Nanoadvanced Silk

Asst.Prof.Dr.Chantana Viriyavejakul

DEPARTMENT OF INDUSTRIAL EDUCATION
FACULTY OF INDUSTRIAL EDUCATION
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG

2006

Nanoadvanced Silk

Asst.Prof.Dr.Chantana Viriyavejakul

FACULTY OF INDUSTRIAL EDUCATION
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG

Acknowledgements

This research is dedicated to my loving husband, Lieutenant Colonel Kom Viriyavejakul, for his undying patience, support and understanding. For the countless hours he sat beside me giving me the strength to complete this effort and to always believe in myself, I owe this research to him. My special thanks to my parents, family and friends who have supported me through the completed of this report.

I would especially like to acknowledge Asso.Prof.Dr. Ravewan Shinatrakool, Dean of the Faculty of Industrial Education, King Mongkut's Institute of Technology Ladkrabang(KMITL) and Asso.Prof.Dr. Punnee Leekitchwatana for providing me motivation to International Conference on Applied Science in Vientiane, Lao PDR.

Chantana Viriyavejakul

Abstract

Research Title Nanoadvanced Silk
Year 2006
Researcher Asst.Prof.Dr.Chantana Viriyavejakul
Office Department of Industrial Education,
Faculty of Industrial Education.
King Mongkut's Institute of Technology Ladkrabang
Chalongkrung Rd., Ladkrabang, Bangkok 10520
Phone : 0-2737-3000 Ext 6061 Fax 0-2326-4511
Email : kmchanta@kmitl.ac.th

ABSTRACT

The purpose of this inquiry is to study literature related to Nanoadvanced Silk. A documentary research design is used in surveying of documents located in libraries and through internet. Nanotechnology combined with silk production is a way to increase benefits of cloth. The meaning of nanotechnology is going into a substance on the molecular level to create changes on the structural level without making external changes so that a better product is available to the consumer. In this case a better quality silk with more strength and more varied uses. Findings are presented in 4 topics namely, (1) Nanotechnology (2) Silk (3) Super Silk and Super Bones And (4) Research.

Contents

Introduction

Silk is a cloth that is beautiful and radiant. However, there are drawbacks to using it. It gets wrinkled easily. It is hot and when it has become wet from sweat or water, it changes color so that the wearer is not pleased with his appearance and comfort of his cloths. If silk were to be made with nanotech supported and serve internal changes, the undesirable traits of cloth could be removed so that it would be a preferred cloth in some occasions. Moreover if other kinds of silks, like that of the spider are mixed with substances such as shell, it can produce a new substance that can be used for bone repair. It is known that bones which are made new from metallic materials present heavy metal problems for the body, some that result in more danger then not having the metal bone parts. With imitation bone material from silk and shell composite material, the bones infused with the body will mix better have less reaction problems with body and be much lighter.

Chapter 1

Nanotechnology

1. Introduction

Despite unprecedented government funding and public interest in nanotechnology, few can accurately define the scope, range or potential applications of this technology. One of the most pressing issues facing nanoscientists and technologists today is that of communicating with the non-scientific community. As a result of decades of speculation, a number of myths have grown up around the field, making it difficult for the general public, or indeed the business and financial communities, to understand what is a fundamental shift in the way we look at our interactions with the natural world. This article attempts to address some of these misconceptions, and explain why scientists, businesses and governments are spending large amounts of time and money on nanoscale research and development.

2. What is nanotechnology?

Take a random selection of scientists, engineers, investors and the general public and ask them what nanotechnology is and you will receive a range of replies as broad as nanotechnology itself. For many scientists, it is nothing startlingly new; after all we have been working at the nanoscale for decades, through electron microscopy, scanning probe microscopies or simply growing and analysing thin films. For most other groups, however, nanotechnology means something far more ambitious, miniature submarines in the bloodstream, little cogs and gears made out of atoms, space elevators made of nanotubes, and the colonization of space. It is no wonder people often muddle up nanotechnology with science fiction.

3. What is the nanoscale?

Although a metre is defined by the International Standards Organization as `the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second' and a nanometre is by definition 10- 9 of a metre, this does not help scientists to communicate the nanoscale to non-scientists. It is in human nature to relate sizes by reference to everyday objects, and the commonest definition of nanotechnology is in relation to the width of a human hair.

Unfortunately, human hairs are highly variable, ranging from tens to hundreds of microns in diameter (10-6 of a metre), depending on the colour, type and the part of the body from which they are taken, so what is needed is a standard to which we can relate the nanoscale. Rather than asking anyone to imagine a millionth or a billionth of something, which few sane people can accomplish with ease, relating nanotechnology to atoms often makes the nanometre easier to imagine. While few non-scientists have a clear idea of how large an atom is, defining a nanometre as the size of 10 hydrogen, or 5 silicon atoms in a line is within the power of the human mind to grasp. The exact size of the atoms is less important than communicating the fact that nanotechnology is dealing with the smallest parts of matter that we can manipulate.

4. Science fiction

While there is a commonly held belief that nanotechnology is a futuristic science with applications 25 years in the future and beyond, nanotechnology is anything but science fiction. In the last 15 years over a dozen Nobel prizes have been awarded in nanotechnology, from the development of the scanning probe microscope (SPM), to the discovery of fullerenes. According to CMP Científica, over 600 companies are currently active in nanotechnology, from small venture capital backed start-ups to some of the world's largest corporations such as IBM and Samsung. Governments and corporations worldwide have ploughed over $4 billion into nanotechnology in the last year alone. Almost every university in the world has a nanotechnology department, or will have at least applied for the funding for one. Even more significantly, there are companies applying nanotechnology to a variety of products we can already buy, such as automobile parts, clothing and ski wax. Nanotechnology is already all around us if you know where to look.
The confusion arises in part because many people in the business world do not know where to look. Over the last decade, technology has become synonymous with computers, software and communications, whether the internet or mobile telephones. Many of the initial applications of nanotechnology are materials related, such as additives for plastics, nanocarbon particles for improved steels, coatings and improved catalysts for the petrochemical industry. All of these are technology based industries, maybe not new ones, but industries with multi-billion dollar markets.

5. The nanotechnology industry

It is increasingly common to hear people referring to `the nanotechnology industry', just like the software or mobile phone industries, but will such a thing ever exist? Many of the companies working with nanotechnology are simply applying our knowledge of the nanoscale to existing industries, whether it is improved drug delivery mechanisms for the pharmaceutical industry, or producing nanoclay particles for the plastics industry. In fact nanotechnology is an enabling technology rather than an industry in its own right. No one would ever describe Microsoft or Oracle as being part of the electricity industry, even though without electricity the software industry could not exist. Rather, nanotechnology is a fundamental understanding of how nature works at the atomic scale. New industries will be generated as a result of this understanding, just as the understanding of how electrons can be moved in a conductor by applying a potential difference led to electric lighting, the telephone, computing, the internet and many other industries, all of which would not have been possible without it.

While it is possible to buy a packet of nanotechnology, a gram of nanotubes for example, it would have zero intrinsic value. The real value of the nanotubes would be in their application, whether within existing industry, or to enable the creation of a whole new one.

6. Fantastic voyage

Shrinking machines down to the size where they can be inserted into the human body in order to detect and repair diseased cells is a popular idea of the benefits of nanotechnology, and one that even comes close to reality. Many companies are already in clinical trials for drug delivery mechanisms based on nanotechnology, but unfortunately none of them involve miniature submarines. It turns out that there are a whole range of more efficient ways that nanotechnology can enable better drug delivery without resorting to the use of nanomachines.

Just the concept of navigating ones way around the body at will does not bear serious scrutiny. Imagine attempting to go against the flow in an artery—it would be like swimming upstream in a fast flowing river, while boulders the size of houses, red and white blood cells, rained down on you. Current medical applications of nanotechnology are far more likely to involve improved delivery methods, such as pulmonary or epidermal methods to avoid having to pass through the stomach, encapsulation for both delivery and delayed release, and eventually the integration of detection with delivery, in order for drugs to be delivered exactly where they are needed, thus minimizing side effects on healthy tissue and cells. As far as navigation goes, delivery will be by exactly the same method that the human body uses, going with the flow and `dropping anchor' when the drug encounters its target.

7. Shrinking stuff

Another common misconception is that nanotechnology is primarily concerned with making things smaller. This has been exacerbated by images of tiny bulls, and miniature guitars that can be strummed with the tip of an AFM, that while newsworthy, merely demonstrate our new found control of matter at the sub-micron scale. While almost the whole focus of micro-technologies has been on taking macro-scale devices such as transistors and mechanical systems and making them smaller, nanotechnology is more concerned with our ability to create from the bottom up. In electronics, there is a growing realization that with the end of the CMOS roadmap in sight at around 10 nm, combined with the uncertainly principal's limit of Von Neuman electronics at 2 nm, that merely making things smaller will not help us. Replacing CMOS transistors on a one for one basis with some type of nano device would have the effect of drastically increasing fabrication costs, while offering only a marginal improvement over current technologies.

