UPM Inaugural Lecture Series

MATERIALS SCIENCE AND TECHNOLOGY: Past, Present and the Future

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MATERIALS SCIENCE AND TECHNOLOGY: PAST, PRESENT AND THE FUTURE

ABSTRACT

There are many questions ask, but not all can be answered (precisely) about matter, its diversity, our existence in this universe and also our relationship with technology. Research shows that matter comes from big explosion, called The Big Bang that produced building blocks particles, and later formed lightest atom. At the centers of big galaxies, heavy atoms were formed and distributed in the universe through explosions of stars and collisions of galaxies. All these atoms, when combined to form molecules or compounds, are called materials. The existence of "Man" through the eyes of science, were made from materials in the universe through evolution process. Since, survival is the keyword for human existence, man needs materials to interact with its surrounding, and this is called technology. Many civilizations use different type of materials and technology but the most significance civilization is in the era of the twentieth century, called the golden era of the century, where the amount of scientifically gained knowledge is at an exponential rate. Many new materials were found and applied to the relevant technology. To survive further in the future, man not only walk on the planet, he needs to go up, "outerspace", to seek new frontier of knowledge and materials that is impossible to acquire on earth. New and future materials, to be produced, need new environment (sophisticated laboratory, laboratory in outerspace or deep in the ocean floor or on other planets) and that will demand superior technology. The needs to be in outerspace, materials that can overcome the harsh and violent environment were needed. All these need scientifically technique/method called research, which will keep man busy playing with the gift from god, matter. Several current researches done on materials science are also highlighted.

The objectives of this presentation are to highlight the source of matter or the materials in the universe, man interaction with materials in its surrounding, the technology, and also looking for the type of materials and technology that is possible for human being to survive in the future.

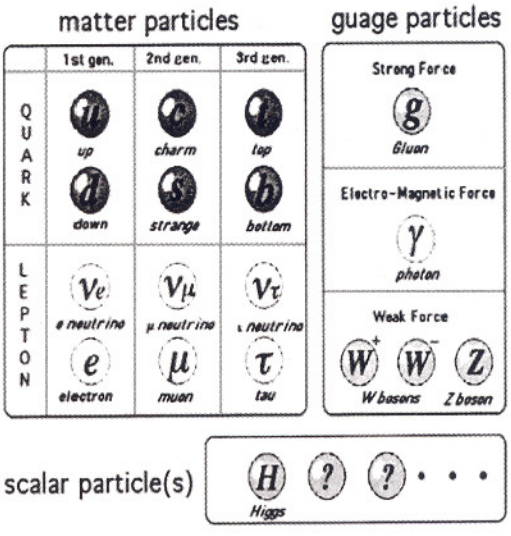
INTRODUCTION

- What is a matter?
- What is the relationship between matter, man and technology?
- What will be the future materials and future technology look like?
- Why is future materials and future technology important to man?
- Probably, we cannot precisely answers all the questions, but by looking back at the history of our past and current state of the universe, perhaps we could understand much better about our existence and the materials that related to our technology, and also perhaps we could predict the type of future materials and future technology that is important FOR MAN TO SURVIVE for his future generation in this violent universe.

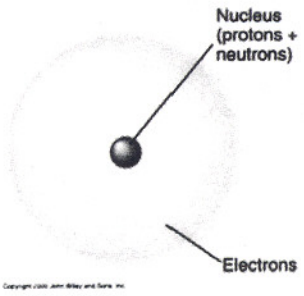
MATTER

All matters (entity with mass and volume) came from the main source event called the Big Bang (Big Explosion) about 13-15 billion years ago in the early process of universe formation.

Quark, formed from photon, are the fundamental building blocks of proton, neutrons and other sub-atomic particles, held together in pairs and triplets by mysterious particles called gluon, whose attractive force is so overwhelming that neither quarks nor gluons have ever been seen separated from one another in nature. Electron comes from other sub-atomic particle called lepton.
(Quarks, leptons, gauge and scalar particles cannot be broken into smaller pieces because they are the smallest building blocks of nature).



Elements of the Standard Model



Composition of an atom

Moments after the big bang, all these exotic particles formed sub-atomic particles (proton, neutron and electron) and then later formed lightest atom called hydrogen.

Heavy Atoms

Through expansion of the universe, period billion of years, many new heavy atoms were formed by nucleosynthesis process at the center (crucibles of the universe) of big galaxies (which contains billion of stars or giant stars).

The Sun's outer visible layer is called the photosphere and has a temperature of 6,000°C (11,000°F). This layer has a mottled appearance due to the turbulent eruptions of energy at the surface. Solar energy is created deep within the core of the Sun. It is here that the temperature reaches 15,000,000° C (27,000,000° F).

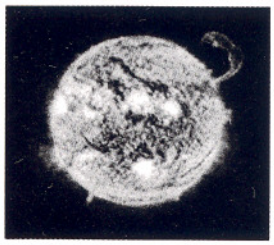
OUR SUN - Crucible of the universe

The first reaction is the proton-proton chain or **the hydrogen "burning" stage.** This involves the transformation of hydrogen into helium in the core of the star via a three-step process MECHANISM REACTION:

Step 1: H + H = 2H + neutrino **[This is the proton-proton chain reaction]**

Step 2: H + 2H = 3He

Step 3: 3He + 3He = 4He + H + H



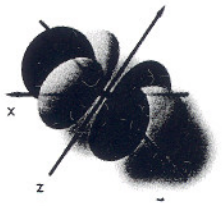
OUR SUN-Crucible of the universe

NUCLEOSYNTHESIS

Number of known elements to exist (natural and by synthesis) up to year 2005 is 111.

This last and latest Element of 111 is Roentgenium albeit Rg (Atomic Weight from 272 to 280).

....				
8s	8p	8d	8f	8g
7s	7p	7d	7f	7g
6s	6p	6d	6f	6g
5s	5p	5d	5f	5g
4s	4p	4d	4f	
3s	3p	3d		
2s	2p			
1s				



The $4f_{y^3 - 3x^2y}$ orbital corresponds to n=4, l=3, and m_l =-3.

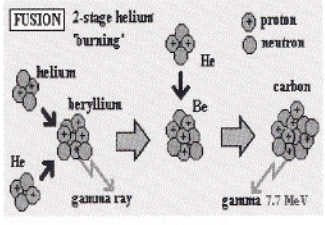
Only three atoms of it have been created (all 272Rg), by the fusion of bismuth-209 and nickel-64 in a linear accelerator.

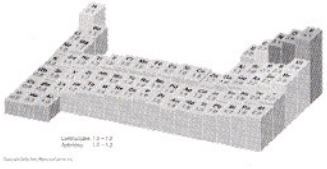
This element was discovered in Germany, Europe on December 8, 1994 and the name was given by IUPAC (2005) to honor the discoverer scientist called Wilhelm Roentgen.

However, there are still many orbitals yet to be filled in by electrons and this atomic number can go up to 218 if we could make those elements in NUCLEAR REACTOR as how few elements have been successfully produced and characterized lately.

Perhaps, in other big crucibles in certain galaxies, those elements might have already been formed by nucleosynthesis process.

