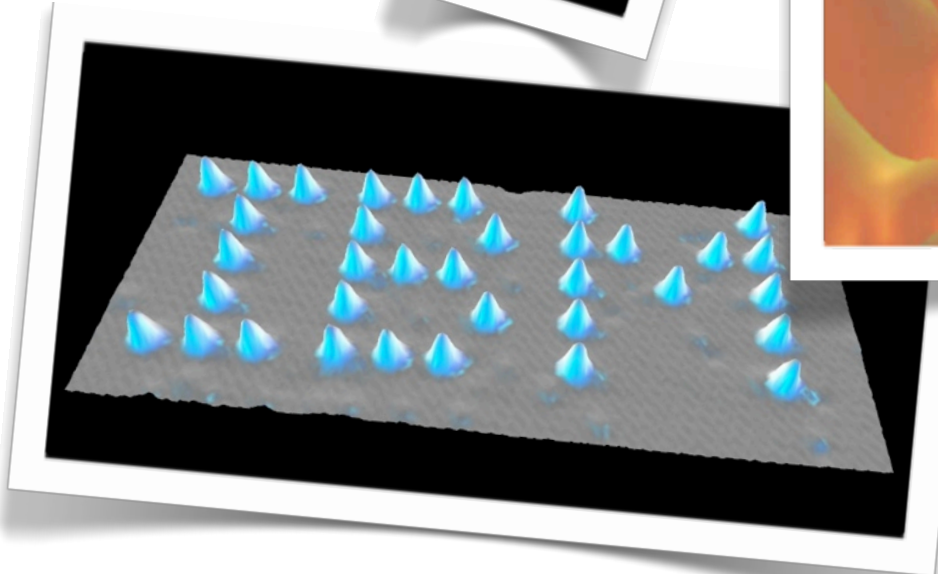
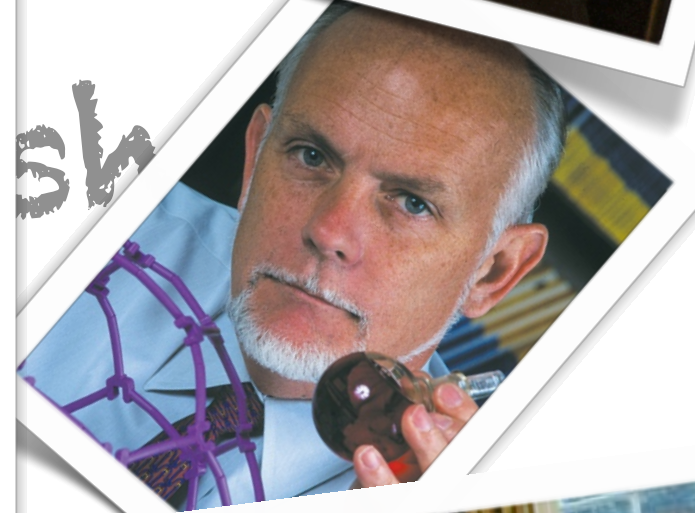
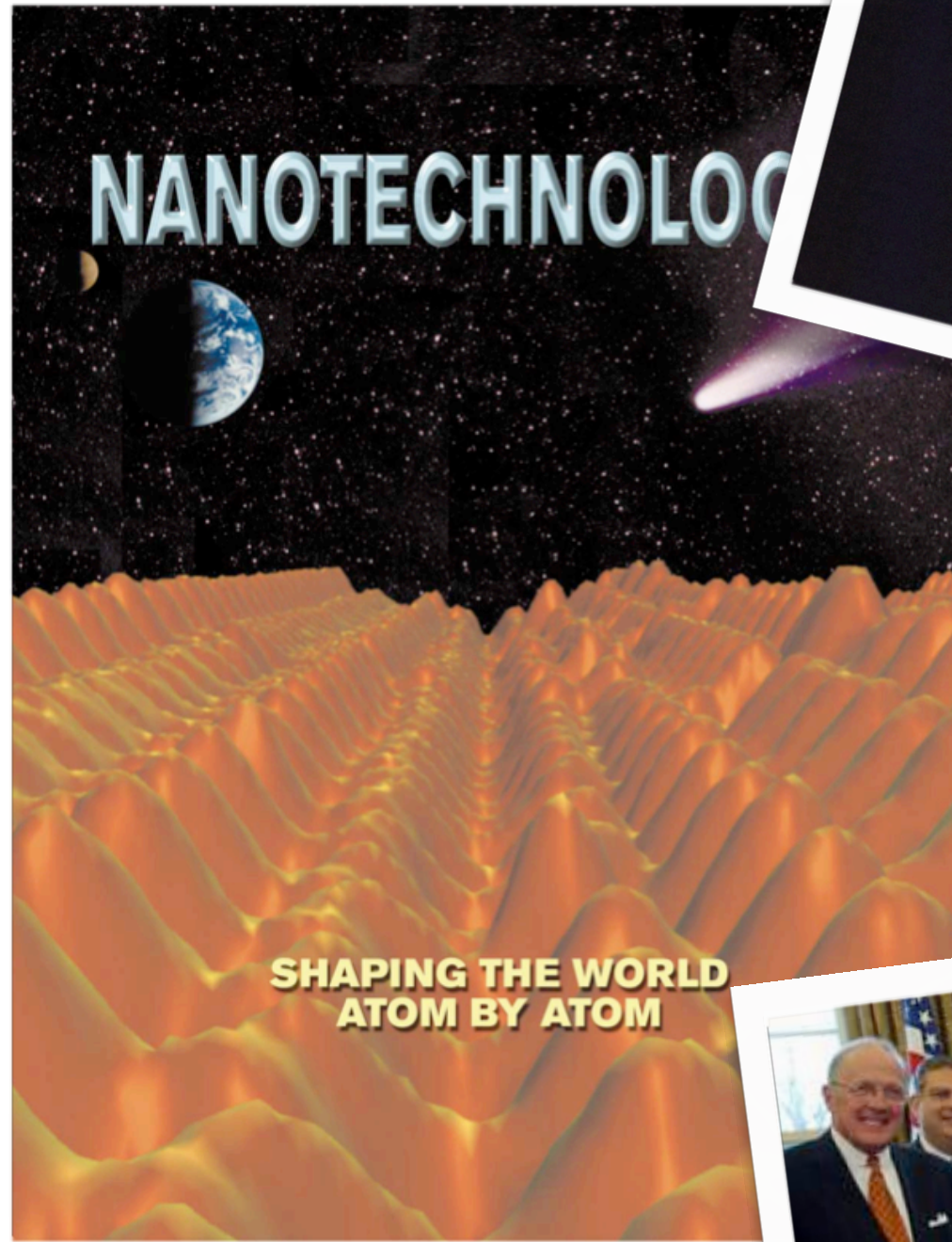
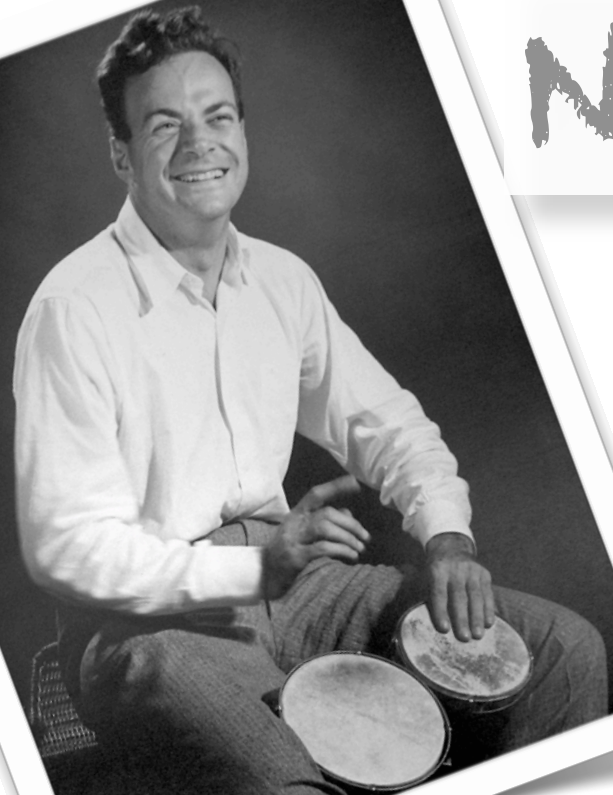
Exploiting quantum effects