However, nanotechnology offers us a way out of this technological and financial cul-de-sac by building devices from the bottom up. Techniques such as self assembly, perhaps assisted by templates created by nano imprint lithography, a notable European success, combined with our understanding of the workings of polymers and molecules such as Rotoxane at the nanoscale open up a whole new host of possibilities. Whether it is avoiding Moore's second law by switching to plastic electronics, or using molecular electronics, our understanding of the behaviour of materials on the scale of small molecules allows a variety of alternative approaches, to produce smarter, cheaper devices. The new understandings will also allow us to design new architectures, with the end result that functionality will become a more valid measure of performance than transistor density or operations per second.

8. Nanotechnology is new

It often comes as a surprise to learn that the Romans and Chinese were using nanoparticles thousands of years ago. Similarly, every time you light a match, fullerenes are produced. Degusssa have been producing carbon black, the substance that makes car tyres black and improves the wear resistance of the rubber, since the 1920s. Of course they were not aware that they were using nanotechnology, and as they had no control over particle size, or even any knowledge of the nanoscale they were not using nanotechnology as currently defined.

What is new about nanotechnology is our ability to not only see, and manipulate matter on the nanoscale, but our understanding of atomic scale interactions.

9. Building atom by atom

One of the defining moments in nanotechnology came in 1989 when Don Eigler used a SPM to spell out the letters IBM in xenon atoms. For the first time we could put atoms exactly where we wanted them, even if keeping them there at much above absolute zero proved to be a problem. While useful in aiding our understanding of the nanoworld, arranging atoms together one by one is unlikely to be of much use in industrial processes. Given that a Pentium 4 processor contains 42 million transistors, even simplifying the transistors to a cube of 100 atoms on each side would require 42 x 102 operations, and that is before we start to consider the other material and devices needed in a functioning processor.

Of course we already have the ability to build things atom by atom, and on a very large scale; it is called physical chemistry, and has been in industrial use for over a century producing everything from nitrates to salt. To do this, we do not need any kind of tabletop assembler as in Star Trek, usually a few barrels of readily available precursor chemicals and maybe a catalyst are all that is required.

Compare this with the difficulty of producing anything organic atom by atom, a sausage for example. Everyone is familiar with the macroscale ingredients of a sausage, some meat, maybe some fat, cartilage or other kinds of tissue, even some bone, all encased in animal gut. Never mind, argue the proponents of assemblers, things are simpler at smaller scales.

Zooming down to the microscale we still have far more complexity than we would like to attempt to replicate, with cells, cytoplasm, mitochondria, chromosomes, ribosomes and many other highly complex items of natural engineering. Moving closer to the nanoscale, we still have to deal with nucleic acids, nucleotides, peptides and proteins, none of which we fully understand, or expect to even have the computing power to understand in the near future.

In terms of return on our investment, a farmyard containing a few pigs is a far more effective sausage machine than we could ever design, and has several other by-products such as hams and a highly effective waste disposal system. This serves to illustrate just how far we are away from being able to replicate nature.

10. Attack of the killer nanobots

In terms of capturing the public imagination, unleashing hordes of self-replicating devices that escape from the lab and attack anything in their path is always going to be popular. Unfortunately nature has already beaten us to it, by several hundred million years. Naturally occurring nanomachines, that can not only replicate and mutate as they do so in order to avoid our best attempts at eradication, but can also escape their hosts and travel with alarming ease through the atmosphere. No wonder that viruses are the most successful living organisms on the planet, with most of their `machinery' being well into the nano realm. However, there are finite limits to the spread of such `nanobots', usually determined by their ability, or lack thereof, of converting a sufficiently wide range of material needed for future expansion. Indeed, the immune systems of many species, while unable to completely neutralize viruses without side effects such as runny noses, are so effective in dealing with this type of threat as a result of the wide range of different technologies available to a large complex organism when confronted with a single purpose nano-sized one. For any threat from the nano world to become a danger, it would have to include far more intelligence and flexibility than we could possibly design into it.

Our understanding of genomics and proteomics is primitive compared with that of nature, and is likely to remain that way for the foreseeable future. For anyone determined to worry about nanoscale threats to humanity should consider mutations in viruses such as HIV that would allow transmission via mosquitoes, or deadlier versions of the influenza virus, which deserve far more concern than anything nanotechnology may produce.

11. Conclusions

Nanotechnology, like any other branch of science, is primarily concerned with understanding how nature works. We have discussed how our efforts to produce devices and manipulate matter are still at a very primitive stage compared to nature. Nature has the ability to design highly energy efficient systems that operate precisely and without waste, fix only that which needs fixing, do only that which needs doing, and no more. We do not, although one day our understanding of nanoscale phenomena may allow us to replicate at least part of what nature accomplishes with ease.

While many branches of what now falls under the umbrella term nanotechnology are not new, it is the combination of existing technologies with our new found ability to observe and manipulate at the atomic scale that makes nanotechnology so compelling from scientific, business and political viewpoints.

For the scientist, advancing the sum total of human knowledge has long been the driving force behind discovery, from the gentleman scientists of the 17th and 18th centuries to our current academic infrastructure. Nanotechnology is at a very early stage in our attempts to understand the world around us, and will provide inspiration and drive for many generations of scientists.

For business, nanotechnology is no different from any other technology: it will be judged on its ability to make money. This may be in the lowering of production costs by, for example, the use of more efficient or more selective catalysts in the chemicals industry, by developing new products such as novel drug delivery mechanisms or stain resistant clothing, or the creation of entirely new markets, as the understanding of polymers did for the multi-billion euro plastics industry.

Politically, it can be argued that fear is the primary motivation. The US has opened up a commanding lead in terms of economic growth, despite recent setbacks, as a result if the growth and adoption of information technology. Of equal significance is the lead in military technology as demonstrated by the use of unmanned drones for both surveillance and assault in recent conflicts. Nanotechnology promises far more significant economic, military and cultural changes than those created by the internet, and with technology advancing so fast, and development and adoption cycles becoming shorter, playing catch-up will not be an option for governments who are not already taking action.

Maybe the greatest short term benefit of nanotechnology is in bringing together the disparate sciences, physical and biological, who due to the nature of education often have had no contact since high school. Rather than nanosubmarines or killer nanobots, the greatest legacy of nanotechnology may well prove to be the unification of scientific disciplines and the resultant ability of scientists, when faced with a problem, to call on the resources of the whole of science, not just of one discipline.

Chapter 2

Silk

History

The discovery of the product silk from the silkworm species Bombyx mori occurred around 2700 BC. According to Chinese tradition the bride of Emperor Huang Ti, a 14-year-old girl called Hsi Ling Shi, discovered the invention of the first silk reel. Sericulture, the cultivation of the silkworm, spread through China making silk a highly valued commodity much sought after by other countries. In 139 BC the world's longest trade route was opened stretching from Eastern China to the Mediterranean Sea. It was named the Silk Road after its most valuable commodity. By 300 AD the secret of silk production had reached India and Japan.

Silk manufacture eventually reached Europe and America. During the 18th and 19th centuries Europeans produced several major advancements in silk production. By the 18th century England led Europe in silk manufacturing because of English innovations in the textiles industry. These innovations included improved silk-weaving looms, power looms and roller printing. Between 1855 and 1865 an epidemic called Pebrine disease, caused by a small parasite, raged through the industry. It was the French scientist Louis Pasteur who discovered that this could be prevented through simple microscopic examination of adult silkmoths. Much research was carried out on silkworms at this time, ultimately setting the stage for a more scientific approach to silk production. Silk production today is a combination of old and modern techniques.

Bombyx Mori

Silkworm is a common name for the silk-producing larvae of any of several species of moths. The larva is not really a worm at all but a caterpillar. There are several species of silkworm that are used in commercial silk production, however Bombyx mori is the most common.

Bombyx mori is native to China and was introduced into Europe and western Asia in the 6th century AD and into North America in the 18th century. It feeds entirely on the leaves of the mulberry tree, so has flourished only where conditions are suitable for large numbers of leaf-bearing mulberry trees. Bombyx mori has been cultivated over many centuries and is no longer known in the wild.

Silk - A Hardened Glandular Fluid

Silkworms possess a pair of specially modified salivary glands called sericteries, which are used for the production of a clear, viscous, proteinaceous fluid that is forced through openings called spinnerets on the mouthpart of the larva. As the fluid comes into contact with the air it hardens. The diameter of the spinneret determines the thickness of the silk thread, which is produced as a long, continuous filament.