(Nucleosynthesis) Crucible of the universe



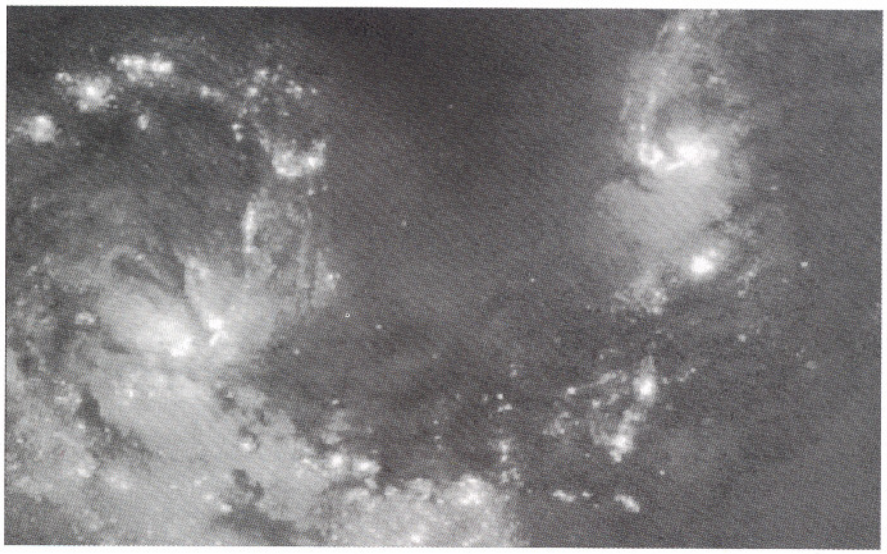


Periodic Table

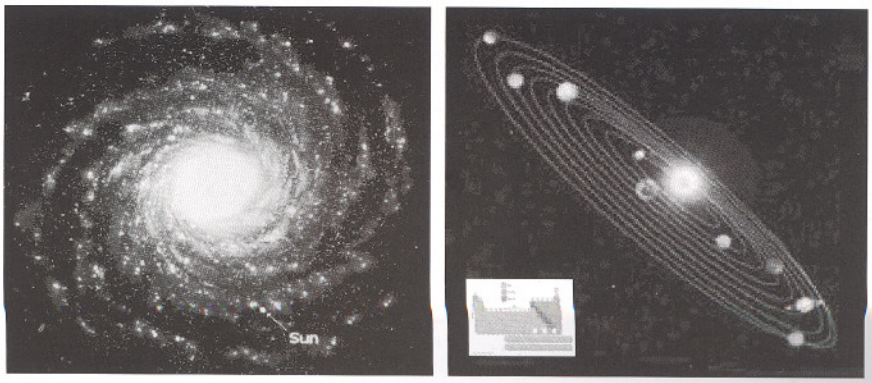
Element	Formation of New Element	Necessary Temperature (Kelvin)
Hydrogen (H)	Helium (He)	~10 million
Helium (He)	Carbon(C) and Oxygen (O)	~100 million
Carbon (C) and Oxygen (O)	Neon (Ne), Magnesium (Mg). Silicon (Si) and Sulfur (S)	~1 billion
Silicon (Si) and Sulfur (S)	Iron (Fe), Nickel (Ni) etc.	~10 billion

THOSE HEAVY ATOMS WERE DISTRIBUTED INTO OUR THREE DIMENSIONAL UNIVERSE WHEN THEY EXPLODED OR COLLIDED

The "Antennae" galaxies (NGC4038, 39) are probably in the act of colliding, or at least experiencing a close encounter, thereby rearranging their galactic contents and inducing bursts of stars formation. They display extended tails as well as double galactic centers in yellow-orange) separated by only ~1000 light years; the bluishness (in the arm) is caused by myriad young, hot stars, many perhaps recently formed in the aftermath of this interaction of cosmic proportions. (STScI)



Our galaxy called "Milky Way" contains billion of stars and one of them is called "Sun", which has planets orbiting around it. It is our own solar system with planets and this is also the nearest star to our home planet called earth.



A galaxy showing similar shape of our Milky Way Galaxy and the approximate position of our Sun (top view). Right-our solar system.

MATERIALS

- MATERIAL IS A GENERAL TERM USED TO DESCRIBE MATTER
- ALL MATERIALS THAT ARE BUILT FROM THE SUB-ATOMIC PARTICLES such as man, stars and galaxies, ARE CALLED BRYONIC MATTER (MATTER THAT CAN BE SEEN about 5% and NON BRYONIC MATTER, matter that cannot be seen, MAKE UP about 95% OF OUR UNIVERSE).

Bryonic matter can exist in many forms (elements, substances and compounds or molecules) and in difference phases (plasma, gas, liquid and solid)

In chemistry, all these bryonic matters or simply matters made from atoms or elements (as shown in the periodic table) or the combination of those elements are called material sciences or materials chemistry that have many applications in our daily activities.

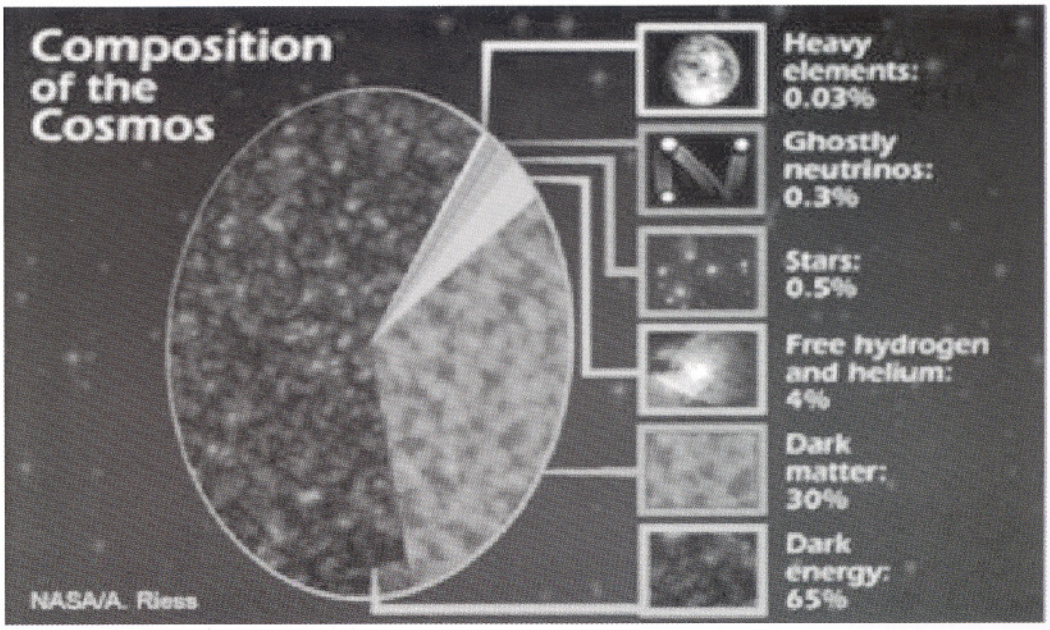


Chart showing Distribution of Bryonic Matter (Ordinary Matter) and Non Bryonic Matter (Dark Energy and Dark Matter or WIMP (Weakly Interacting Massive Particle)).

