1974

Norio Taniguchi

Manifestos

1959 Richard Feynman
«There's Plenty of Room at the Bottom»

1986 Eric K. Drexler «Engines of Creation: The Coming Era of Nanotechnology»

"NANOTECHNOLOGY-BRIDGE TO THE FUTURE"

‘The list of things you could do with nanotechnology reads like much of the Christmas Wish List of our civilization’

Richard Smalley, 1995.

Tamar Chachibaia

Presented at

EthicSchool summerschool on Ethics on Nanotechnology,

UNIVERSITY OF TWENTE, NETHERLANDS

24-29 August, 2008

Health Monitoring and Assessment of Nondestructive Use of Nanoparticle Gold Compounds

Georgian National
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Initiative Group &
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Technology Assessment

- The aim of Technology Assessment is to measure benefit to risk ratio and to maintain balance between benefits & risks of technology.
- The purpose of TA is to study ethical controversies in societal prism.
- Technology Assessment determines public perception and formation of visionary attitude.

How should people benefit from achievements of Nanotechnology and engineering?

At which extent the quality of life will improve thanks to synthesis of new materials?
Answers to these and related questions are encouraging , thanks to achievements in Nanotechnology.

Nanotechnology

Although nanotechnology is a relatively recent development in scientific research, the development of its central concepts happened over a longer period of time.

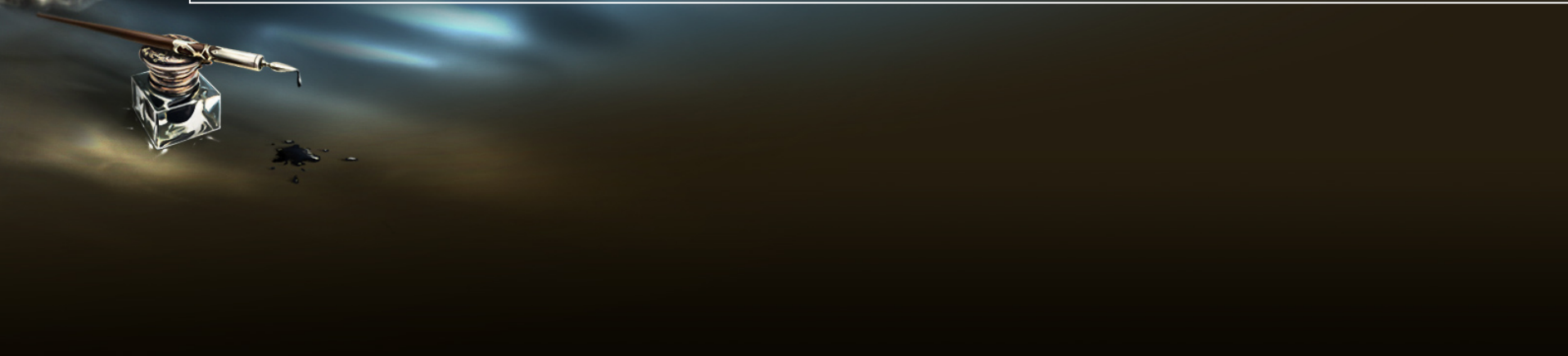
• So, what we know about NT?

- Has a long history
- Has a solid theoretical basis
- Has been looked at seriously for nearly

30 years!

Nanotechnology - shift from visual to tactile perception

- NanoT&S got started in the early 1980s with two major developments: invention of the scanning tunneling microscope (STM), and the atomic force microscope was invented after five years.
- The AFM uses atomic force to see the atoms.
- IBM scientist enabled manipulation even individual atoms to design and synthesize materials for desired features.