Typical Commercial Silkworm Production

The first stage of silk production is the hatching of the silkworm eggs, in a controlled environment such as an aluminium box, which are then examined to ensure they are free from disease. The female deposits 300 to 400 eggs at a time. In an area the size of this page around 50 moths would deposit more than 20,000 eggs, each about the size of a pinhead. The female dies almost immediately after depositing the eggs and the male lives only a short time after. The adult possesses rudimentary mouthparts and does not eat during the short period of its mature existence.

These disease-tested eggs are raised in temperature and disease-controlled conditions. They are fastened to a flat surface by a gummy substance secreted by the female. The larvae hatch in about 10 days and are about 0.6cm long. Once hatched, they are placed under a layer of gauze and fed huge amounts of chopped mulberry leaves during which time they shed their skin four times. The larvae may also feed on Osage orange or lettuce. Larvae fed on mulberry leaves produce the very finest silk. The larva will eat 50,000 times its initial weight in plant material.

After it has achieved its maximum growth of 7.5cm at around 4 to 6 weeks, it stops eating, changes colour and attaches itself to a compartmented frame, twig, tree or shrub in a rearing house to spin a silk cocoon over a 3 to 8 day period. This is period is termed pupating.

A Hard Day's Night

Steadily over the next four days the silkworm produces a fine thread by making a figure of eight movement some 300,000 times, constructing a cocoon in which it intends to spend the chrysalis stage where it is in a state of sleep and casting off its skin. After this the pupae begin the sixteen days that would normally result in the miracle of transformation to a winged being - the moth. However, if the pupa (chrysalis) remains alive it will begin to secrete an alkali, which eats its way through the cocoon, ruining the silk threads. Therefore during the commercial production of silk, only enough adult moths are allowed to emerge to ensure continuation of the species. Most of the remainder of the silkworms are killed by heat, e.g. immersion in boiling water, steaming or drying in an oven.

Hundreds Die

The amount of useable silk from each cocoon is small. One hectare of mulberry trees yields 11.25 tonnes of leaves, producing around 200kg of cocoons, but just 40kg of raw silk. The silk yield is many times smaller than this in countries such as Thailand, where the silk is reeled by hand rather than by machine. So it takes hundreds of tiny lives to produce just one silk scarf or tie.

Stud Bank & Breeding Research

A limited number of pupae are allowed to complete their chrysalis stage, the resulting silk moths being the stud bank that produces eggs to breed future generations of silkworm.

Much research has been carried out on silkworm breeding or sericulture worldwide over centuries and it continues today. Researchers are keen to establish a certain type of silkworm variety typically for low cost cocoons, disease resistance, high temperature resistance, polyphagy (ability to utilise more than one type of food), and choice quality silk. As with other types of animal farming industries, biotechnology is well established.

Thai Silk Production

The Thai silk moth is adapted to tropical conditions and is multivoltine, producing at least ten batches of eggs each year. Silk from the Thai moth is hand reeled from green cocoons. These are cocoons that still contain the live pupae. These small cocoons do not have the pupae 'stifled' or killed prior to the thread being unwound, as that would make it difficult to reel. The green cocoons are placed in hot, nearly boiling water, which loosens the end of the thread. With less than 10 days available before the moths emerge and ruin the cocoon, the Thai workers may run out of time, limiting the scale of the industry. Even experienced workers rarely produce more than 300g per day. The pupae may be eaten by local workers. Similar production techniques have been used in India, although increasingly Indian silk is woven using machines.

Chinese & Japanese Silk Production

The moth favoured in China and Japan is univoltine or bivoltine, producing one or two batches of eggs annually, which enter a diapausal state (suspended development) and can then be treated to induce hatching at a commercially convenient time. Cocoons are large and lend themselves to machine reeling, offering a long, continuous filament. The adult moths retained for reproduction purposes are too fat to fly, as the best fliers do not produce as much silk. The stifled or dead pupae are usually composted to feed the mulberry trees.

Whilst the tropical silkworm favoured by Thailand is a natural, hardy creature quite capable of surviving in the wild state, the larvae farmed by the industrialised mass production techniques of China and Japan are selectively bred creatures aimed at maximum output for minimum input.

The Silk Thread

Silk is a continuous filament fibre consisting of fibroin protein secreted from two salivary glands in the head of each larva and a gum called sericin which cements the two filaments together. Silk must be reeled off the cocoon quickly before the pupa begins to rot and taint the thread with unpleasant smells. The cocoon is then softened in hot water to remove the sericin, which frees the silk filament ends for reeling or filature. Single filaments are drawn from cocoons in water bowls and combined to form yarn. This yarn is drawn under tension through several guides and eventually wound onto reels. The yarn is dried, packed according to quality and is now raw silk ready for marketing. The worn and withered body of what was intended to become the wondrous flying creature slips silently away.

Fibre Properties

Silk is a natural protein fibre containing about 70-75% of actual fibre fibroin and about 25-30% sericin. Silk filaments are very fine and long - as much as 300 to 900 metres in length. Silk has a high natural lustre and sheen of a white or cream colour; and is one of the strongest fibres at 2.6 to 4.8 grams per denier. When it is dry the elongation (elastic recovery) varies from 10-25% and when wet it will elongate as much as 33-35%. Silk has a relatively high standard moisture regain of 11%. At saturation the regain is 25-35%. Silk can be dyed before or after it has been woven into a cloth. It can be woven or knitted.

Types of Silk

Next, the raw silk is twisted into a strand sufficiently strong for weaving or knitting. This procedure is called throwing, and prevents the thread from splitting into its constituent fibres. Four different types of silk thread may be produced from this procedure: crepe, tram, thrown singles and organzine. Crepe is made by twisting individual threads of raw silk, doubling two or more of these together, and then twisting them again. Tram is made by twisting two or more threads in only one direction. Thrown singles are individual threads that are twisted in only one direction. Organzine is a thread made by giving the raw silk a preliminary twist in one direction and then twisting two of these threads together in the opposite direction. In general, organzine thread is used for the warp threads of materials, tram threads for the weft or filling, crepe thread for weaving crinkly fabrics and a single thread for sheer fabrics.

Broken or waste filaments and damaged cocoons are retained, treated to remove the sericin, and combed. This is then processed into yarn, marketed as spun silk, which is inferior in character to the reeled product and much cheaper. Low grade silk is made from damaged cocoons that were spoiled by emerging moths used for breeding stock. Filaments from the coarse outer portion of the cocoon, which is removed by brushing before reeling, and the inner portion of the cocoon, which remains after reeling the raw silk, are mixed with silk from damaged cocoons to make low grade silk.

In common with all other animal production systems, nothing is wasted if it can be sold.

After the silk is harvested from the cocoons it is brought to the weavers for dyeing and preparation for weaving. Today most dyes are chemical although a lac (insect) dye was once used as well as plant dyes.

Another product of sericulture is silkworm gut. Immediately before the cocoon stage, pupae are killed by immersion in an acid bath. Their bodies are opened and the fluid, which hardens upon contact with the air and would otherwise be used to build the cocoon, is removed from their silk glands. This 'gut' was once favoured by surgeons for stitching and by anglers for lines, but has now been almost entirely replaced by nylon, although it still figures in some surgical and contraceptive applications.

World Silk Production

World silk production has more than doubled during the last 30 years in spite of the availability of man-made fibres. China and Japan have been the main silk producers, together manufacturing more than half of the world production each year. Chinese silk is highly prized throughout the world. Since 1949 silk making methods have been modernized and silk is of better quality.

World Raw Silk Production

Year	Metric Tonnes
1993	56, 500
1970	41, 000
1980	55, 315
1985	59, 232
1990	69, 120
1992	80, 934
1993	89, 982
1994	95, 498
1995	91, 476
1996	83, 670

Say No to Silk

Silk is used for suits, coats, trousers, jackets, shirts, ties, lingerie, hosiery, gloves, lace, curtains, linings and handbags. Synthetic fibres such as nylon and polyester are stronger than silk and lower in price. In common with western factory farming techniques, the main areas of silk production are labour-intensive, automated and soul-less. The terminology - stifled for killed and crop for pupae - echoes the denial that we are dealing with living creatures which are awe inspiring when one considers their metamorphic life-cycle. Plant fibres are capable of producing some amazing fabrics. Fibres from the pineapple, for example, may be made into fabrics as strong and lustrous as any silk. Synthetic fibres e.g. nylon produced from minerals, polyester from petroleum spirit (Terylene, Dacron) or acrylic from oil and coal (Courtelle, Orlon, Dralon) also have their place.