Self-assembling materials

Designing materials from atoms up

Smart prosthetics

Nano is rubbish



Welcome to the Nanotechnology

BRAND

Attention-grabbing

Worth lots of dosh

But is it Safe/Ethical/Legal?
(or is that a daft question?)

Inspirational



The **Lady Gaga**
Brand

Attention-grabbing

Worth lots of dosh



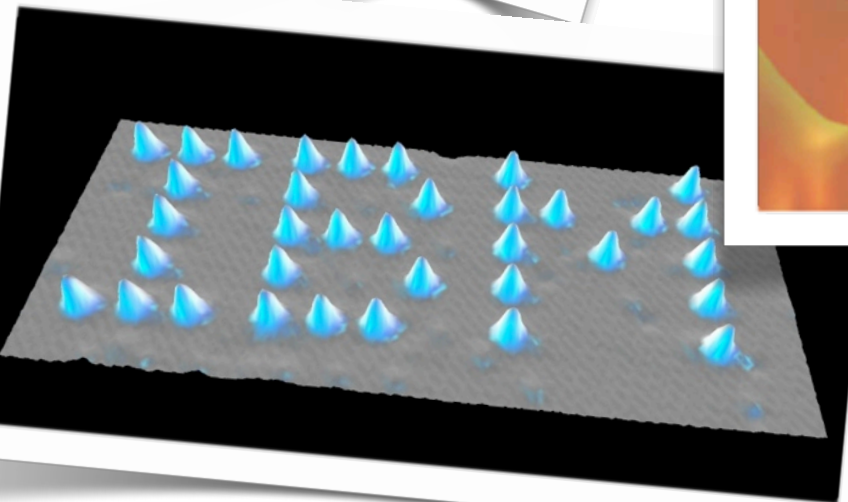
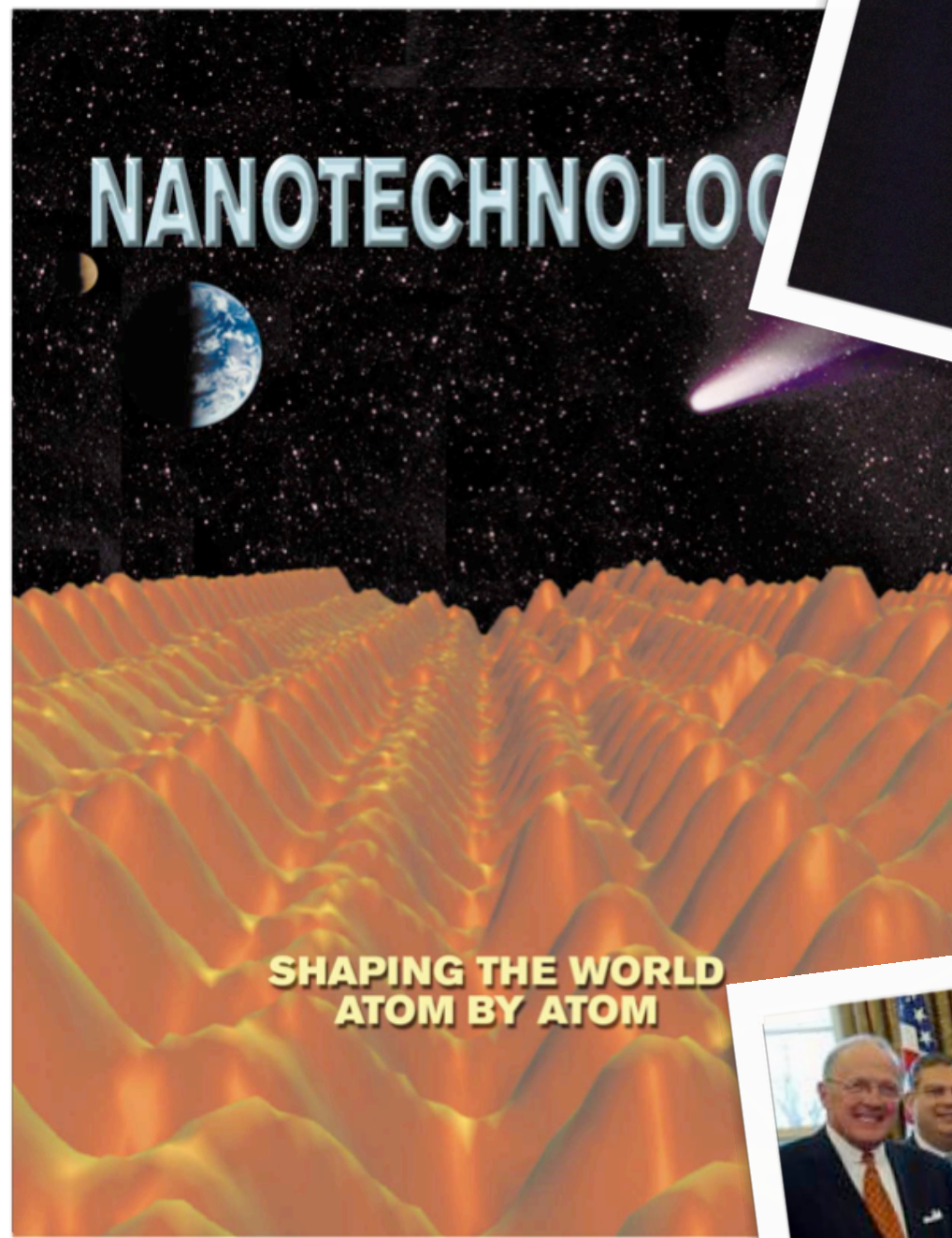
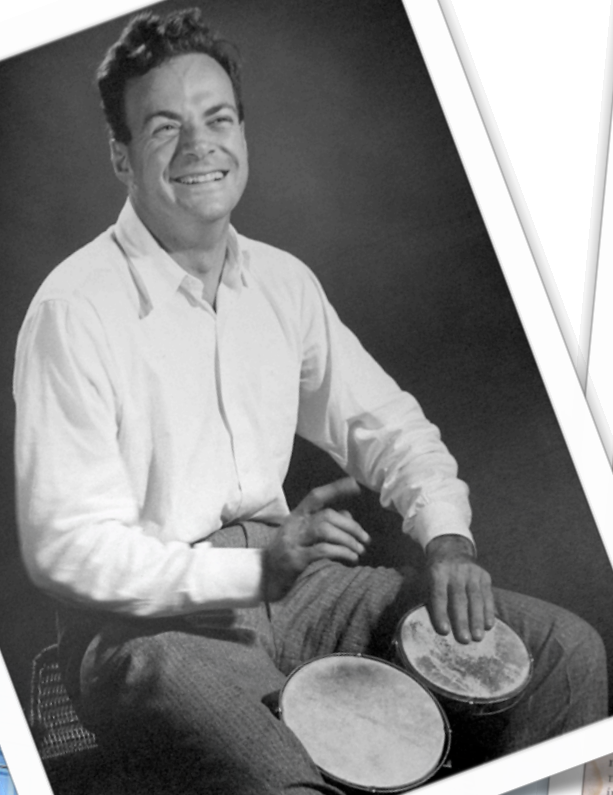
But is it Safe/Ethical/Legal?
(or is that a daft question?)