MAN AND TECHNOLOGY

SINCE **MATERIALS** HAVE BEEN IN EXISTENCE BILLION OF YEARS AGO, THEIR USEFULLNESS FOR SPECIES CALLED **HUMAN** WAS RECENTLY ACKNOWLEDGED ABOUT FEW MILLION YEARS AGO WHEN **EVOLUTION IN THE EYES OF SCIENCE CREATED "MAN".**

Since survival is part of evolution process, "man" uses materials that exist in the surrounding to interact with nature and it's surrounding.
This interaction (skill) and the used of materials is called "technology".

There is no doubt that about 400 thousand years ago, man acquired this so-called primitive technology to survive.

They used many existing materials such as stone, minerals, leather and woods that plenty around at the time for their need to interact with it's surrounding and to survive.
About 50,000 years ago, man started to migrate due to the weather changes of the globe.

They moved from African continent and spread around the globe to middle east, center of Asia then splitted to Europe to the west, south Asia to the south and china and Japan to the east.

These new places and habitats need new skill and new materials for survival.

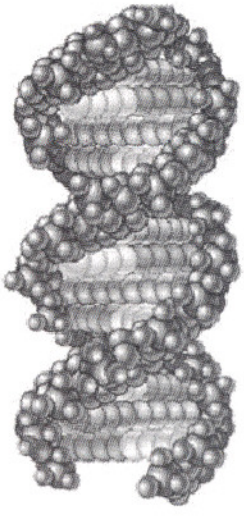
In cold places, they need material to warm themselves and in watery areas, transportation called "boat" is important.

Through time, man, by observation through nature already mastered many skills (technology) and used of many newly found materials around them such as iron, bronze, clay and etc.

These changes were observed through many civilizations and known as middle age civilizations.

Complex molecule of DNA-the building block of life formed.

A three dimensional model of the double stranded DNA molecule.



MATERIALS SCIENCE AND THE GOLDEN ERA OF TECHNOLOGY

About 200 years ago, man started to understand phenomena (scientifically) that occurring in nature and the materials that they interacted (technology) with at a phenomenal (exponential) rate.

Golden era

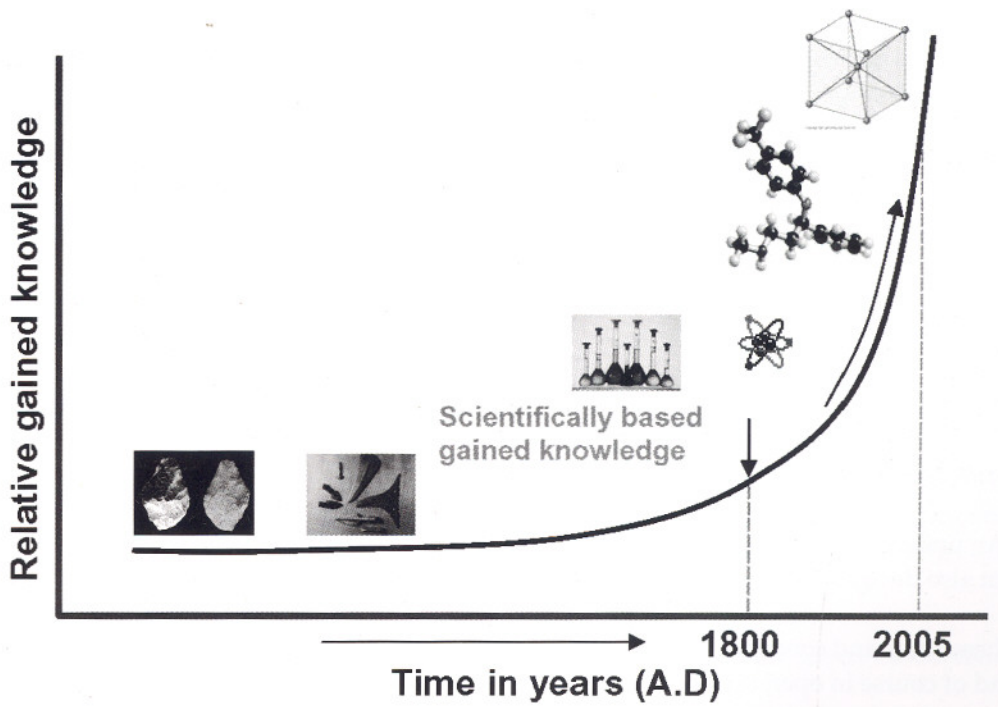
WHY IS THE LAST 200 YEARS????

Why not say 1000 years or before that (since man had been on the moved around 50,000 years ago or more)?

This is a big question mark (???). That has puzzled scientists and has become one of the debates of the century.

What is the catalyst that really causing this phenomenon?

Do really "aliens" (???) teach us about scientific ideas without our knowledge or consciousness?



This understanding through observation, experimental and rational explanation or so-called "knowledge through science" has brought tremendous or exponential changes in human civilization and technology.

Many natural phenomena already understood and scientifically explained and those have opened up many new windows of technologies.

These new technologies need new materials that again, like a domino, will open up more areas of new materials that some cannot be obtained naturally in the surrounding.

Man with new materials, can go into outerspace or dive into deep ocean that is impossible previously thought.

The era, the combination of these new obtained materials (through synthetic or natural, for example polymers, liquid crystal, ceramics and new conducting materials) for new technology acquired is called the golden era of human technology and a triumph for science of the 21st century.

CURRENT MATERIALS

Without materials there is no PRODUCT and without man there is no technology.

As mentioned previously, past materials used depends on the ability of man to obtain or acquire the natural materials directly from its surrounding, example copper and sulfur from volcanic sites or mining, leather from animals skin and some organics substances and wood from tree.

These materials have been in applied in wood structures, corten steel, oxidized copper, zinc, washed brick and unfinished concrete etc.

However, this development is coming to an end.

Current development among researches, technologies, engineers, designers and future materials people show an increased interest in different kinds of "new, cross-discipline and surprising materials and techniques" with which future ideas and concepts can be formed and realized.

"An understanding of materials science allows us to not only analyze existing materials, but also design on an atomic or molecular level to produce entirely new materials."

These ideas and concepts always find their origin in economical and social circumstances and of course in open up a new frontier of knowledge.

Materials	Compounds	Industrial application	Related technology
Ceramics	Clay, silicate, Concrete, silicon carbide etc.	Construction material, temperature shielding, electronic chip etc.	High-rise building, spaceship etc.
Polymer	Polyethylene, polyvinyl alcohol, nylon etc.	Textiles, plastic and wrapper, toys etc.	Interior design, fabric, etc
Composite	Composite of carbon, polymer or ceramic etc.	Mould, vehicle body etc.	Transportation, moulding, etc

SYNTHESIS AND/OR MODIFICATION can produce many materials that required to be used in new technology, besides being discovered naturally, in their preparation techniques. These are called new materials or current materials (advanced or intelligence materials) that their applications depend on the technology related to them.