Chapter 3

Super Silk and Super Bones

Spiders Silk and Silica Nanocomposite has Potential Biomedical Applications

Bioengineers at Tufts University have created a new fusion protein that for the first time combines the toughness of spider silk with the intricate structure of silica. The resulting nanocomposite could be used in medical and industrial applications, such as growing bone tissue.

"This is a novel genetic engineering strategy to design and develop new 'chimeric' materials by combining two of nature's most remarkable materials -- spider silk and diatom glassy skeletons – that normally are not found together," said David L. Kaplan, professor and chair of biomedical engineering and director of Tufts' Bioengineering and Biotechnology Center.

Kaplan, along with his Tufts graduate students and collaborators Carol C. Perry from Nottingham Trent University in England and Rajesh Naik from the Air Force Research Laboratory, released their findings in the paper "Novel Nanocomposites from Spider Silk-Silica Fusion (Chimeric) Proteins" published in the Proceedings of the National Academy of Sciences.

Silica provides structural support to diatoms (single-celled organisms known for their remarkable nanostructural details) while silk proteins from spiders and silkworms are more flexible, stronger and able to self-assemble into readily defined structures. The Tufts researchers were able to design and clone genetic fusions of the encoding genes for these two proteins, and then generate these genetically engineered proteins into nanocomposites at ambient temperatures using only water. In contrast, high temperatures and harsh conditions are typically required by geochemical and industrial synthesis of silica in the laboratory.

Another remarkable detail about the spider silk-silica composite is its size. While past tests using silica have formed silica particles with a diameter between 0.5 and 10 nanometers, the silk-glass composite has a diameter size distribution between 0.5 and 2 nanometers. The smaller, more uniform size will provide better control and more options for processing, which would be "important benefits for biomedical and specialty materials," according to the research.

Kaplan says this new chimeric protein could lead to a variety of biomedical materials that restore tissue structure and function, including bone repair and regeneration. Other likely applications involve more basic areas of materials science and engineering, including "green chemistry," which will prevent or reduce pollution.

The research was funded by the National Institutes of Health, the U.S. Air Force Office of Scientific Research and the European Commission.

Silk research spans a decade

Kaplan and his fellow researchers have been working on silks for more than a decade and have focused on these specific spider silk-silica chimeric proteins for about a year.

"We have worked on silks for a long time and we were designing new versions of silks using genetic engineering," said Kaplan. "Since the diatom and other mineral forming domains had recently been identified in the literature, the silk-silica combination seemed potentially important from a materials perspective."

In 2002, Kaplan and his team of researchers from Tufts' School of Engineering and School of Medicine developed a tissue engineering strategy to repair one of the world's most common knee injuries -- ruptured anterior cruciate ligaments (ACL) -- by mechanically and biologically engineering new ones using silk scaffolding for cell growth. A year later, Kaplan and a postdoctoral fellow at Tufts discovered how spiders and silkworms are able to spin webs and cocoons made of silk and aspects of the spinning process to replicate it artificially.

Tufts University, located on three Massachusetts campuses in Boston, Medford/Somerville, and Grafton, and in Talloires, France, is recognized among the premier research universities in the United States. Tufts enjoys a global reputation for academic excellence and for the preparation of students as leaders in a wide range of professions. A growing number of innovative teaching and research initiatives span all Tufts campuses, and collaboration among the faculty and students in the undergraduate, graduate and professional programs across the University's eight schools is widely encouraged.

Chapter 4

Research

1. A novel systems biology/engineering approach solves fundamental molecular mechanistic problems in bioenergetics and motility

Sunil Nath,
Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology, Delhi, Hauz Khas, New Delhi 110016, India

Abstract

A large number of new insights and further intricate details of the molecular mechanisms of ATP synthesis and muscle contraction have been offered from the perspective of the torsional mechanism of energy transduction and ATP synthesis and the rotation-uncoiling-tilt (RUT) energy storage mechanism of muscle contraction. In this paper, a new systems thermodynamics analysis of oxidative- and photo-phosphorylation has been performed. New experimental data has been reported on the inhibition of ATP synthesis by known specific anion channel blockers: the triorganotin compound, tributyltin chloride (TBTCl), and the stilbene compound 4,4′-diisothiocyanostilbene-2,2′-disulfonate (DIDS), and interpreted as supporting the new framework. A bioinformatic analysis of the interacting a–c regions in FO has been carried out to locate the anion binding pocket in the anion–proton symsequenceporter and insights into the coordination chemistry of the bound chloride in its internal cavity at the lipid–water interface have been obtained. The need to look at ATP synthesis in FO as a multisubstrate reaction has been emphasized and a detailed microscopic explanation of the mechanism of inhibition by these blockers and its relationship to the conformational cycle within FO has been postulated. Such detailed explanations of the role of membrane elements in a lipophilic region have been shown to lead to deeper understanding and to offer a more realistic and complete picture of biological energy transduction than considering the bilayer as "mere insulation", as in chemiosmotic dogma. Details of the elementary force production events by myosin II have been provided within the novel molecular systems framework of the RUT mechanism in which the S-1, the S-1–S-2 hinge, and the S-2 coiled coil all have essential roles in the in vivo contractile process. The new paradigm is shown to be consistent with the great body of experiments usually considered to support the swinging crossbridge/lever arm models of muscle contraction, because these events also occur during the cycle but as events preliminary to the occurrence of the power stroke. The crucial role of energy storage in mechanically strained nonequilibrium conformational states of myosin, specifically as a high-energy state of S-2 with uncoiled first few N-terminal heptads is highlighted. The propensity of these heptads to recoil and regain the resting state of the coiled coil is postulated to be a primary driving force of the power stroke. The new paradigms of ATP synthesis/muscle contraction have been shown to remove the inconsistencies present in previous theories and to have the sound backing of the first and second laws of thermodynamics, the principle of electrical neutrality, the laws of Newtonian mechanics, and the great conservation laws of mechanics. A systems integration of muscle contraction has been successfully made and a systems electrical analog

constructed. The unifying laws and principles in the new theories have been further applied to understand the functioning of other protein molecular machines such as kinesin, ncd and unconventional myosins. Finally, the major physical, chemical, biological and technological implications arising as a result of this research have been discussed. Taken together, the new paradigms have been shown to solve fundamental molecular mechanistic problems in bioenergetics and motility and to offer a most detailed, unified and appealing picture of energy generation, transduction, storage and utilization processes in systems of biological molecular machines.

2. A study on the effects of ozone treatment on the properties of raw and degummed mulberry silk fabrics

D. Sargunamani, a, and N. Selvakumara
Department of Textile Technology, A C College of Technology, Anna University, Chennai, Tamil Nadu 600 025, India

Abstract

Ozone is a powerful oxidizing agent and is widely used in various applications, which includes bleaching of cotton. Its application on the processing of silk is non-existent. Research studies on degumming and bleaching of silk reveal that almost no work involving ozone has been carried out. Therefore a study was carried out to understand the effects of process parameters namely wet pickup, pH and time in the ozone treatment of raw and degummed mulberry and tassar silk fabrics on their properties. This paper reports on the effects of ozone treatment on the mulberry silk fabrics. The study was extended with a view to compare the ozone treatment with soap degumming and hydrogen peroxide treatment carried out on raw and degummed mulberry silk fabrics, respectively. The treatment results in increase in yellowness index and amino group content and decrease in breaking strength and elongation, weight and flexural rigidity. The results obtained are substantiated with tyrosine content, scanning electron micrographs and infrared spectroscopy of the treated materials. The effect of pH on the treatment is maximum up to pH 4 and then decreases. The treatment is more severe when the wet pickup used is 50% compared to that of 10 and 100%. With respect to treatment time, though the severity increases with time, it is maximum during the first 10 min of the treatment. Soap degumming of raw silk fabric results in lower yellowness index and flexural rigidity and lesser loss in breaking strength and elongation compared to that of ozone treated material. There is not much of difference between ozone and hydrogen peroxide treatments of degummed silk fabric except for the lower yellowness index obtained in the latter case.

3. Arthropod cuticle: a natural composite shell system

Julian F. V. Vincent,
Department of Mechanical Engineering, The University of Bath, Bath BA2 7AY, UK

Abstract

The cuticle of arthropods (jointed-limb animals), and especially of insects is, by biological standards, a relatively simple composite. It is a single external layer of material forming the skeleton and many sense organs. The fibrous phase is crystalline chitin making nanofibrils of about 3 nm diameter, a few hundreds of nanometers long and a modulus probably in excess of 150 GPa. At least two surfaces of the nanofibril can have silk-like protein attached through specific H-bonds; the rest of the protein is globular. The protein matrix stiffens through dehydration controlled by the introduction of hydrophobic phenolics. Crustacea add up to 40% calcium salts. The stiffness of cuticle can range from tens of GPa to 1 kPa. It can be hardened by the addition of Zn or Mn. It can form springs and change its stiffness and plasticity under the control of the animal.