Nobel Prize Awards

IBM - 1986

Binnig & Rohrer

1990

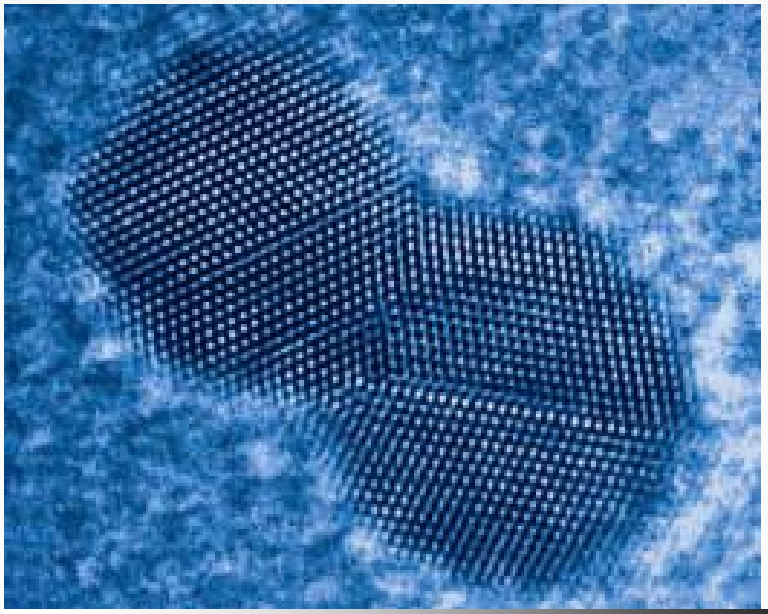
Eigler & Schweitzer

- This image created by IBM scientists demonstrates a new nano "printing" technique they believe will lead to breakthroughs in ultra-tiny chips, ultra tiny lenses for optics, and biosensors for healthcare.. The recreation of ***Robert Fludd's 17th century drawing of the Sun – the alchemists' symbol for gold*** -- was created by precisely placing 20,000 gold particles, each about 60 nanometers in diameter.
- Credit: IBM

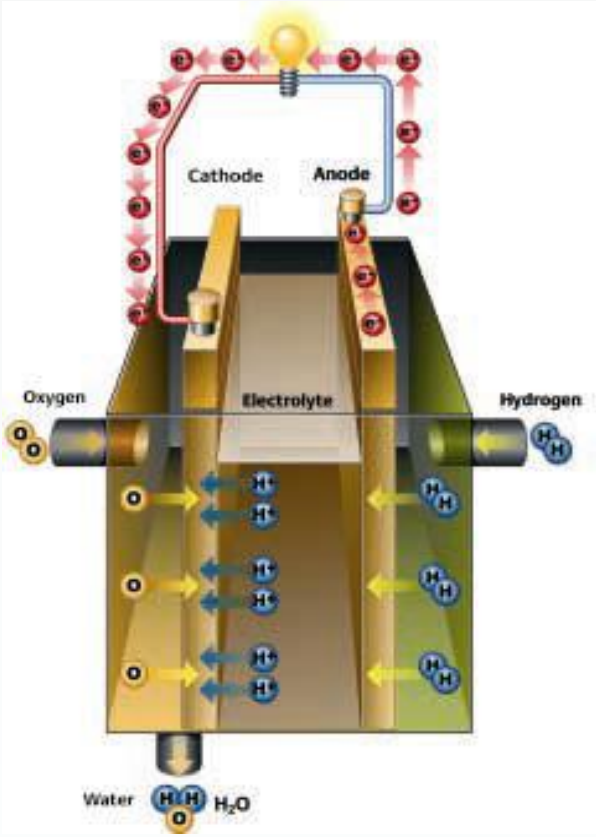
Published: 07:56 EST, September 11, 2007
http://archive.physorg.com/11/09/2007

- When dealing with constraints of size below 100 nm, the laws of quantum physics supersede those of traditional physics, resulting in changes of a substance’s properties.
- For instance, Japanese scientists from Osaka National Research Institute (Haruta, 1997) discovered *catalytic behavior of nanoscaled gold particles*, which is revealed while the particle diameter is turned smaller than 3-5 nm. Gold nanoparticle catalysts can vanish smells created by bacteria. In practice this invention was tested to prevent odor. In Japan already in service in rest rooms.

•Another application for this invention is utilized in fuel cells of hydrogen batteries. Above described case emerges awareness of risk - what is the possibility of nanosized gold particles to become potentially toxic catalysts within the human body.