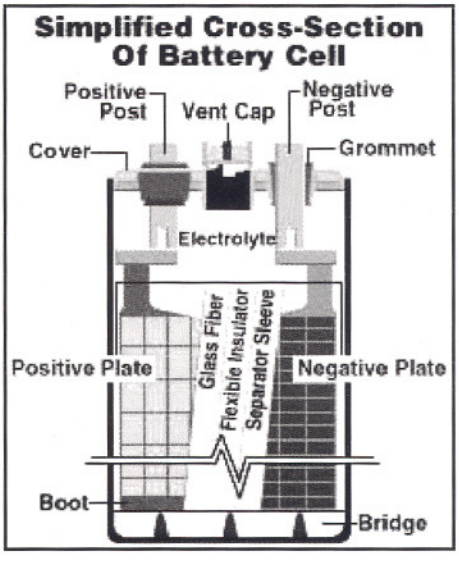
They're many materials such as polymers, ceramics and composites materials, liquid crystals etc. that have been recently produced and successfully used in various technologies.

Example of Realizations and Prototypes of Current Materials: Battery for Electric Vehicle (EV).

High-performance batteries are crucially needed for an application that has kept scientist and engineers at a stalemate for almost a century, electric vehicles (EV)-technology and product.

Growing concern for the environment has revitalized programs on: green automobiles throughout the industrialized world-human survival.

Example, state of California requires that 2% of a manufacture's sales be zero-emission vehicles by 1998 to reach 10% in 2003. No presently available system can meet this zero-emission requirement for the corresponding battery of an electric vehicle.



Battery construction and materials composition in this simplified cross-section acknowledge a normal amount of expansion and contraction of plate materials in the course of routine cycling.

SUMMARY: Relationship between man and technology observed from the example.

Man needs new technology to SURVIVE-POLLUTION.

Battery vehicle is **one of the New Technologies** chosen.

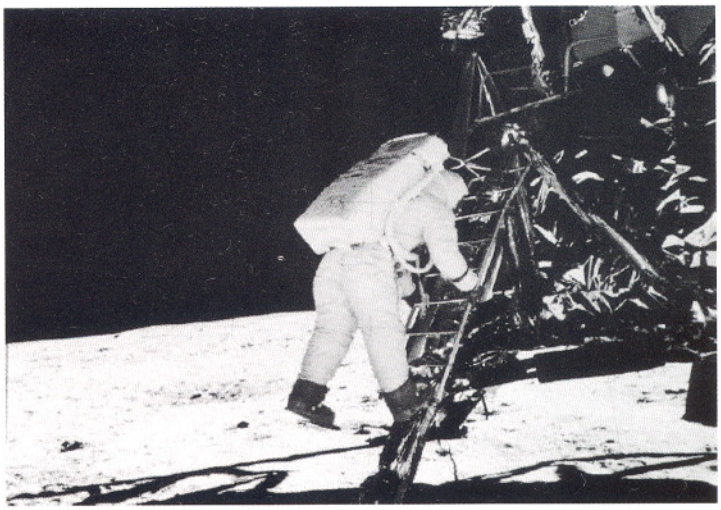
New suitable materials are needed related to this new technology.

Development from prototype **to realization product (commercialization) needs effort and time.**

There is no wonder that man, material (BRYONIC MATTER) and technology are closely interrelated because of THE SURVIVAL NATURE OF MAN.

Man needs new materials and dynamic technology forever to SURVIVE.

Man and Technology- Man on the moon



Needs combination of man, material and technology for this achievement.

FUTURE MATERIALS AND SUPERIOR TECHNOLOGY.

Due to the explosion of scientific knowledge started 200 years ago, more windows of new materials and technologies HAVE BEEN AND WILL BE OPENED UP to enhance, and to further the frontier of human knowledge and technology for the purpose of so-called "HUMAN SURVIVAL" IN FUTURE CIVILIZATION.

Superior technology

Man can go into outer space, deep into the ocean and be at other planets. All these places have different NEW CONDITIONS (NEW LABORATORIES), which is suitable to TEST and PRODUCE NEW MATERIALS of the future.

(Where can we find the "Einstein's laboratory?")

Future Materials	Compounds	Industrial application	Related to FUTURE technology
Super conductor-Ceramics and organics	Lead, mercury, YBCO	Electronics, transportations	Super-computer, electronic devices
Nanomaterials	Nano-based silicone and carbon (carbon nano tube CNT)	Construction material, biomedical, nano-machine	Building, Machinery, biomedical treatment
Plasma	Ionic hot gas of Xenon	Power driven	Space-ship

Perhaps the previous and current materials science (materials chemistry) will become obsolete or might not be very useful anymore in our new generation to come so-called future civilization.

Example-NASA (National Aeronautics and Space Administration) Future Materials- Source NASA 2001.

The advanced space ships of tomorrow will be crafted from far-out materials with extraordinary resistance to the harsh environment of space.

The Materials International Space Station Experiment, or MISSE for short (pronounced "Missy") consists of two suitcase-like containers, each holding hundreds of advanced materials that might someday be used to build solar sails, large antennas, super-spaceships, or thousands of other far-out devices.

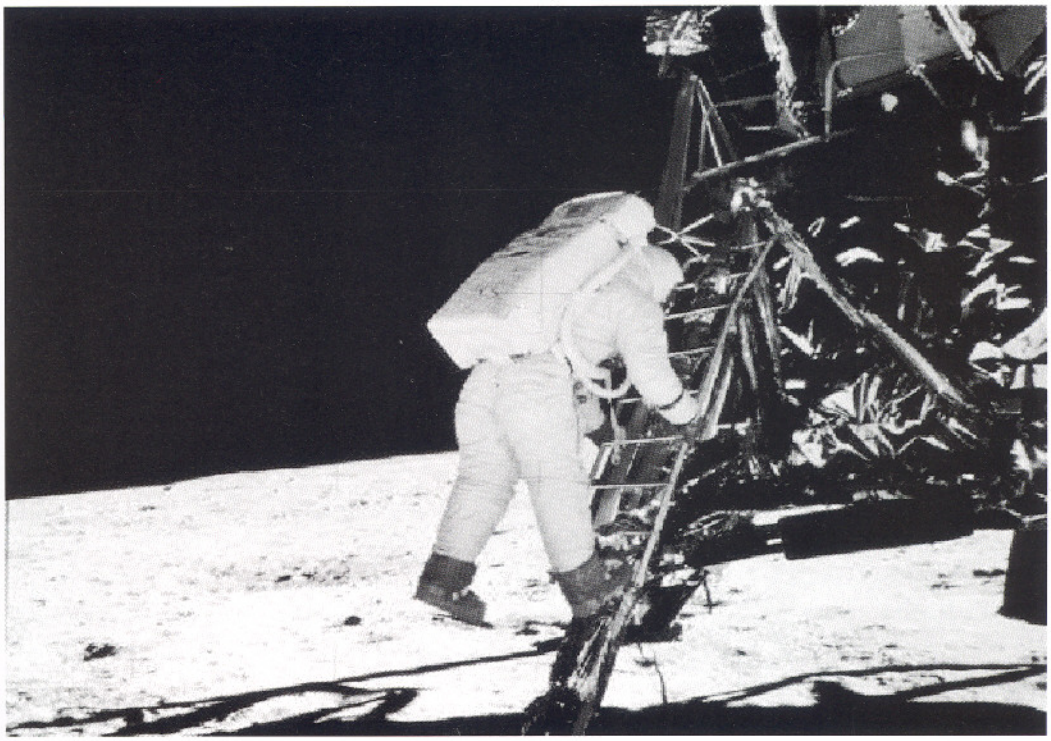
During a space walk recently (August 2001), shuttle crewmembers attached the "suitcases" to the outside of the space station and opened them up to expose the material samples to the harsh environment of space. MISSE will be the first externally mounted science experiment on the ISS. Once opened, the suitcases will require no attention from the ISS crew until a year later, when they will be returned to Earth, where scientists will examine the materials and see how well they fared. About 1500 total samples were approved for the mission, roughly half of which were installed recently. The rest will go up in two more suitcases scheduled to fly in about 18 months.