4. Bone and cartilage tissue constructs grown using human bone marrow stromal cells, silk scaffolds and rotating bioreactors

Darja Marolta, b, Alexander Augsta, Lisa E. Freeda, Charu Veparic, Robert Fajardod, f, Nipun Pateld, f, Martha Graya, f, g, Michelle Farleya, f, g, David Kaplanc and Gordana Vunjak-Novakovica
Harvard-MIT Division of Health Sciences and Technology, Cambridge, MA, USA
Blood Transfusion Center of Slovenia, Ljubljana, Slovenia
Department of Biomedical Engineering, Tufts University, Medford, MA, USA
Orthopedic Biomechanics Laboratory, Harvard Medical School and Beth Israel Deaconess Medical Center, Boston, MA, USA
Department of Biomedical Engineering, Columbia University, 1210 Amsterdam Avenue, 351 Engineering Terrace, Mail Code 8904, New York, NY 10027, USA
Beth Israel Deaconess Medical Center, Boston, MA, USA
New England Baptist Bone and Joint Institute, Boston, MA, USA

Abstract

Human bone marrow contains a population of bone marrow stromal cells (hBMSCs) capable of forming several types of mesenchymal tissues, including bone and cartilage. The present study was designed to test whether large cartilaginous and bone-like tissue constructs can be selectively engineered using the same cell population (hBMSCs), the same scaffold type (porous silk) and same hydrodynamic environment (construct settling in rotating bioreactors), by varying the medium composition (chondrogenic vs. osteogenic differentiation factors). The hBMSCs were harvested, expanded and characterized with respect to their differentiation potential and population distribution. Passage two cells were seeded on scaffolds and cultured for 5 weeks in bioreactors using osteogenic, chondrogenic or control medium. The three media yielded constructs with comparable wet weights and compressive moduli (25 kPa). Chondrogenic medium yielded constructs with higher amounts of DNA (1.5-fold) and glycosaminoglycans (GAG, 4-fold) per unit wet weight (ww) than control medium. In contrast, osteogenic medium yielded constructs with higher dry

weight (1.6-fold), alkaline phosphatase (AP) activity (8-fold) and calcium content (100-fold) per unit ww than control medium. Chondrogenic medium yielded constructs that were weakly positive for GAG by contrast-enhanced MRI and alcian blue stain, whereas osteogenic medium yielded constructs that were highly mineralized by μCT and von Kossa stain. Engineered bone constructs were large (8 mm diameter × 2 mm thick disks) and resembled trabecular bone with respect to structure and mineralized tissue volume fraction (12%).

5. Clusters on soft matter surfaces

A.M. Bittnera,
Max-Plank-Institut für Festkörperforschung, Department of Nanoscale Science (Abt. Kern), Heisenbergstraße 1, 70569 Stuttgart, Germany

Abstract

Clusters built from metals, semiconductors and dielectric materials, whether they are bare or coated by ligand molecules, interact in many different ways with soft matter. The ensuing phenomena are of great relevance for technical problems such as metal/polymer interfaces, but also to fundamental questions such as controlled charging of single clusters. Clusters on soft matter may be employed for nanotechnology, when a collective physical property of an assembly of many clusters is aimed at. Most interesting is the fact that the interaction with a solid substrate that supports the soft layer can be suppressed. This means that the clusters are adsorbed, but preserved as entities, and hence their size-dependent physical properties are not affected by coupling to the solid substrate (e.g. optical excitation or electronic properties).

"Soft matter" is anything but a well-defined term, but thin layers and organic molecules assembled on solid substrates can exhibit excellent ordering and conformational stability, and a wide range of highly interesting and finely tunable chemical properties. The layers can be organic monolayers such as self-assembling monolayers, but also two-dimensional arrangements of proteins. The surfaces of polymers and organic crystals are very nicely comparable to such systems. In all cases, the surfaces may show conformational flexibility, but their composition and atomic arrangement (in each molecule) are well defined. Special cases are inert gas layers at low temperature, used for soft landing of clusters, again with the aim of preserving the clusters' properties.

Typically a cluster/soft matter system is prepared by vacuum deposition, adsorption from solution, or by electrochemical or chemical synthesis, all of which are considered here. For a proper description of the system, cluster/surface interactions can be treated macroscopically, inspired from colloid science, but also microscopically on the atomic level.

6. Coloration of textiles with self-dispersible carbon black nanoparticles

Dapeng Li1, a, and Gang Sun, a,

Division of Textiles and Clothing, University of California, Davis, CA 95616, USA

Abstract

Cotton, wool, acrylic and nylon fabrics can be directly dyed by using surface modified carbon black (CB), self-dispersible carbon black (SDCB), nanoparticles through an exhaustion process. The SDCB nanoparticles were prepared by refluxing CB particles in nitric acid for certain time to result in hydrophilic carboxylic groups on their surfaces. The SDCB nanoparticles behaved similarly to direct or acid dyes in dyeing cotton, acrylic and nylon fibers. The SDCB nanoparticles were characterized by infrared spectroscopy and particle size analyzer. The SDCB-dyed fabrics showed good colorfastness against crocking. However, the wash fastness of the nanoparticle-dyed cotton fabrics is relatively lower than the crocking fastness due to the hydrophilic feature of the SDCB nanoparticles. Direct employment of the nanoparticles in dyeing opens new applications of nanotechnologies in textile production.

7. Dyeing of natural and synthetic textiles in supercritical carbon dioxide with disperse reactive dyes

M. van der Kraana, , , M.V. Fernandez Cida, G.F. Woerleeb, W.J.T. Veugelersb and G.J. Witkampa
Laboratory for Process Equipment, Delft University of Technology, Leeghwaterstraat 44, 2628 CA Delft, The Netherlands
bFeyeCon Development & Implementation B.V., Rijnkade 17a, 1382 GS Weesp, The Netherlands

Abstract

Polyester, nylon, silk and wool were dyed with disperse reactive dyes in supercritical carbon dioxide (scCO2). The dyes were substituted with either vinylsulphone or dichlorotriazine reactive groups. Since earlier research showed that water, distributed over the scCO2 and the textile, increased the colouration, experiments were done with the vinylsulphone dye with varying amounts of water in the dyeing vessel, to investigate if there is an optimum water concentration. The amounts were such, that no liquid water was present. The maximum colouration was obtained when both the scCO2 and the textiles were saturated with water. At the saturation point, deep colours were obtained with the vinylsulphone dye for polyester, nylon, silk and wool, with fixation percentages between 70 and 92% when the dyeing time was 2 h. The positive effect of water was due to its ability to swell fibres or due to an effect of water on the reactivity of the dye–fibre system. Also the dichlorotriazine dye showed more colouration when the scCO2 was moist. With this dye, experiments were conducted in water-saturated scCO2, varying the pressure from 225 to 278 bar and the temperature from 100 to 116 °C. The colouration of polyester increased with pressure, the results for silk and wool were not sensitive to pressure. Increasing the temperature had no influence on the dyeing of polyester, silk and wool. The fixations on polyester, silk and wool, being between 71 and 97%, were also independent of pressure and temperature.

8. Measures for knowledge-based economic development: Introducing data mining techniques to economic developers in the state of Georgia and the US South

Philip Shapiraa, and Jan Youtieb, ,

School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332-0345, USA
Georgia Tech Economic Development and Technology Ventures, Atlanta, GA 30332-0640, USA

Abstract

The contribution of knowledge to economic growth and competitiveness has attracted increased attention. Publications with a topical focus on areas related to innovation have risen dramatically from 1963 to 2005, but more slowly in local and regional development journals. In contrast to the wide use of aggregate measures of innovation, this paper presents four cases presenting disaggregated knowledge-based approaches into the policy- and decision-making processes of economic developers in the state of Georgia and the US South. The first case uses information obtained from patents and publications to inform traditional out-of-area economic development recruitment strategies in a more knowledge-oriented direction. The second case exemplifies the use of data mining to identify top researchers as part of a strategic state economic development effort. The third case illustrates how local knowledge-based capabilities can be identified in cities not traditionally viewed as innovative. Nanotechnology-related knowledge assets in the southern United States are mapped and assessed in the fourth case. Disaggregated methods used in traditional strategies were most intuitively understood and used, but new knowledge measures were found to encourage local and state economic developers to begin to embrace new paradigms.

9. Nanotechnology for the developing world

M. Saladin El Naschie, a, b, c
Department of Physics, University of Alexandria, Egypt
Department of Astrophysics, Cairo University, Egypt
Department of Physics, Mansura University, Egypt

Abstract

The letter discusses the indispensable importance of Nanotechnology for the scientific and economical revival of the developing world. Similar to the nuclear age, and maybe far more so, the nanoage will be something of a Hemingway line of demarcation between the have and the have nots.