Inspirational

The Nanotech
Brand

Nano is real



Bitte, fordern Sie den neu
DEGUS
ABT. RUSS · FRAN

*Oh @\$% , we have a **Problem!***

A Wicked Problem: a problem “which [has] a multitude of stakeholders showing interest, but an inability for stakeholders to agree on either the nature of the ‘problem’ (to the degree that it exists at all), or on the most desirable solution to be applied”

Klijn, E-H. (2008), It's the Management, Stupid', On the Importance of Management in Complex Policy Issues, Uitgeverij LEMMA: The Hague

Challenges

Climate change, **environment**, and sustainability
Rapidly growing demand for **energy**
Limited **resources**
Shifting centers of **economic activity**
Growing demand for **food**, nutrition, and health

Increasing scarcity and unequal distribution of **water**
Corporate global **citizenship**
Social life in a technological world
Demographics, including shifting populations and mobility

Innovations

Vaccines

Advanced **sensors**

Next generation **electronics**

Point of use **energy** generation

Better **food** preservation

Smart **drugs**

Water desalination

Strong, lightweight **materials**

Automated **traffic** management

Carbon **sequestration**

Soil management

Efficient **resources** use

Climate control

Resilient **crops**

Increased **land** productivity

Thermal **insulators**

Irrigation

Better **batteries**

Smart **grids**

Smart **materials**

Bottom-up **manufacturing**

Renewable **energy** sources

Immersive **communications**

High value **crops**

Efficient resource **extraction**

Disease management

Advanced **prosthetics**

Better health **diagnostics**

High conductivity **materials**

Safer **nuclear** power

Substitute materials

Targeted **pesticides**

Biofuels

Water separation

Sustainable **production** processes

At-source water **purification**

Technology Platforms

Biotechnology

Geoengineering

Cognitive technology

Synthetic Biology

Robotics

Computational chemistry

Information technology

Nanotechnology

Artificial Intelligence

Bio-interfaces

Web 2.0

Data interfaces

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Innovations

Vaccines	Carbon sequestration	Smart grids	Better health diagnostics
Advanced sensors	Soil management	Smart materials	High conductivity materials
Next generation electronics	Efficient resources use	Bottom-up manufacturing	Safer nuclear power
Point of use energy generation	Climate control	Renewable energy	Substitute materials
Better food preservation	Resilient crops	Intelligent pesticides	Advanced manufacturing processes
Smart drugs	Increased land productivity	Advanced robotics	Advanced material creation
Water desalination	Thermal insulators		
Strong, lightweight materials	Irrigation		
Automated traffic management	Better batteries		

Tech

Biotechnology	Synthetic
Geoengineering	Robotics
Cognitive technology	Computational

Information technology

Nanotechnology

Artificial Intelligence

Deconstructing **Nanotechnology**

Nanotechnology is the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications. Encompassing nanoscale science, engineering, and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.

National Nanotechnology Initiative: www.nano.gov

Mmm...

Deconstructing **Nanotechnology**

What is **OLD**?



Generation

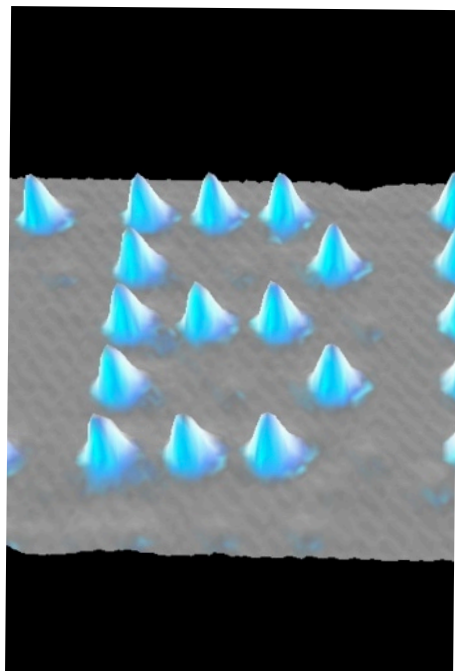


Utilization



Manufacture

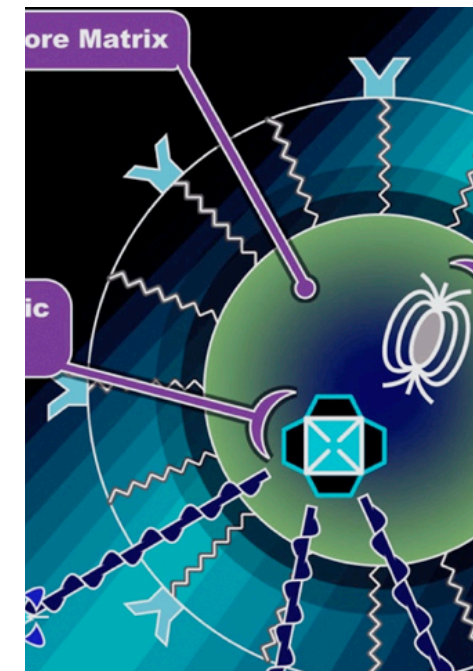
What is **NEW**?



Control



Strangeness



Sophistication

Reconstructing **Nanotechnology**

Nanoscale Science
and Engineering

Playing around with *small stuff* to make the
big stuff work better

Reconstructing Nanotechnology

Nanoscale Science
and Engineering

What is OLD?