Nanoparticles of gold for new catalysts

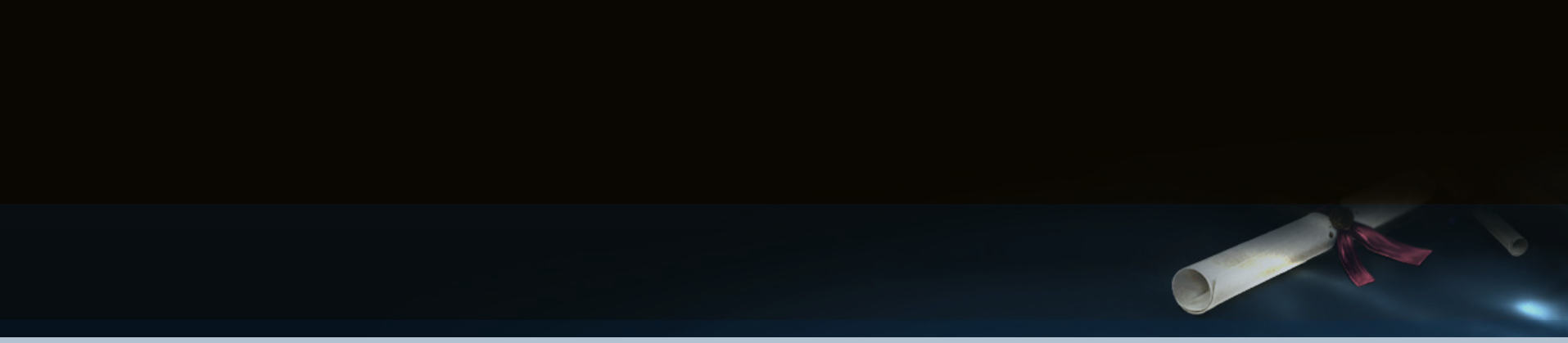


Credit: Nanotechnology 'Innovation for tomorrow's world'

by Dr. Mathias Schulenburg, 2004

Quantum Mechanical properties at nanoscale

One hundred and fifty years after one of the founders of chemistry Michael Faraday in 1850s first created gold nanoparticles and observed that these nanoparticles absorbed light, researchers in XX century rediscovered that a mere flash of light can cause the particles to melt. Absorbed light is efficiently turned into extreme heat, that is capable of killing cancer cells. The external energy can be mechanical, radio frequency, laser, optical, near-infrared light – resultant therapeutic action is the same.