10. Preparation of non-woven mats from all-aqueous silk fibroin solution with electrospinning method

Chen Chena, Cao Chuanbao, a, , Ma Xilana, Tang Yina and Zhu Hesuna
Research Center of Material Science, Beijing Institute of Technology, No. 5, Zhongguancun South Street, Beijing 100081, China

Abstract

In the present study, we successfully prepared non-woven mats from stable regenerated silk fibroin aqueous solution at high concentration. Scanning electronic microscope (SEM) was used to observe the morphology of the fibers. The structure of the fibers was characterized using Fourier transform infrared (FTIR), wide-angle X-ray diffraction (WAXD) and differential scanning calorimetry (DSC). The mechanical tests were also performed. In the as-spun fibers, silk fibroin was present in a random coil conformation, the stress and strain at break were 0.82 MPa and 0.76%, respectively, while after methanol treatment, the silk fibroin was transformed into a β-sheet-containing structure, the stress and strain at break increased to 1.49 MPa and 1.63%, respectively. This study provided an option for the electrospinning of silk fibroin without using organic solvent or blending with any other polymers, which may be important in tissue engineering scaffold preparation.

11. Stability of neuropathic pain symptoms in partial sciatic nerve ligation in rats is affected by suture material

Ian Robinsona, b and Theo F Meerta, ,

aJohnson & Johnson Pharmaceutical Research and Development, Turnhoutseweg 30, B-2340 Beerse, Belgium
bSchool of Clinical and Laboratory Sciences, Faculty of Medical Sciences, Medical School, University of Newcastle-Upon-Tyne, Newcastle NE2 4HH, UK

Received 25 June 2004; revised 16 September 2004; accepted 30 September 2004. Available online 28 October 2004.

Abstract

Many factors affect the development of neuropathic pain behavior in animal models. In this letter, we describe the differences in the development of neuropathic pain behavior observed when the partial sciatic nerve ligation (PNL) is performed with either a synthetic silk or chromic catgut ligation. To characterize nociceptive changes over time after surgery, neutral plate, hot plate, Von Frey, pinprick, acetone spray and cold plate testing was performed. The results indicated that a chromic catgut ligature caused cold allodynia, chemical hyperreactivity, mechanical hyperalgesia and hypersensitivity that remained present for the entire 56 days post-surgical observation period. With the synthetic silk ligature, comparable functional deficits were present in the initial phase after surgery, but several of these deficits diminished over time 21–28 days post-surgery. In conclusion, performing the PNL using chromic catgut suture thread gives rise to more robust sensory deficits than when synthetic silk is used. Therefore, the material that is used for the ligature in the partial sciatic ligation model has an effect on the outcome of the observed sensory abnormalities.

12. Structure by design: from single proteins and their building blocks to nanostructures

Chung-Jung Tsai1, Jie Zheng1, Carlos Alemán2 and Ruth Nussinov1, 3,
1Basic Research Program, SAIC-Frederick, Inc., Center for Cancer Research Nanobiology Program, NCI-Frederick, Frederick, MD 21702, USA
2Departament d'Enginyeria Química, E. T. S. d'Enginyeria Industrial de Barcelona, Universitat Politécnica de Catalunya, Diagonal 647, Barcelona E-08028, Spain
3Sackler Institute of Molecular Medicine, Department of Human Genetics and Molecular Medicine, Sackler School of Medicine, Tel Aviv University, Tel Aviv 69978, Israel

Abstract

Nanotechnology realizes the advantages of naturally occurring biological macromolecules and their building-block nature for design. Frequently, assembly starts with the choice of a 'good' molecule that is synthetically optimized towards the desired shape. By contrast, we propose starting with a pre-specified nanostructure shape, selecting candidate protein building blocks from a library and mapping them onto the shape and, finally, testing the stability of the construct. Such a shape-based, part-assembly strategy is conceptually similar to protein design through the combinatorial assembly of building blocks. If the conformational preferences of the building blocks are retained and their interactions are favorable, the nanostructure will be stable. The richness of the conformations, shapes and chemistries of the protein building blocks suggests a broad range of potential applications; at the same time, it also highlights their complexity. In this Opinion article, we focus on the first step: validating such a strategy against experimental data.

13. Structure of the Nacreous Organic Matrix of a Bivalve Mollusk Shell Examined in the Hydrated State Using Cryo-TEM

Yael Levi-Kalismana, Giuseppe Falinib, Lia Addadia and Steve Weinera
Department of Structural Biology, Weizmann Institute of Science, 76100, Rehovot, Israel
Dipartimento di Chimica "G. Ciamician," Università degli Studi di Bologna, via Selmi 2, 40126, Bologna, Italy

Abstract

During mollusk shell formation, the mineral phase forms within an organic matrix composed of β-chitin, silk-like proteins, and acidic glycoproteins rich in aspartic acid. The matrix is widely assumed to play an important role in controlling mineralization. Thus, understanding its structure is of prime importance. Cryo-transmission electron microscopy (Cryo-TEM) studies of the matrix of the bivalve Atrina embedded in vitrified ice show that the interlamellar sheets are composed mainly of highly ordered and aligned β-chitin fibrils. The silk, which is quantitatively an important component of the matrix, could not be imaged within the sheets. Organic material was, however, observed between sheets. We infer that this is the location of the silk. As this material reveals no regular structure, we suggest that at least prior to mineralization the silk is in the form of a hydrated gel. This is supported by cryo-

TEM structural observations of an artificial assembly of β-chitin with and without silk. This view of the nacreous organic matrix significantly changes previous models of the matrix structure and hence hypotheses pertaining to the mechanisms by which mineral formation occurs.

14. Text mining as a valuable tool in foresight exercises: A study on nanotechnology

Marcio de Miranda Santoa, Gilda Massari Coelho, a, , Dalci Maria dos Santosa and Lélio Fellows Filhoa
Center for Management and Strategic Studies – CGEE, SCN Quadra 2, Bloco A, Ed. Corporate Financial Center, 11° andar, Sala 1102, CEP 70712-900 Brasília-DF-Brazil

Abstract

Since its inception in 2001, the Center for Management and Strategic Studies (CGEE) has as its main activity the conduct of foresight studies in support of the decision making process related to the establishment of ST&I policies and activities in Brazil. The methodology used by the center combines quantitative and qualitative methods. Explicit and tacit knowledge is mobilized in the process of developing complementary or differentiated visions of the future.

Most of the studies conducted by CGEE begin with data monitoring activities, making use of text mining techniques. One case study carried out by CGEE on the field of nanotechnology is presented. In this case, text mining was used at the first stage followed by qualitative techniques. Results were used to guide government agencies to fund nanotechnology R&D to help raise the competitiveness of several sectors of the Brazilian economy.

15. The support of adenosine release from adenosine kinase deficient ES cells by silk substrates

Lorenz Uebersaxa, 1, Denise E. Fedelea, b, 1, Claudia Schumacherb, David L. Kaplanc, Hans P. Merklea, Detlev Boisond, , and Lorenz Meinela, c

Institute for Pharmaceutical Sciences, Drug Formulation and Delivery, ETH Zurich, CH 8093 Zurich, Switzerland
Institute for Pharmacology and Toxicology, University of Zurich, CH 8057 Zurich, Switzerland
Department for Biomedical Engineering, Tufts University, Medford, MA 02155, USA
R.S. Dow Neurobiology Laboratories, Legacy Research, 1225 NE 2nd Avenue, Portland, OR 97232 2003, USA

Abstract

Adenosine kinase deficient (Adk−/−) embryonic stem cells (ESCs) encapsulated in synthetic polymers have previously been shown to provide therapeutic adenosine release and transient seizure suppression in epileptic rats. Here we explored the utility of biopolymer-substrates to promote long-term adenosine release from Adk−/− ESCs. Three different substrates were studied: (1) type I collagen (Col-1), (2) silk-fibroin (SF), and (3) poly(l-ornithine) (PO) coated tissue

culture plastic. Adk−/− or wild type (wt) ESC-derived glial precursor cells were seeded on the substrates and cultured either in proliferation medium containing growth factors or in differentiation medium devoid of growth factors. In proliferation medium cell proliferation was higher and metabolic activity lower on Col-I and PO substrates as compared to SF. Cells from both genotypes readily differentiated into astrocytes after growth factor removal on all substrates. Adk−/− cells cultured on biopolymers released significantly more adenosine than their wt counterparts at all developmental stages. Adenosine release was similar on SF and PO substrates and the amounts released from Adk−/− cells (>20 ng/ml) were considered to be of therapeutic relevance. Taken together, these results suggest that silk matrices are particularly suitable biomaterials for ESC encapsulation and for the design of adenosine releasing bioincubators for the treatment of epilepsy.