Generation

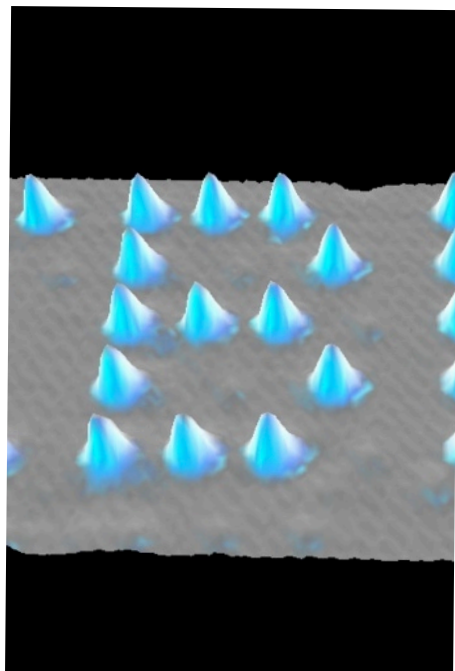


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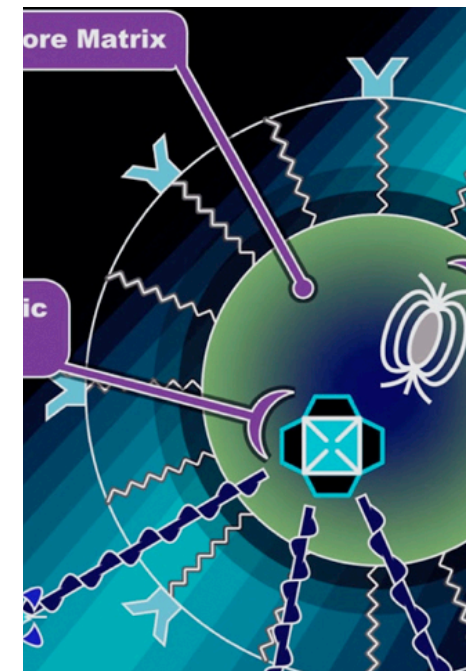
What is NEW?



Dexterity



Exploitation



Complexity

Technology Platforms

Biotechnology
Geoengineering
Cognitive technology

Synthetic Biology
Robotics
Computational chemistry

Information technology
Nanotechnology
Artificial Intelligence

Bio-interfaces
Web 2.0
Data interfaces

**Nanoscale Science
& Engineering**

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Geoengineering
Cognitive technology
Synthetic Biology
Robotics
Computational chemistry
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Nanoscale Science & Engineering

Vaccines

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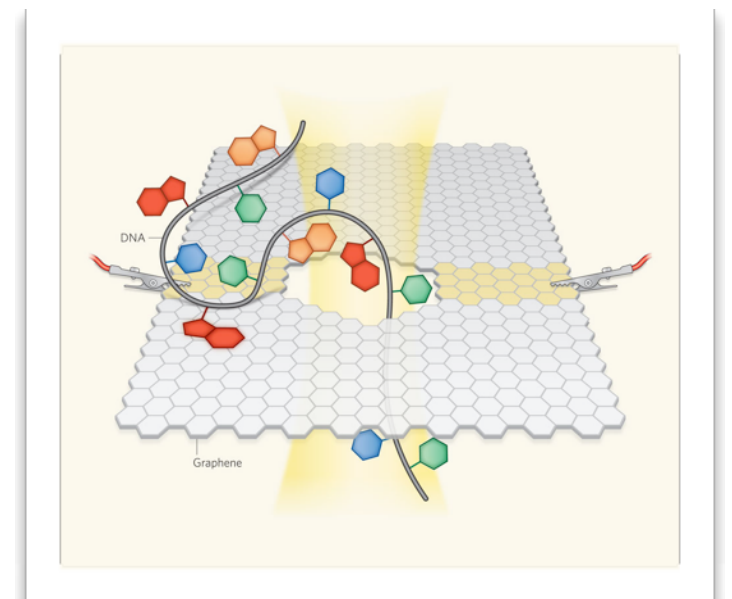
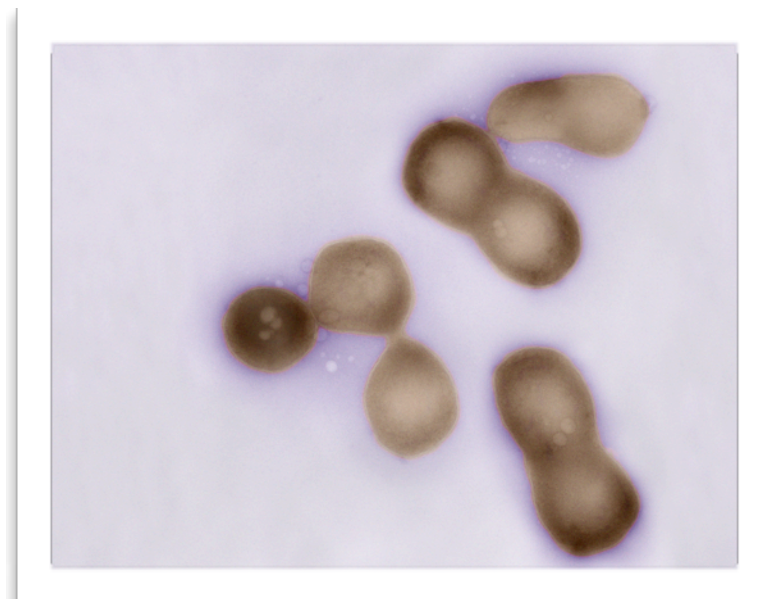
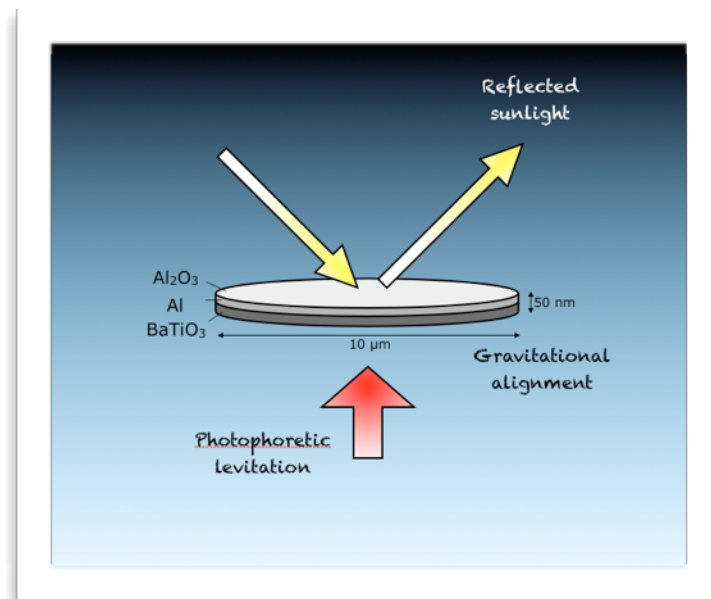
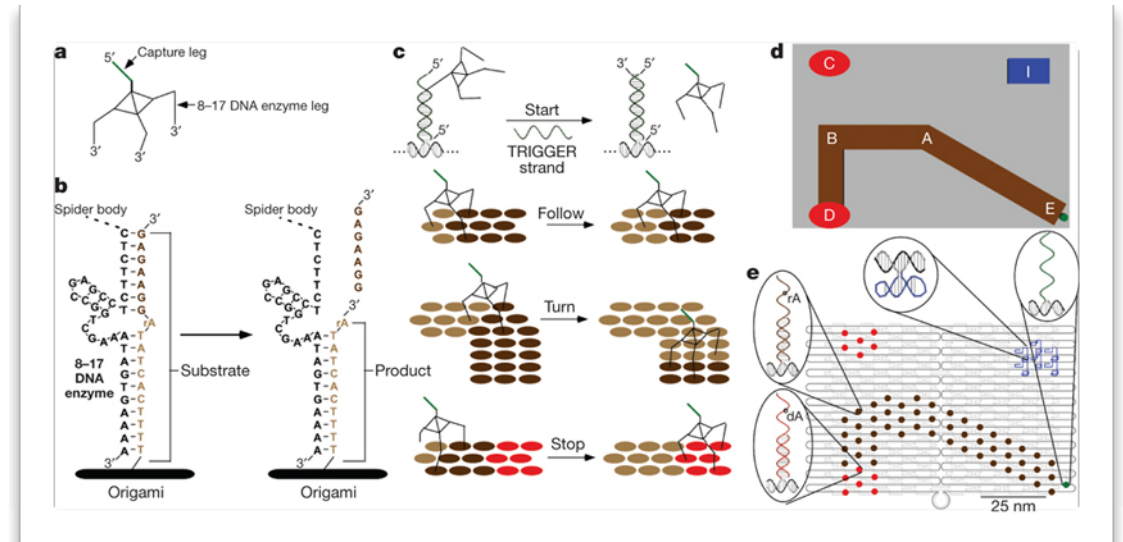
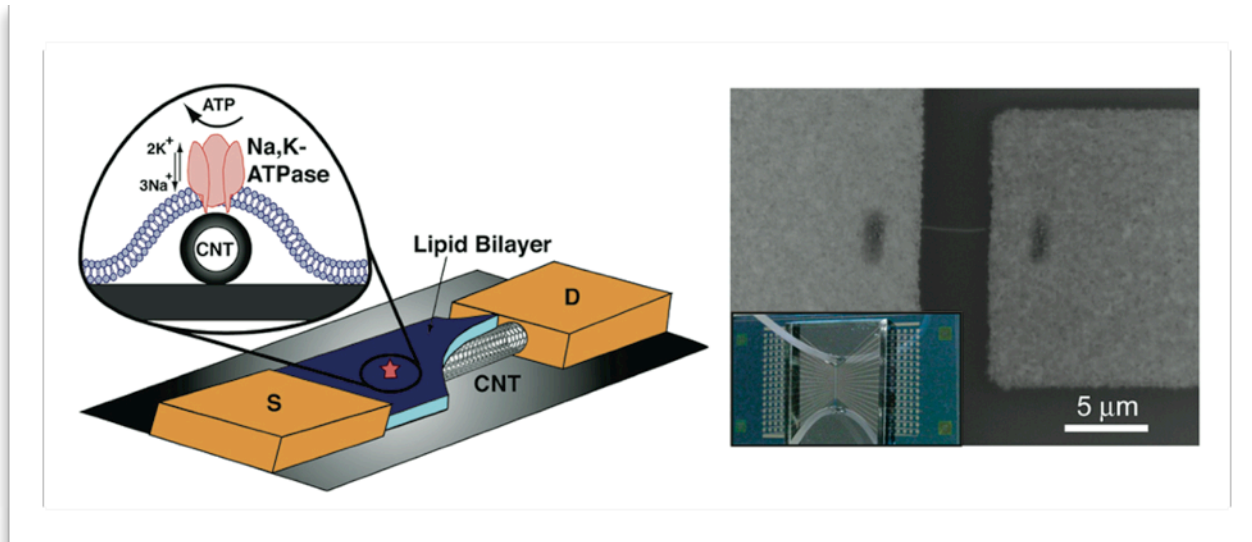
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Demographics, including shifting populations and mobility