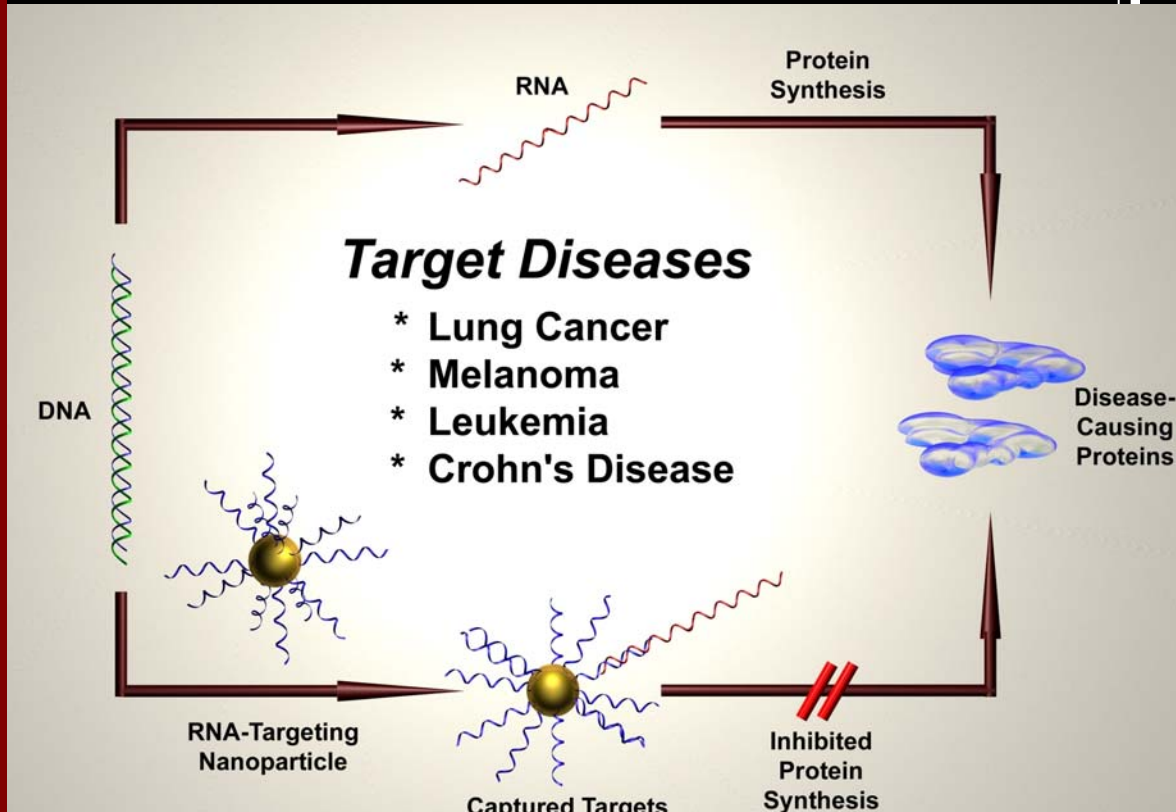


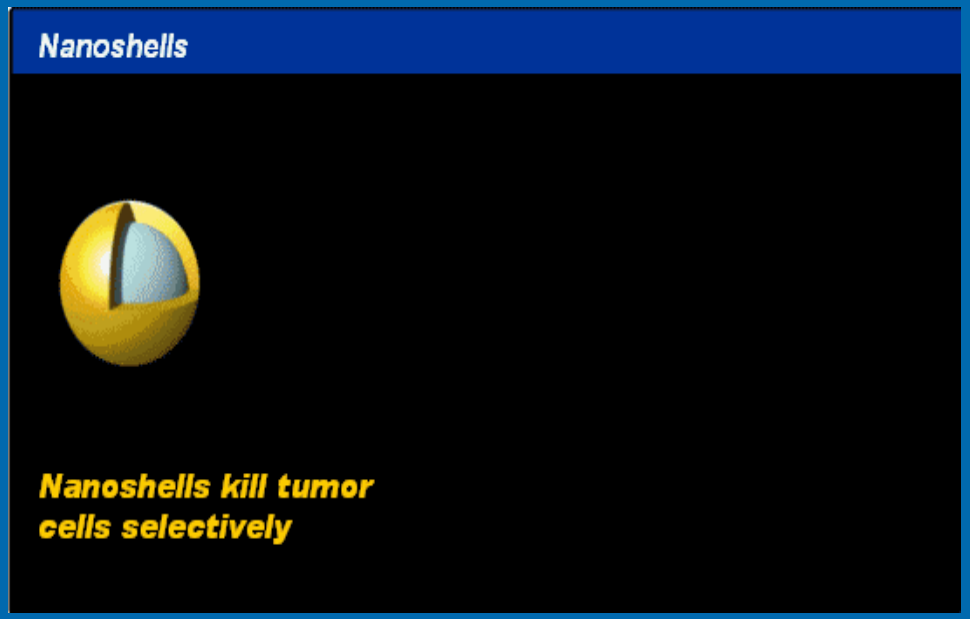
Hammad-Shifferli et al. (2002) have demonstrated that transmitted radio signals influence DNA strand integrity by means of attached nanometer gold particles, opening up the possibility of future to control electronically more complex biological processes such as enzymatic activity, protein folding and biomolecular assembly.

Gold Nanoparticles coated with antisense DNA can disrupt protein production quite effectively by Chad A. Mirkin, Nathaniel L. Rosi, David A. Giljohann et al - Northwestern University, 2006

Attaching antisense DNA strands to the surface of gold nanoparticles not only makes the strands more stable, but more effective in its protein-suppression role.

Antisense DNA, a kind of molecular mirror image of ordinary DNA, can be tailored to disrupt the production of specific protein molecules in the cell. For this reason, researchers have long believed that antisense DNA could be more effective than conventional drugs at fighting cancer and other diseases with a genetic basis.





Nanoshells have a core of silica and a metallic outer layer e.g. gold, cupper, iron. Nanoshells will preferentially concentrate in cancer lesion sites. Nanoshells are “essentially a nanolens” that captures light and then focuses it around itself. Shining a near-infrared laser on the tumor site from outside the body (light can travel through tissue more than 10 cm), the nanoshells absorb the light and focus it on the tumor. The area around the nanoshells heats up and the tumor “cooks” until it is ablated. Nanoshells leave no “toxic trail” in the body the way conventional chemotherapeutic agents do, stated that “long-term studies have not indicated any toxicity or effect on the immune system.”