The potential materials are material for solar cell, ultra lightweight polymer for solar sail, lightweight radiation shielding films, and optical material to withstand atomic oxygen in the outer space. thin micrometeor-resistant polymer for huge fold-up antennas and lenses for solar power collection.

Perhaps, in future civilization, silicon-based and carbon-based materials and their related future technology (used in robotic, cyborg, bionic and clone world) will replace the existing materials used by carbonated life (human).

Some of these materials such as "superconductors (super ceramic materials), nanomaterials (nanomolecules and bio-complex molecules, silicon- based and carbon-based materials), plasma (ionic hot gas) material ", have been successfully produced and need superior technologies to realize their future applications for the coming future civilization.

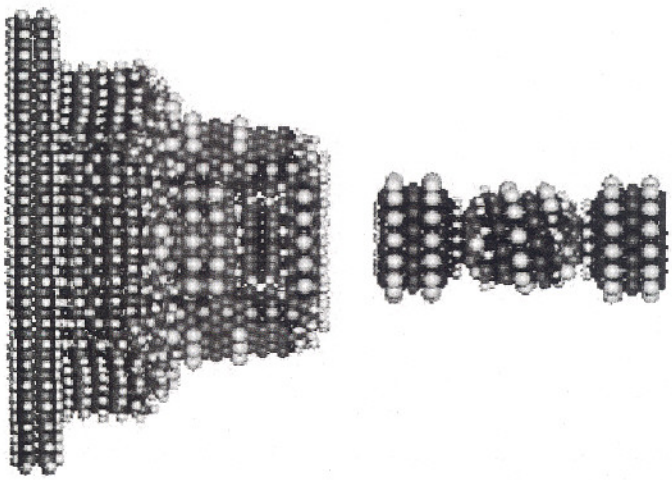
Current materials: Application and Technology



Needs combination of man, material and technology for this achievement.

Future materials: Application and Technology

Biomedical: Nanomachines (decoder, dripper and driller) made from nanomaterial **attacking cancerous cell.**



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Pump Tube

Nanotechnology: Molecular machine, **pump and tube made from complex molecules (using 6165 atoms).**

Future materials: Application and Technology

Superconductor, nanomaterials and polymers **for future ocean city or in other planet (alien world).**

WHERE ARE WE?

- Man, since they are trapped in their own expanding violent universe, they have plenty of space and plenty of activities to work with to survive.

- However, there is "no way out" to SURVIVE except to follow the laws of the universe, the second law of thermodynamics (entropy of the universe is always increasing or universe is always expanding or changes of matters towards more state of disorder, $\Delta S > 0$), meaning MAN HAS TO DO MORE AND MORE to survive – **TO BE MORE KNOWLEDGEBLE THROUGH TIMES**.

- The universe is expanding, galaxies tend to collide, our Milky Way galaxy will collide with its neighbor, Andromeda galaxy, and our sun will become the RED SUN and eventually the solar system will collapse, both in about three to five billions years from now. All these phenomena seem to fit or follow the second law of thermodynamics nicely, towards more disorder state or more chaotic environment.

- So, what will happen to the evolution process related to man in millions of years to come? We have to follow the rule of the universe. Will we become humanoid, robotic, cyborg or superhuman? Will space travel from star to star or galaxy be accomplished in order to SURVIVE?

- Man has to survive by clinging to the materials they could produce and technologically sound they should posses.

- "Man" has to understand the space and materials that come with it BECAUSE

"SURVIVAL", in the name of FUTURE CIVILISATION that acquires FUTURE MATERIALS and SUPERIOR TECHNOLOGIES, depends on the current materials and the dynamic technologies of today".

Matter, a GIFT from GOD

Since "MAN" is not a "GOD"!!!, and there is "No way out"!!!, man has something to play with and it is "MATTER", THE GIFT OF GOD. This material will keep man VERY VERY BUSY THROUGH TIME. Those are:

BRYONIC MATTER (MATTER THAT CAN BE SEEN about 5% and NON BRYONIC MATTER, matter that cannot be seen, MAKE UP about 95% OF OUR UNIVERSE).

The game that "MAN" plays with "MATTER" is called "RESEARCH".

THE IMPORTANT OF RESEARCH

Since knowledge is obtained through scientific method so-called research, hence RESEARCH IS VERY IMPORTANT:

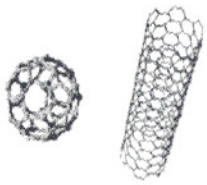
"To enhance and to open up a new frontier of knowledge for humankind to understand of his behavior, phenomena observed and interaction (that acquire a new technology) with surrounding that future generation will survive for the better".

NEWLY DISCOVERED MATERIALS

(a) FULLERENE, C60 (new impact to man and technology)

The first buckminster-fullerene C60 was discovered in 1985. Fullerenes are large carbon-cage molecules. They have been found in interstellar dust and meteor rocks and seem to be present everywhere in the universe.

Nanoballs



Carbon nano-tube (CNT)

Potential applications: Buckyballs have also shown the ability to block the HIV virus from attacking healthy cells under certain conditions. Nanotubes are quite intriguing, and may actually have some practical uses as nano-machine, "nanowire," and is surely the world's smallest BNC cable and drug delivery.

(b) SILICON CARBIDE (SiC) - a gift from the stars

Silicon carbide does not occur naturally on Earth so it cannot be mined like other minerals, hence the need for its synthesis in a high temperature furnace. The only occurrence of silicon carbide in nature is in meteorites, and some researchers have described it as a gift from the stars. Mineralogists call natural silicon carbide moissanite after the man who first identified it in a meteorite in 1905.

Silicon carbide is prepared commercially by fusing sand and coke in an electric furnace at temperatures above 2,200°C. It's known as the Acheson process. The overall reaction is $SiO2 + 3C = SiC + 2CO$.

Potential application: Silicon carbide (SiC) is extremely hard and sharp, with excellent chemical properties; consequently it has many applications as an abrasive or refractory material.

Widely used as an abrasive, silicon carbide is marketed under such familiar trade names as Carborundum and Crystolon.

It is extremely heat resistant, only decomposing when heated to about 2,700°C; and is used in refractory materials (eg, rods, tubes and firebricks), and in special parts for nuclear reactors.

Very pure silicon carbide is white or colorless; and crystals of it are used in semiconductors for high-temperature applications. Silicon carbide fibers, added as reinforcement to plastics or light metals, impart increased strength and stiffness.

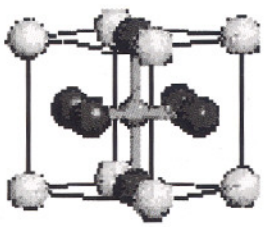
(c) SUPERCONDUCTIVITY MATERIALS: (new impact to man and technology)

Superconductivity was discovered in 1911 by Heike Kamerlingh Onnes and was awarded the Nobel Prize In Physics in 1913. He observed the resistivity of solid Mercury (Hg) abruptly disappear at temperature of 4.2 K using liquid helium as a refrigerant. Since then many types of superconductor categories as Type I and Type II were discovered.