**Nanoscale Science
& Engineering**

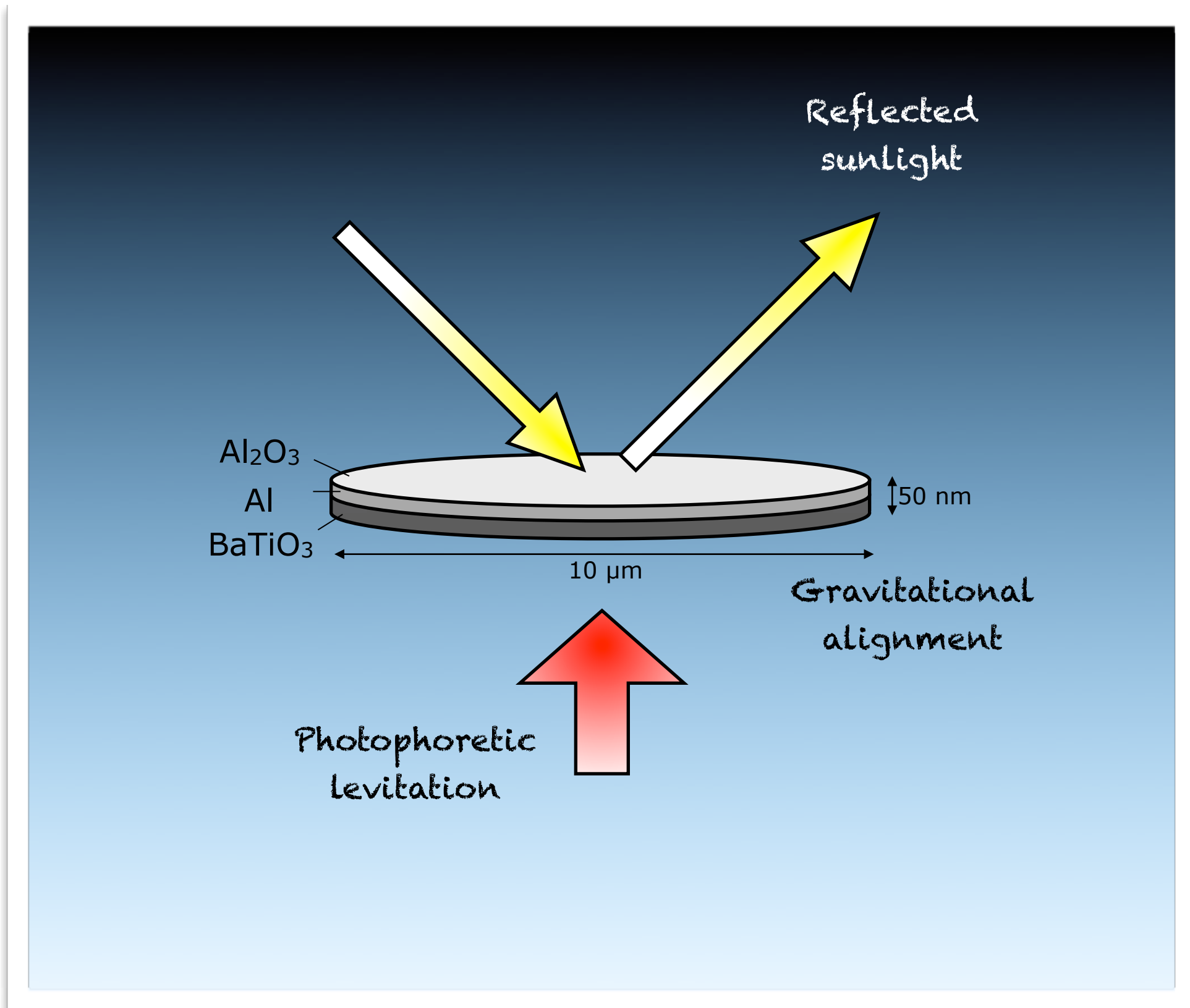
**Social, economic &
political factors**

Environment
Sustainability
Energy
Resources
Economics
Food
Water
Citizenship
Social life
Demographics