Reference: Naomi Halas, Rebekah Drezek and Jennifer West, Rice University

http://nano.cancer.gov/index.asp

• First use of gold salts in rheumatology

- Throughout the history, gold was used to cure diseases. First, in 1935, gold drugs were reported to be effective for the treatment of rheumatoid arthritis. It is thought that gold affects the entire immune response (phagocytes, leukocytes, T-Cells...) and reduce its potency and limit its oxidizing nature, ending the cycle of joint inflammation and erosion. Effect is explained by the fact that administered gold compounds accumulate within body once absorbed into the cell and linked to anti-mitochrondrial activity, induced cell apoptosis.

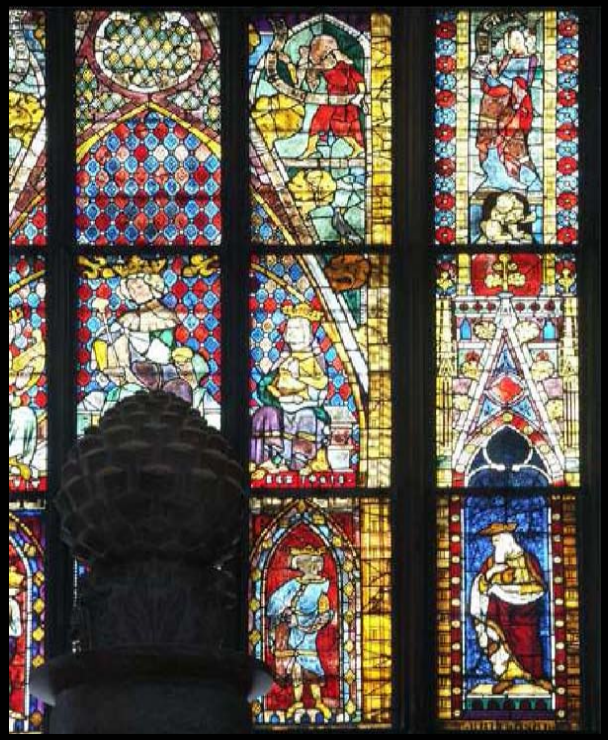
- Except of gold compounds, which are classified by the WHO as an *antirheumatic agent* included in the basic treatment scheme, not any developing nanoparticle gold containing medication is yet FDA approved.

Nanotechnologies - not completely new

- Nanoscale gold particles may act absolutely diversely. Usually characterized by its yellow color, while gold is processed in nanospheres, gives way to orange, purple, red or greenish tint. British Museum exhibits Lycurgus Cup, which is ruby gold glass. Almost no one declines the statement, that "Nano gold doesn’t act like bulk gold" (Ratner & Ratner 2003). Moreover, gold is mostly studied chemical element, thus with most predictable behavior. Dating back to Roman Empire, colloidal gold was thought to have healing properties. All these properties is of great interest for the industry and society as it enables new applications and products. Consequently, more attention is focused on revealing balance between efficiency and toxicity, finally determining the destination of drug or cosmetic product.