A magnet levitating above a "high - temperature" superconductor with boiling liquid nitrogen underneath demonstrates the Meissner effect.

Ceramic-based: Ceramic superconductor

For the first time, 2001, a material (today referred to as YBCO) had been found that would superconduct at temperatures warmer than liquid nitrogen - a commonly available coolant. The current class (or "system") of ceramic superconductors with the highest transition temperatures is the mercuric-cuprates. The world record Tc of 138 K is now held by a thallium-doped, mercuric-cuprate comprised of the elements Mercury, Thallium, Barium, Calcium, Copper and Oxygen.



$Ba_{0.6}K_{0.4}BiO_3$

Ba0.6K0.4BiO3, which becomes superconducting below 32 K, was discovered 1999. It is the *"fourth order" phase transition superconductor (that exhibits no measurable change in its specific heat while going through up to 3 different "critical" magnetic fields) and* something that has never before been observed in nature.

Organic-based: Molecular superconductor

The first organic superconductor discovered, $(TMTSF)2PF_6$ (tetramethyltetraselenafulvalene phosfor hexaflouride in 1980 (Europe).

The fullerene also called a buckminsterfullerene or "buckyball" - exists on a molecular level when 60 carbon atoms join in a closed sphere. When doped with one or more alkali metals the fullerene becomes a "fulleride" and has produced Tc's ranging from 8 K for Na2Rb0.5Cs0.5C60 up to 40 K for Cs3C60.

In 1993, it was reported that Tc's between 60 K and 70 K for C-60 doped with the interhalogen compound ICl was observed.

Potential applications

Transport vehicles:

Transport vehicles such as trains can be made to "float" on strong superconducting magnets, virtually eliminating friction between the train and its tracks. The Minister of Transport authorized construction of the Yamanashi Maglev Test Line, which opened on April 3, 1997. In December 2003, the MLX01 test vehicle (shown above) attained an incredible speed of 361 mph (581 kph).

Magnetic Resonance Imaging (MRI):

An area where superconductors can perform a life-saving function is in the field of biomagnetism. By impinging a strong superconductor-derived magnetic field into the body, hydrogen atoms that exist in the body's water and fat molecules are forced to accept energy from the magnetic field. They then release this energy at a frequency that can be detected and displayed graphically by a computer. Magnetic Resonance Imaging (MRI) was the first MRI exam on a human being was not performed until July 3, 1977. And, it took almost five hours to produce one image! Today's faster computers process the data in much less time.

The development of a double-relaxation oscillation SQUID (Superconducting Quantum Interference Device) for use in Magnetoencephalography. SQUID's are capable of sensing a change in a magnetic field over a billion times weaker than the force that moves the needle on a compass (compass: 5e-5T, SQUID: e-14T.). With this technology, the body can be probed to certain depths without the need for the strong magnetic fields associated with MRI's.

Super-Collider:

A PLACE TO PRODUCE NEW ELEMENTS OR TO SPLIT THEM !!!

Probably the one event, more than any other, that has been responsible for putting "superconductors" into the American lexicon was the Superconducting Super-Collider project planned for construction in Ellis County, Texas. Though Congress cancelled the multi-billion dollar effort in 1993, the concept of such a large, high-energy collider would never have been viable without superconductors. High-energy particle research hinges on being able to accelerate sub-atomic particles to nearly the speed of light. Superconductor magnets make this possible. CERN, a consortium of several European nations, is doing something similar with its Large Hadron Collider (LHC) now under construction along the Franco-Swiss border.

Transformer and fault current controller: Power utilities
Electric generators made with superconducting wire are far more efficient than conventional generators wound with copper wire. In fact, their efficiency is above 99% and their size about half that of conventional generators. These facts make them very lucrative ventures for power utilities. General Electric has estimated the potential worldwide market for superconducting generators in the next decade at around $20-30 billion dollars. Late in 2002 GE Power Systems received $12.3 million in funding from the U.S. Department of Energy to move high-temperature superconducting generator technology toward full commercialization.

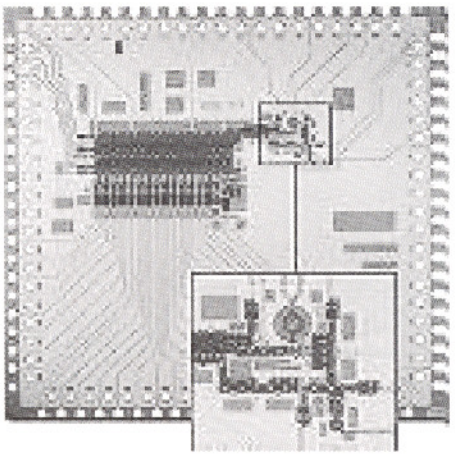
Recently, power utilities have also begun to use superconductor-based transformers and "fault limiters". The Swiss-Swedish company ABB was the first to connect a superconducting transformer to a utility power network in March of 1997. ABB also recently announced the development of a 6.4MVA (mega-volt-ampere) fault current limiter - the most powerful in the world. This new generation of HTS superconducting fault limiters is being called upon due to their ability to respond in just thousandths of a second to limit tens of thousands of amperes of current. Advanced Ceramics Limited is another of several companies that makes BSCCO type fault limiters. Intermagnetics General recently completed tests on its largest (15kv class) power-utility-size fault limiter at a Southern California Edison (SCE) substation near Norwalk, California. And, both the US and Japan have plans to replace underground copper power cables with superconducting BSCCO cable-in-conduit cooled with liquid nitrogen. (See photo below.) By doing this, more current can be routed through existing cable tunnels. In one instance 250 pounds of superconducting wire replaced 18,000 pounds of vintage copper wire, making it over 7000% more space-efficient.

HTS power cable: transmission of commercial power to cities.
An idealized application for superconductors is to employ them in the transmission of commercial power to cities. However, due to the high cost and impracticality of cooling miles of superconducting wire to cryogenic temperatures, this has only happened with short "test runs". In May of 2001 some 150,000 residents of Copenhagen, Denmark, began receiving their electricity through HTS (high-temperature superconducting) material. That cable was only 30 meters long, but proved adequate for testing purposes. In the summer of 2001 Pirelli completed installation of three 400-

foot HTS cables for Detroit Edison at the Frisbie Substation capable of delivering 100 million watts of power. This marked the first time commercial power has been delivered to customers of a US power utility through superconducting wire. Intermagnetics General has announced that its IGC-SuperPower subsidiary has joined with BOC and Sumitomo Electric in a $26 million project to install an underground, HTS power cable in Albany, New York, in Niagara Mohawk Power Corporation's power grid. The 350-meter cable, believed to be four times the length of any previously installed HTS cable, will be designed to provide more power and operate at significantly lower loss levels than other HTS installations.