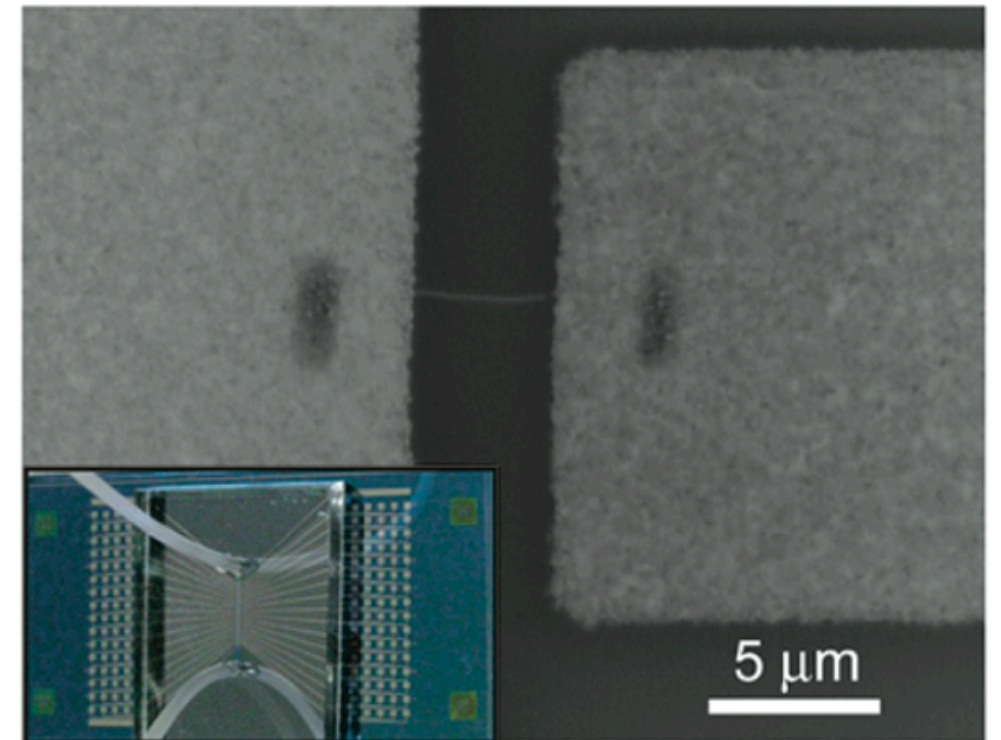
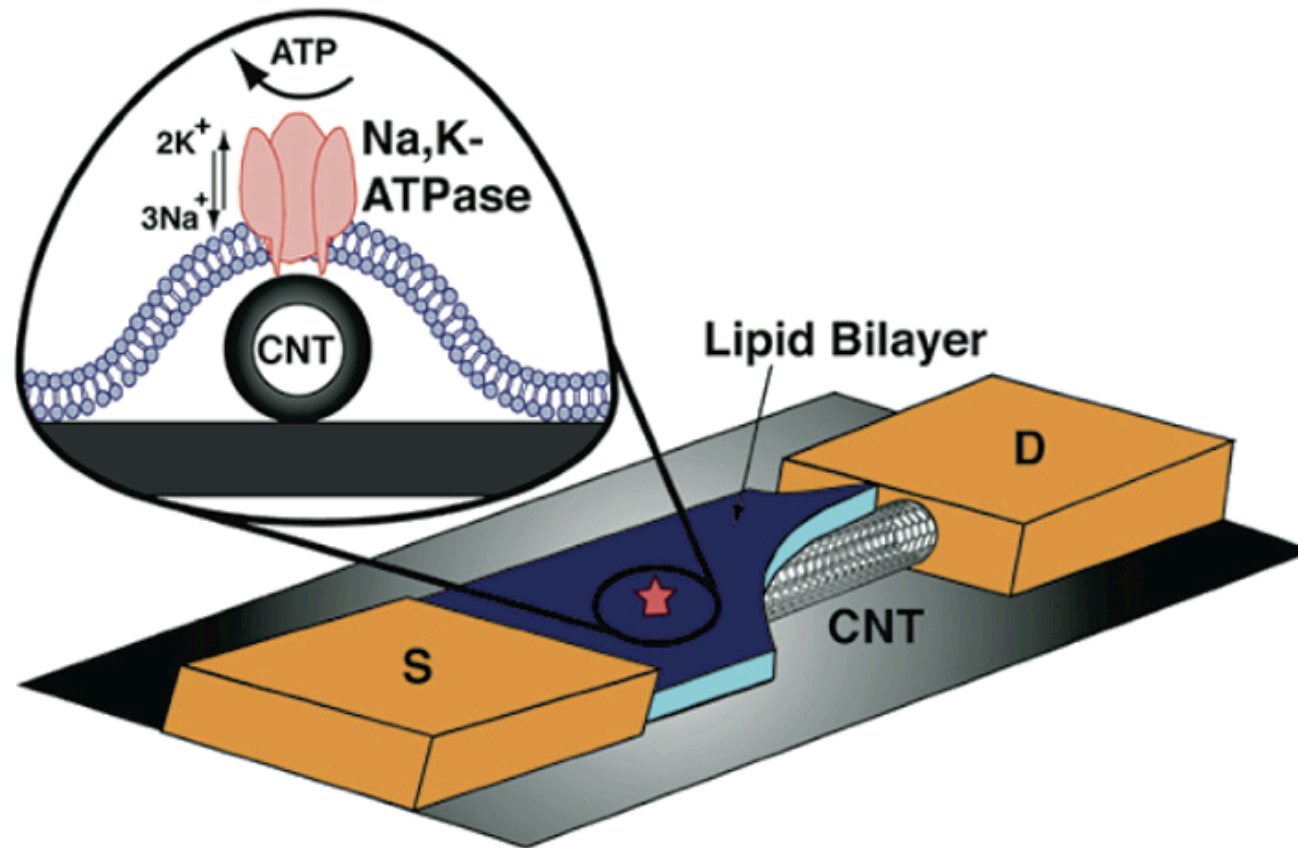
Five Examples:



Geoengineering

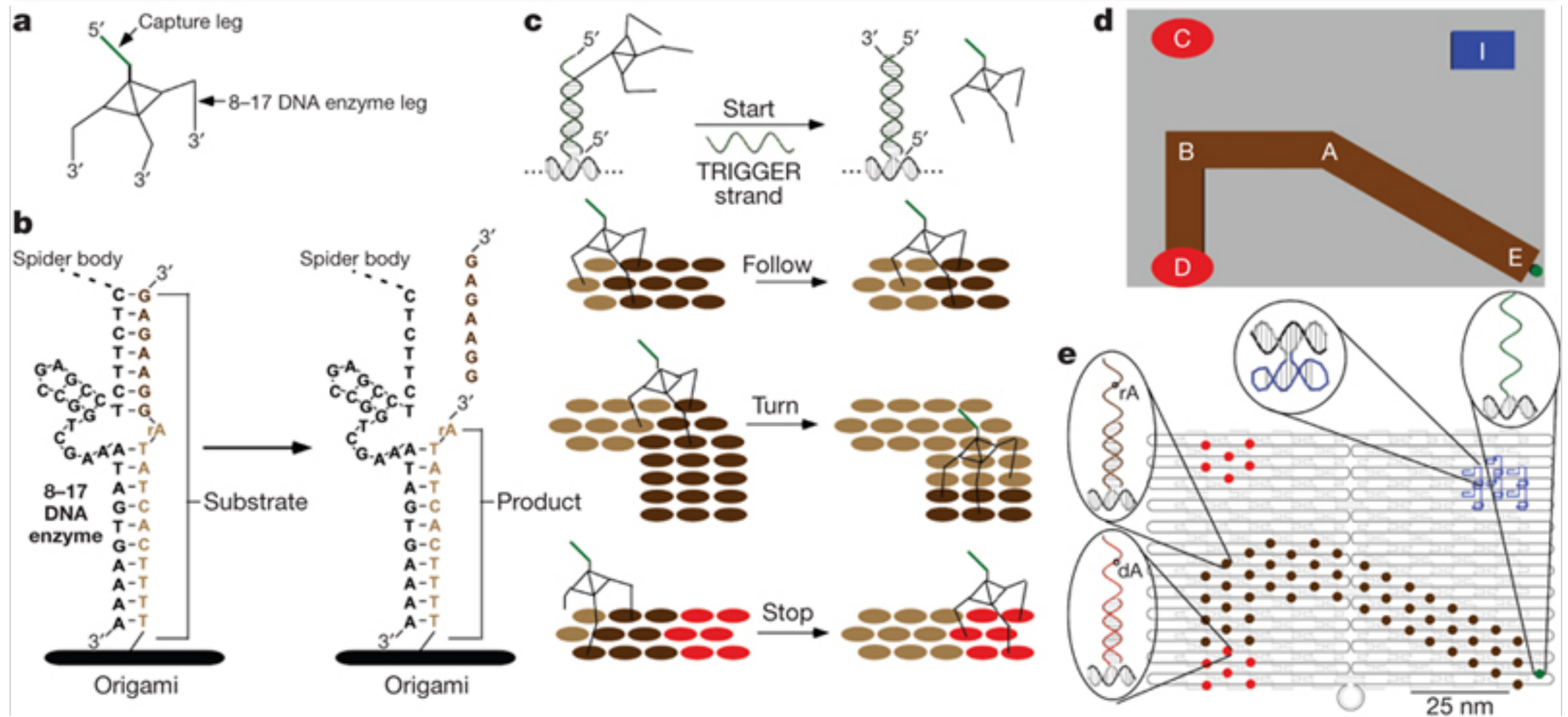


Hybrid electronics

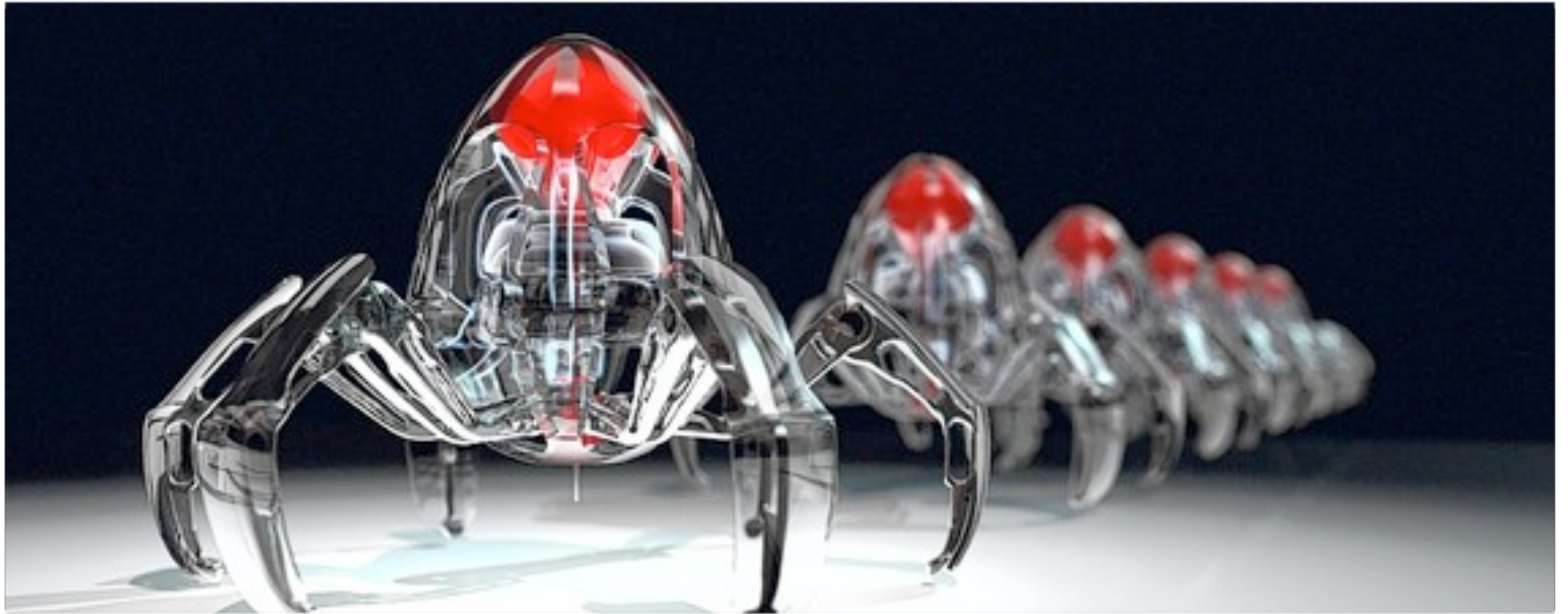


S-C J. Huang *et al.* *Nano Letters* **10**, 1812-1816 (2010) doi:10.1021/nl100499x