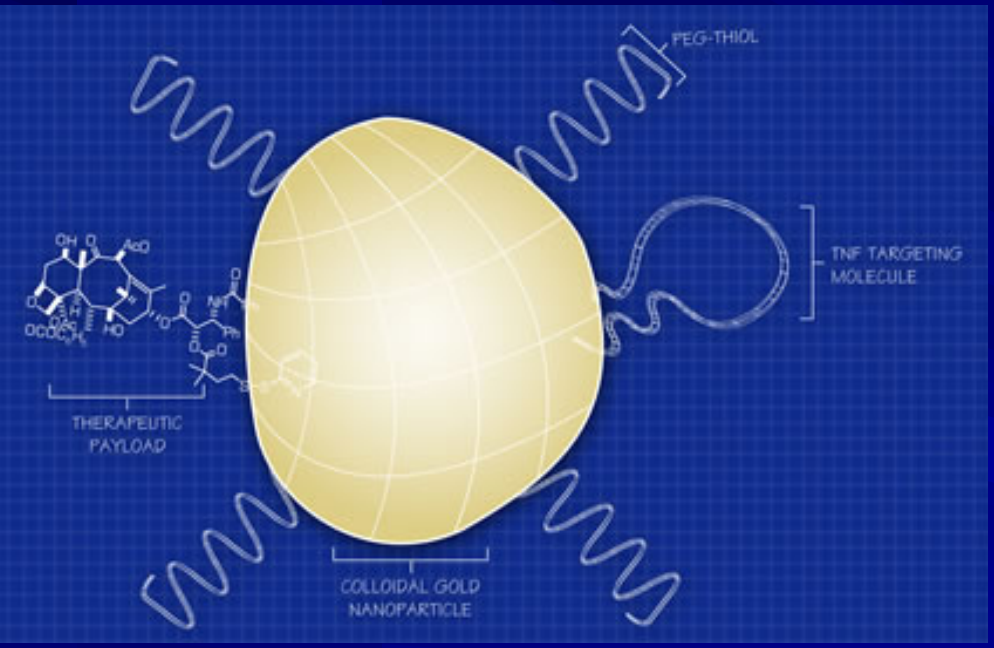
Nanotechnologies - not completely new

Nanogold already used in medieval times.`



CytImmune - PEGilated gold nanoparticals -

A Novel Vector for Tumor Directed Drug Delivery



- ***In 2000, CytImmune discovered that pegylated colloidal gold nanoparticles bind anti-cancer therapeutics on their surface and carry these drugs safely through the blood stream.***

Thiolated forms of small molecule therapeutics, such as TNF, bind directly to the surface of colloidal gold nanoparticles.

With tumor targeting resulting in increased drug levels in the tumor and *reduced drug uptake by healthy organs,* the technology improves efficacy and reduces toxicity.

Nanotechnology

Nanotechnology Nanotechnology

Nanotechnology

Nanotechnology

- *Gold nanoparticles* are also more biocompatible, than other types of optically active nanoparticles, such as cadmium containing quantum dots. The process of nano-fabrication, in particular the making of *gold nanodots* or quantum dots, is well known.
- For example, nanoparticles that are *36 nanometers* wide, absorb light over *10,000* times better than conventional organic dyes, making them potential candidates for optical imaging applications of small tumors. In the study, researchers found that the gold nanoparticles have *600%* greater affinity for specific overexpressed surface receptors of cancer cells, rather, than for noncancerous cells.

NANODOTS OF GOLD OR QUANTUM DOTS

Credit: Nanotechnology 'Innovation for tomorrow's world'

by Dr. Mathias Schulenburg, 2004

Question is:

- How do manage producers of cosmetics to sell nano gold based products, while not any of gold nano-particle enabled anti cancer drug is yet FDA approved and they are only on half way to prove safety and efficacy. Usually this process takes up to 15 years. NB!
- While FDA requirement are strict for novel medications, conversely, regulatory mechanisms for the cosmetics allow earlier market entry. Unlike medical and healthcare sectors, cosmetic industry outpaces commercial potential of nanoparticle containing product. To compare with the rate of released cosmetics, widely distributed worldwide, situation is quite unequal.

- *A recent report by J. Davies from the Woodrow Wilson Center's Project on Emerging Nanotechnologies strongly criticized the current approach regulating cosmetics as wholly inadequate to dealing with the risks posed by nanotechnologies: "Although the FDCA [Food, Drug and Cosmetic Act] has a lot of language devoted to cosmetics, it is not too much of an exaggeration to say that cosmetics in the USA are essentially unregulated."*

‘Green’ Nanotechnology:

- **Besides health hazard issues, tight ethical control is sought to distinguish misnomer of the term ‘green’, while cosmetic firms sell their ‘green nano gold’ containing personal care products for exorbitant prices mostly online. For comparison, real *green nanotechnology* is developed in environmentally friendly manner.**
- **Dr. Jim Hutchinson’s research group in the University of Oregon, directed at the cleaner and greener production of gold nanoparticles, a process that also reduces the cost of synthesizing these materials from *300,000 to 500 dollars per gram.***

‘Be a Scientist – Save the World’.

Albert Einstein

….for responsible development of NT!

Thank you for your time