Results and Discussion

Silk is a desirable material for both beauty and fashion. It is durable and strong but has drawbacks. By using new modern nanotech silk, a person will get the benefits of strength and beauty with no problems from wrinkles, discolorations from water or sweat strains or the strains of oil or water-based liquids that might spill on a person when wearing the silk cloths.

Bones are a majors support for the body, but when they break they need to be repaired. Minor repairs are no problem but major repairs can result in infections, and if steel bars are put in , rejection and allergies can result as well as slow growth and little strength. With new silica /silk bone structures; bones will not only grow back faster but have no allergy or rejection problems and can be stronger than the original bones.

In summary nanotech silk work can benefit the world in both internal and external ways.

References

Internet Citations

[1] www.http://www.azonano.com/news.asp?newsID=2494
[2] www.http://www.crnano.org/benefits.htm
[3] www.http://www.earthsky.org/shows/show.php?date=20060718
[4] www.http://www.phys.ntnu.no/complex/nanotechnology_e.php3
[5] www.http://www.vegansociety.com/html/animals/exploitation/silk_worm.php
[6] www.http://www.sciencedirect.com/science

Appendix

NANOADVANCED SILK

Chantana Viriyavejakul *

Department of Industrial Education, Faculty of Industrial Education
King Mongkut's Institute of Technology Ladkrabang,
Chalongkrung Road, Ladkrabang, Bangkok 10520, Thailand

ABSTRACT

Nanotechnology combined with silk production is a way to increase benefits of cloth. The meaning of nanotechnology is going into a substance on the molecular level to create changes on the structural level without making external changes so that a better product is available to the consumer. In this case, a better quality silk with more strength and more varied uses.

KEYWORDS: nanotechnology, silk, super silk, super bones

1. INTRODUCTION

Silk is a cloth that is beautiful and radiant. However, there are drawbacks to using it. It gets wrinkled easily. It is hot and when it has become wet from sweat or water, it changes color so that the wearer is not pleased with his appearance and comfort of his cloths. If silk were to be made with nanotech supported and serve internal changes, the undesirable traits of cloth could be removed so that it would be a preferred cloth in some occasions. Moreover if other kinds of silks, like that of the spider are mixed with substances such as shell, it can produce a new substance that can be used for bone repair. It is known that bones which are made new from metallic materials present heavy metal problems for the body, some that result in more danger then not having the metal bone parts. With imitation bone material from silk and shell composite material, the bones infused with the body will mix better have less reaction problems with body and be much lighter.

2. MATERIALS AND METHODS

Nanotechnology

A basic definition is: engineering of functional systems at the molecular scale. This covers current work and concepts that are more advanced. In its original sense, 'nanotechnology' refers to the projected ability to construct items from the bottom up, using techniques and tools being developed today to make complete, high performance products. Based on Richard Feynman's vision of miniature factories using nanomachines to build complex products, advanced nanotechnology (sometimes referred to as molecular manufacturing) will make use of positionally-controlled mechanochemistry guided by molecular machine systems. Its best known exposition is in the books of K. Eric Drexler . Formulating a roadmap for its development is now an objective of a broadly based technology roadmap project led by Battelle (the manager of several U.S. National Laboratories) and the Foresight Nanotech Institute.

---

*Corresponding author. Tel: 66-2737-3000 ext.6061 Fax: 66-2326-4511 E-mail: kmchanta@kmitl.ac.th

Shortly after this envisioned molecular machinery is created, it will result in a manufacturing revolution, probably causing severe disruption. It also has serious economic, social, environmental, and military implications.

When Eric Drexler popularized the word 'nanotechnology' in the 1980's, he was talking about building machines on the scale of molecules, a few nanometers wide—motors, robot arms, and even whole computers, far smaller than a cell. Drexler spent the next ten years describing and analyzing these incredible devices, and responding to accusations of science fiction. Meanwhile, mundane technology was developing the ability to build simple structures on a molecular scale. As nanotechnology became an accepted concept, the meaning of the word shifted to encompass the simpler kinds of nanometer-scale technology. The U.S. National Nanotechnology Initiative was created to fund this kind of nanotech: their definition includes anything smaller than 100 nanometers with novel properties[1].

Nanotechnology is often referred to as a general-purpose technology. That's because in its advanced form it will have significant impact on almost all industries and all areas of society. It offers better built, longer lasting, cleaner, safer, and smarter products for the home, for communications, for medicine, for transportation, for agriculture, and for industry in general.

Imagine a medical device that travels through the human body to seek out and destroy small clusters of cancerous cells before they can spread. Or a box no larger than a sugar cube that contains the entire contents of the Library of Congress. Or materials much lighter than steel that possess ten times as much strength. — U.S. National Science Foundation

Why does nanotechnology have to be used responsibly?

Like electricity or computers before it, nanotech will offer greatly improved efficiency in almost every facet of life. But as a general-purpose technology, it will be dual-use, meaning it will have many commercial uses and it also will have many military uses—making far more powerful weapons and tools of surveillance. Thus it represents not only wonderful benefits for humanity, but also grave risks.

A key understanding of nanotechnology is that it offers not just better products, but a vastly improved manufacturing process. A computer can make copies of data files—essentially as many copies as you want at little or no cost. It may be only a matter of time until the building of products becomes as cheap as the copying of files. That's the real meaning of nanotechnology, and why it is sometimes seen as "the next industrial revolution."

The power of nanotechnology can be encapsulated in an apparently simple device called a personal nanofactory that may sit on your countertop or desktop. Packed with miniature chemical processors, computing, and robotics, it will produce a wide-range of items quickly, cleanly, and inexpensively, building products directly from blueprints.

Nanotechnology not only will allow making many high-quality products at very low cost, but it will allow making new nanofactories at the same low cost and at the same rapid speed. This unique (outside of biology, that is) ability to reproduce its own means of production is why nanotech is said to be an exponential technology. It represents a manufacturing system that will be able to make more manufacturing systems—factories that can build factories—rapidly, cheaply, and cleanly. The means of production will be able to reproduce exponentially, so in just a few weeks a few nanofactories conceivably could become billions. It is a revolutionary, transformative, powerful, and potentially very dangerous—or beneficial—technology[4].

How soon will all this come about? Conservative estimates usually say 20 to 30 years from now, or even later. However, CRN is concerned that it may occur much sooner, quite possibly within the next decade. This is because of the rapid progress being made in enabling technologies, such as optics, nanolithography, mechanochemistry and 3D prototyping. If it does arrive that soon, we may not be adequately prepared, and the consequences could be severe[2].

Silk

The discovery of the product silk from the silkworm species Bombyx mori occurred around 2700 BC. According to Chinese tradition the bride of Emperor Huang Ti, a 14-year-old girl called Hsi Ling Shi, discovered the invention of the first silk reel. Sericulture, the cultivation of the silkworm, spread through China making silk a highly valued commodity much sought after by other countries. In 139 BC the world's longest trade route was opened stretching from Eastern China to the Mediterranean Sea. It was named the Silk Road after its most valuable commodity. By 300 AD the secret of silk production had reached India and Japan.

Silk manufacture eventually reached Europe and America. During the 18th and 19th centuries Europeans produced several major advancements in silk production. By the 18th century England led Europe in silk manufacturing because of English innovations in the textiles industry. These innovations included improved silk-weaving looms, power looms and roller printing. Between 1855 and 1865 an epidemic called Pebrine disease, caused by a small parasite, raged through the industry. It was the French scientist Louis Pasteur who discovered that this could be prevented through simple microscopic examination of adult silkmoths. Much research was carried out on silkworms at this time, ultimately setting the stage for a more scientific approach to silk production. Silk production today is a combination of old and modern techniques.

Silk - A Hardened Glandular Fluid : Silkworms possess a pair of specially modified salivary glands called sericteries, which are used for the production of a clear, viscous, proteinaceous fluid that is forced through openings called spinnerets on the mouthpart of the larva. As the fluid comes into contact with the air it hardens. The diameter of the spinneret determines the thickness of the silk thread, which is produced as a long, continuous filament.