DNA manipulation



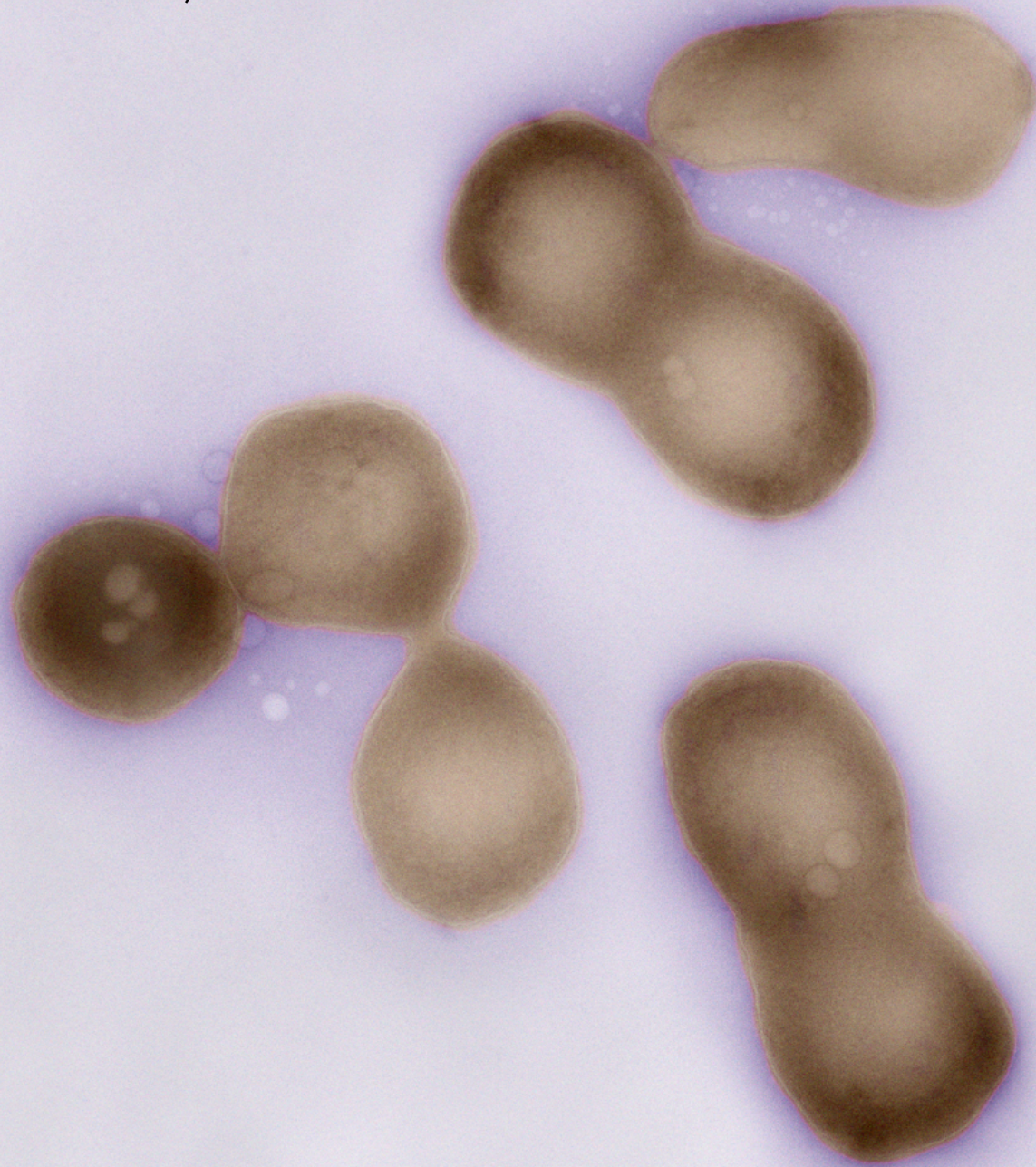
K Lund *et al.* *Nature* **465**, 206-210 (2010) doi:10.1038/nature09012



“They Walk. They Work. New DNA Robots Strut Their Tiny Stuff”
Wall Street Journal, May 13 2010

Genome engineering

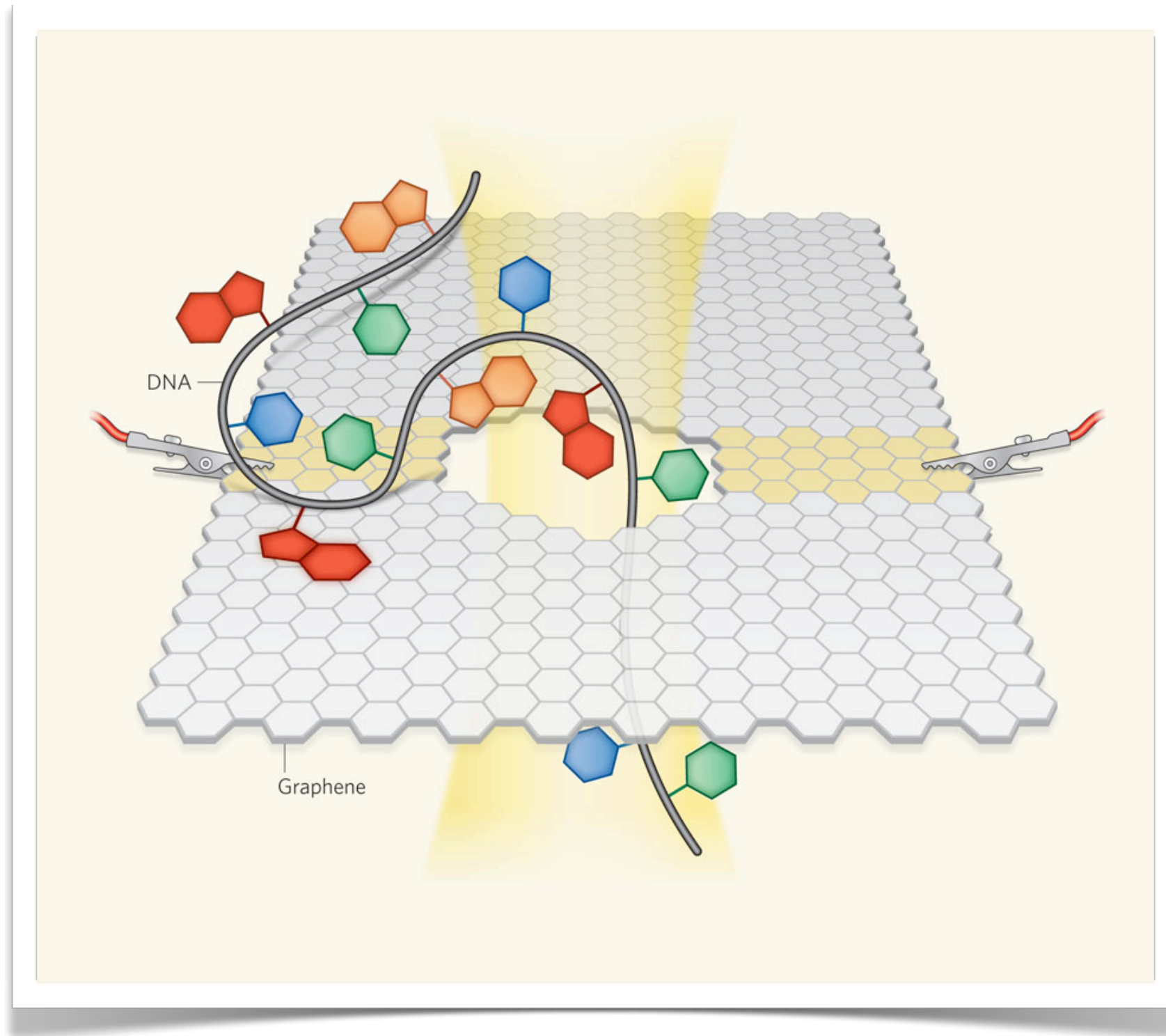
Mycoplasma mycoides JCVI-syn1



J. Craig Venter Institute

Gibson et al. (2010). Science, DOI: [10.1126/science.1190719](https://doi.org/10.1126/science.1190719)

Graphene DNA-sequencing



Bayley H. 2010. Nanotechnology: Holes with an edge. *Nature* 467(7312): 164-165.

And your point was?

Nanoscale science & engineering are much bigger than brand-nano.

Nanoscale science & engineering are powerful agents of change. But...

...they need to be understood in a broad technological, social, economic and political context. And...

...if you want to engage people on nano, starting with the nano *brand* probably isn't the best way to go about it.

Andrew D. Maynard

Director, Risk Science Center
University of Michigan School of Public Health
1415 Washington Heights
SPH I Room 1792
Ann Arbor, MI 48109
Email: maynarda@umich.edu

Contact: Hilda McDonald, Tel: 734-615-3050, Email: hildiris@umich.edu

Risk Science Center: <http://umriskcenter.org>

Blog: <http://2020science.org>

Twitter: <http://twitter.com/2020science>