Superconducting Microchip: For supercomputer

The National Science Foundation, along with NASA and DARPA and various universities, are currently researching "petaflop" computers. A petaflop is a thousand trillion floating-point operations per second. Today's fastest computing operations have only reached "teraflop" speeds - trillions of operations per second. Currently the fastest is the IBM Blue Gene/L running at 70.7 teraflops per second (multiple CPU's). The fastest single processor is a Lenslet optical DSP running at 8 teraflops. It has been conjectured that devices on the order of 50 nanometers in size along with unconventional switching mechanisms, such as the Josephson junctions associated with superconductors, will be necessary to achieve such blistering speeds. TRW researchers (now Northrop Grumman) have quantified this further by predicting that 100 billion Josephson junctions on 4000 microprocessors will be necessary to reach 32 petabits per second. These Josephson junctions are incorporated into field-effect transistors, which then become part of the logic circuits within the processors. Recently it was demonstrated at the Weizmann Institute in Israel that the tiny magnetic fields that penetrate Type 2 superconductors can be used for storing and retrieving digital information. It is, however, not a foregone conclusion that computers of the future will be built around superconducting devices. Competing technologies, such as quantum (DELTT) transistors, high-density molecule-scale processors, and DNA-based processing also have the potential to achieve petaflop benchmarks.

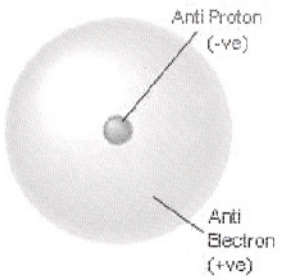


Hypres Superconducting Microchip, Incorporating 6000 Josephson Junctions For supercomputer.

(d) ANTI HYDROGEN ATOM (future material for future technology)

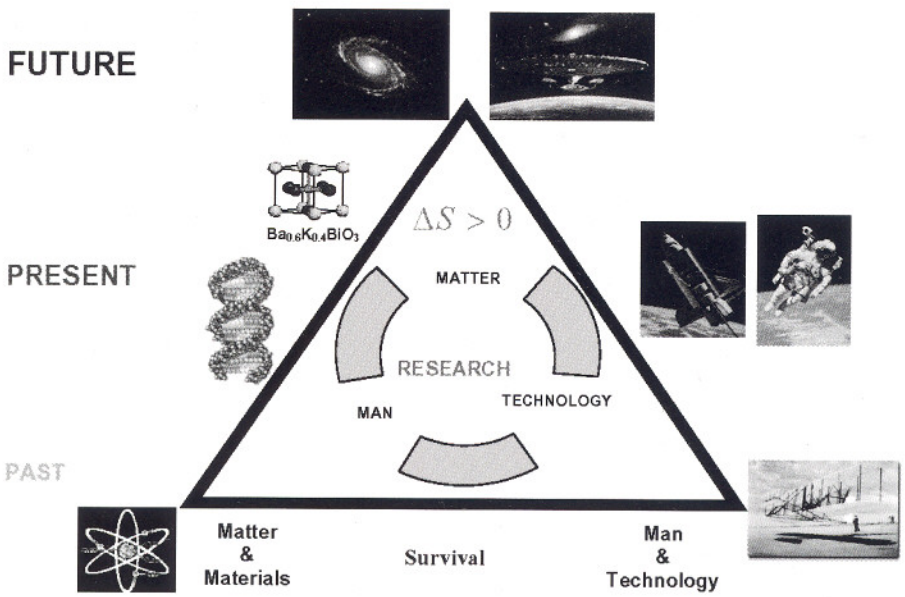
In 1995, a CERN (European Organisation Research For Nuclear) and Fermilab (near Chicago, USA) collaboration succeeded in producing on flight some anti-hydrogen atoms (only nine atoms in three weeks, quickly annihilating onto the vacuum chamber walls). So far, in 2002, ATHENA experiment has produced about 50,000 antihydrogen atoms, the most abundant and anti matter produced.

Potential applications: Fuel for future spaceship, medical diagnostics where positrons are used to help identify different diseases with the Positron Emission Tomography (or PET scan)



Anti hydrogen atom (anti matter)

SUMMARY: HISTORY OF MATTER, MAN AND UNIVERSE



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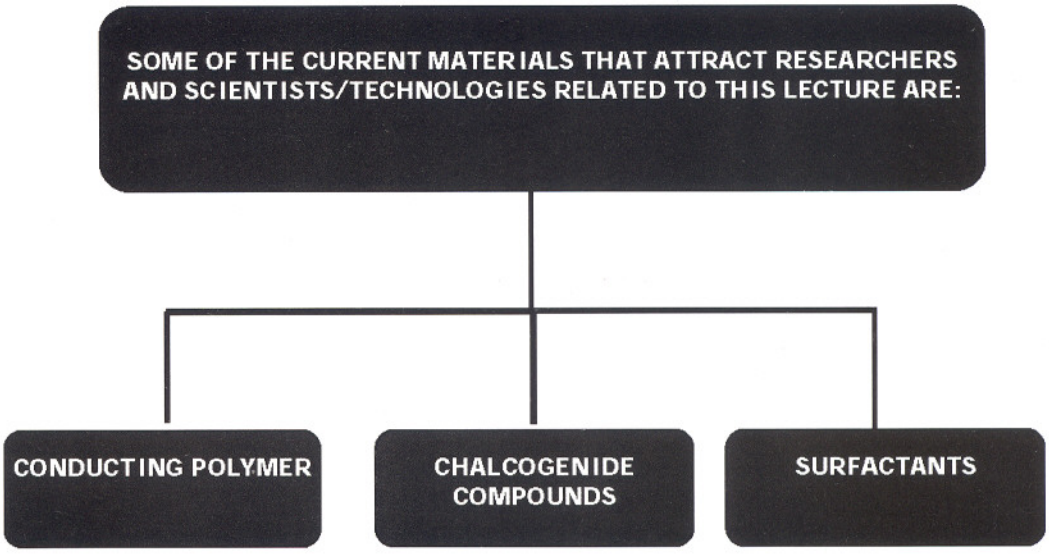


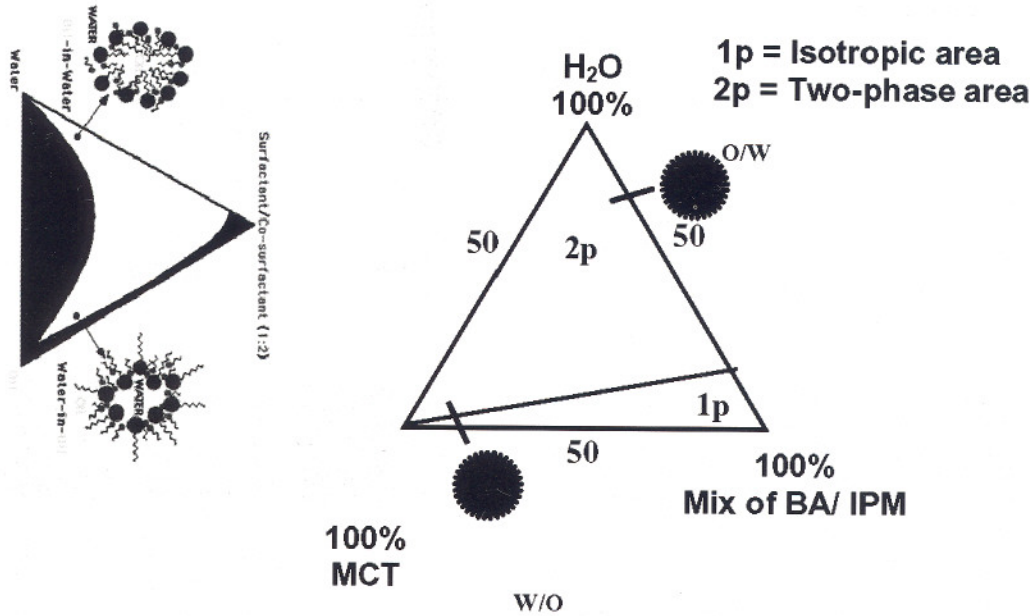
SURFACTANT: SOFT MATERIALS

Anuar K., et al., (2005). Journal of Dispersion Science and Technology, Volume 26, Number 3, 349-354.

Title: Emulsion Properties of Batyl Alcohol

Abstract:
Using a combination of batyl alcohol (BA), isopropyl myristate (IPM), medium chain triglyceride (MCT), and water, an emulsion Oil/Water (O/W) was developed. A ratio of 1:1 MCT: water was emulsified with 5% and 10% BA. A weak viscoelastic network was formed with 5% BA but without stearic acid (SA) (Emulsion S1). With SA (Emulsion S2) a strong viscoelastic network was formed with the acid acting as a co-emulsifier. No network structure was found in the emulsion containing 10% BA (Emulsion S4) as it was stabilized by the right percentage of BA. The emulsifiers adsorbed at the MCT/H 2 O interface, reducing the droplet size and increasing the viscosity, while the rest formed liquid crystalline lamellar in the continuous phase to physically trap the droplets in the network. The conductivity measured revealed that the emulsifier in Emulsion S2 encapsulated the oil droplets.

Emulsion properties of batyl alcohol (BA)



Phase diagram of Mix BA/IPM/H_2O/MCT or PG system.

CHALCOGENIDE MATERIALS

Anuar Kassim, et al., (2001). *Solar Energy Materials and Solar Cells* 73, 351-365.

Title: Cathodic electrodeposition of Cu2S thin film for solar energy conversion.

Abstract:
Electrodeposition method was used to prepare Cu2S thin film deposited on Ti substrate. The effect of deposition potential, concentration and deposition time was studied to determine the optimum condition for electro-deposition process. Cyclic voltammetry was performed to elucidate the electrodic processes that occur while potentials for electrodeposition were applied to determine the optimum potential for electrodeposition. The thin films are characterised by X-ray diffractometry. Scanning electron microscopy was performed to observe the morphology, composition and structure of the deposits. Cu2S showed a cubic morphology.

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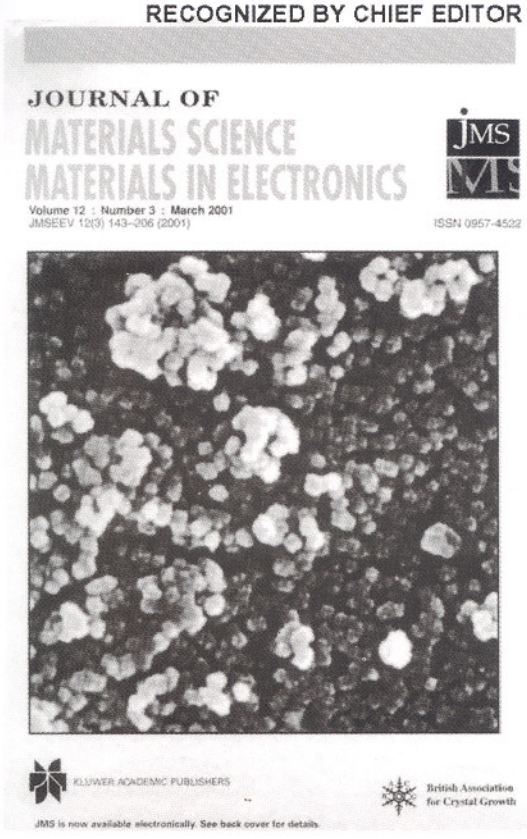
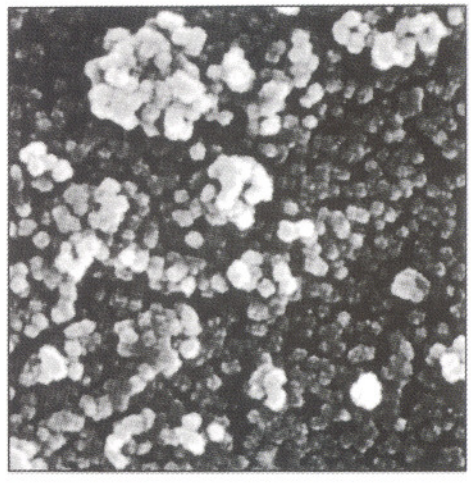


Cu_2S showed a cubic morphology as confirmed by x-ray



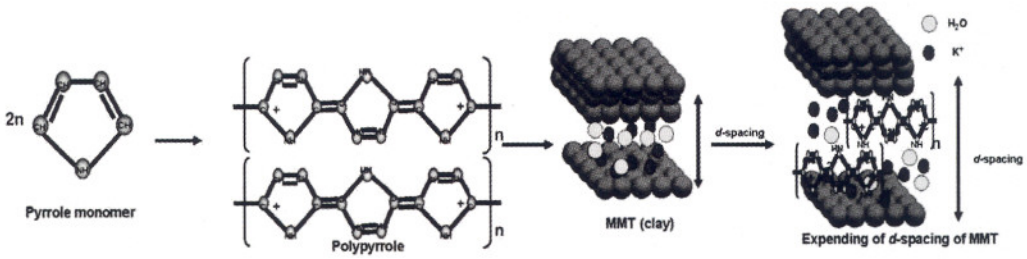
SEM micrograph (10 000X) of Cu_2S film deposited at – 0.40V vs Ag/AgCl

CONDUCTING POLYMER

Anuar, K., et al. (2004). *Materials Science (Medziagotyra).* Vol 10, No.3, 255-258.

Title: NANOCOMPOSITE MATERIAL-PPY/CLAY: Conducting Polymer/Clay Composites: Preparation and Characterization.

Abstract:
The conducting polypyyrole-montmorillonite clay (PPy/MMT) composites were prepared using 2:1 mole ratio of FeCl3 / pyrrole with various percentages of MMT clay in aqueous medium. The prepared samples were subjected to structural, thermal and morphological characterizations and d.c. conductivity measurement. The conductivity increased from 3.090 x 10-2 S/cm to 1.370 x 10-1 S/cm with the increase in the percentage of clay from 0.2% to 1.0%. The surface morphology of the prepared composite is denser and more compact. The X-ray diffraction result for PPY/MMT showed the intercalation of PPy polymer between the clay layers. The FT-IR result shows the successful incorporation of montmorillonite clay in the prepared PPy/MMT clay composite.



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NANOCOMPOSITE MATERIAL-PPY/CLAY

CONCLUSION

The discussion shows the origin of matter through The Big Bang theory. There are many types of matters and their distribution in the universe is bryonics matter about 5% and nonbryonics matter about 95%. Man related to material, exists through evolution process. Man to survive needs materials and technology and were seen changing through time till the greatest era of civilization, the twentieth century. This relationship between man, materials and technology will become very close in order for man to survive in the future.

ACKNOWLEDGEMENT

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