Typical Commercial Silkworm Production : The first stage of silk production is the hatching of the silkworm eggs, in a controlled environment such as an aluminium box, which are then examined to ensure they are free from disease. The female deposits 300 to 400 eggs at a time. In an area the size of this page around 50 moths would deposit more than 20,000 eggs, each about the size of a pinhead. The female dies almost immediately after depositing the eggs and the male lives only a short time after. The adult possesses rudimentary mouthparts and does not eat during the short period of its mature existence. These disease-tested eggs are raised in temperature and disease-controlled conditions. They are fastened to a flat surface by a gummy substance secreted by the female. The larvae hatch in about 10 days and are about 0.6cm long. Once hatched, they are placed under a layer of gauze and fed huge amounts of chopped mulberry leaves during which time they shed their skin four times. The larvae may also feed on Osage orange or lettuce. Larvae fed on mulberry leaves produce the very finest silk. The larva will eat 50,000 times its initial weight in plant material. After it has achieved its maximum growth of 7.5cm at around 4 to 6 weeks, it stops eating, changes colour and attaches itself to a compartmented frame, twig, tree or shrub in a rearing house to spin a silk cocoon over a 3 to 8 day period. This is period is termed pupating.

A Hard Day's Night : Steadily over the next four days the silkworm produces a fine thread by making a figure of eight movement some 300,000 times, constructing a cocoon in which it intends to spend the chrysalis stage where it is in a state of sleep and casting off its skin. After this the pupae begin the sixteen days that would normally result in the miracle of transformation to a winged being - the moth. However, if the pupa (chrysalis) remains alive it will begin to secrete an alkali, which eats its way through the cocoon, ruining the silk threads. Therefore during the commercial production of silk, only enough adult moths are allowed to emerge to ensure continuation of the species. Most of the remainder of the silkworms are killed by heat, e.g. immersion in boiling water, steaming or drying in an oven.

Hundreds Die : The amount of useable silk from each cocoon is small. One hectare of mulberry trees yields 11.25 tonnes of leaves, producing around 200kg of cocoons, but just 40kg of raw silk.

The silk yield is many times smaller than this in countries such as Thailand, where the silk is reeled by hand rather than by machine. So it takes hundreds of tiny lives to produce just one silk scarf or tie.

Stud Bank & Breeding Research : A limited number of pupae are allowed to complete their chrysalis stage, the resulting silk moths being the stud bank that produces eggs to breed future generations of silkworm. Much research has been carried out on silkworm breeding or sericulture worldwide over centuries and it continues today. Researchers are keen to establish a certain type of silkworm variety typically for low cost cocoons, disease resistance, high temperature resistance, polyphagy (ability to utilise more than one type of food), and choice quality silk. As with other types of animal farming industries, biotechnology is well established.

Thai Silk Production : The Thai silk moth is adapted to tropical conditions and is multivoltine, producing at least ten batches of eggs each year. Silk from the Thai moth is hand reeled from green cocoons. These are cocoons that still contain the live pupae. These small cocoons do not have the pupae 'stifled' or killed prior to the thread being unwound, as that would make it difficult to reel. The green cocoons are placed in hot, nearly boiling water, which loosens the end of the thread. With less than 10 days available before the moths emerge and ruin the cocoon, the Thai workers may run out of time, limiting the scale of the industry. Even experienced workers rarely produce more than 300g per day. The pupae may be eaten by local workers. Similar production techniques have been used in India, although increasingly Indian silk is woven using machines.

Chinese & Japanese Silk Production : The moth favoured in China and Japan is univoltine or bivoltine, producing one or two batches of eggs annually, which enter a diapausal state (suspended development) and can then be treated to induce hatching at a commercially convenient time. Cocoons are large and lend themselves to machine reeling, offering a long, continuous filament. The adult moths retained for reproduction purposes are too fat to fly, as the best fliers do not produce as much silk. The stifled or dead pupae are usually composted to feed the mulberry trees. Whilst the tropical silkworm favoured by Thailand is a natural, hardy creature quite capable of surviving in the wild state, the larvae farmed by the industrialised mass production techniques of China and Japan are selectively bred creatures aimed at maximum output for minimum input.

The Silk Thread : Silk is a continuous filament fibre consisting of fibroin protein secreted from two salivary glands in the head of each larva and a gum called sericin which cements the two filaments together. Silk must be reeled off the cocoon quickly before the pupa begins to rot and taint the thread with unpleasant smells. The cocoon is then softened in hot water to remove the sericin, which frees the silk filament ends for reeling or filature. Single filaments are drawn from cocoons in water bowls and combined to form yarn. This yarn is drawn under tension through several guides and eventually wound onto reels. The yarn is dried, packed according to quality and is now raw silk ready for marketing. The worn and withered body of what was intended to become the wondrous flying creature slips silently away.

Fibre Properties : Silk is a natural protein fibre containing about 70-75% of actual fibre fibroin and about 25-30% sericin. Silk filaments are very fine and long - as much as 300 to 900 metres in length. Silk has a high natural lustre and sheen of a white or cream colour; and is one of the strongest fibres at 2.6 to 4.8 grams per denier. When it is dry the elongation (elastic recovery) varies from 10-25% and when wet it will elongate as much as 33-35%. Silk has a relatively high standard moisture regain of 11%. At saturation the regain is 25-35%. Silk can be dyed before or after it has been woven into a cloth. It can be woven or knitted.

Types of Silk : Next, the raw silk is twisted into a strand sufficiently strong for weaving or knitting. This procedure is called throwing, and prevents the thread from splitting into its constituent fibres. Four different types of silk thread may be produced from this procedure: crepe, tram, thrown singles and organzine. Crepe is made by twisting individual threads of raw silk, doubling two or more of these together, and then twisting them again. Tram is made by twisting two or more threads in only one direction. Thrown singles are individual threads that are twisted in only one direction. Organzine is a thread made by giving the raw silk a preliminary twist in one direction and then twisting two of these threads together in the opposite direction. In general, organzine thread is used for the warp threads of materials, tram threads for the weft or filling, crepe thread for weaving crinkly fabrics and a single thread for sheer fabrics.

Broken or waste filaments and damaged cocoons are retained, treated to remove the sericin, and combed. This is then processed into yarn, marketed as spun silk, which is inferior in character to the reeled product and much cheaper. Low grade silk is made from damaged cocoons that were spoiled by emerging moths used for breeding stock. Filaments from the coarse outer portion of the cocoon, which is removed by brushing before reeling, and the inner portion of the cocoon, which remains after reeling the raw silk, are mixed with silk from damaged cocoons to make low grade silk.

In common with all other animal production systems, nothing is wasted if it can be sold.

After the silk is harvested from the cocoons it is brought to the weavers for dyeing and preparation for weaving. Today most dyes are chemical although a lac (insect) dye was once used as well as plant dyes. Another product of sericulture is silkworm gut. Immediately before the cocoon stage, pupae are killed by immersion in an acid bath. Their bodies are opened and the fluid, which hardens upon contact with the air and would otherwise be used to build the cocoon, is removed from their silk glands. This 'gut' was once favoured by surgeons for stitching and by anglers for lines, but has now been almost entirely replaced by nylon, although it still figures in some surgical and contraceptive applications.

World Silk Production : World silk production has more than doubled during the last 30 years in spite of the availability of man-made fibres. China and Japan have been the main silk producers, together manufacturing more than half of the world production each year. Chinese silk is highly prized throughout the world. Since 1949 silk making methods have been modernized and silk is of better quality[5].

Super Silk

Silk has long been touted for its strength and flexibility while silica often gets praise for its structural qualities. New research into the two substances has allowed scientists to create a fusion material that features the best of both worlds. The discover, reported in recent issue of Proceedings of the national Academy of Sciences, opens the door to advances in the field of medicine where the new protein could be used, among other things, to build replacement bone tissue. Spider silk has long been the focus of research into how it manages to be so strong, but yet so light and flexible. Silica protein, which forms the strong skeletons of creatures like plankton, is a glass-like substance with incredible strength. By cloning the silk protein, and then combining them with natural silica, the researchers from Tufts University created a new composite nano-material that is not only able to self-assemble, but controllable as well. The silica protein adhered themselves to the silk protein, and formed a strong outer skeleton around the artificial silk fibers. As a bonus, the size of the particles of the new material is more consistent and smaller, ranging in diameter from .5 to 2.0 nanometers. Previous research into artificial silica resulted in larger-sized particles with less consistency. The formation of the so-called "chimeric" protein-essentially silk with a tough outer skin-can be regulated, allowing for the creation of films or fibers of the new material. Currently, the building of the protein structures in taking place in vitro, but the researches are looking to take the process into the animal world for further testing. The hope is that the material could be assembled within a living animal where it could the regeneration of bone for a hip-replacement.

Super Bones

Bones replacement is a problem with the medical field and problems frequently occur because no substitute materials other than metal can be formed. Metal can only be used if it is Teflon coated as to prevent rust and rejection[3]. Teflon also is a problem as it can make toxic reactions to the body in some case. Therefore, a new material made from silica and spider silk will make the new substitute. Not only is the substance non-allergenic, but it is able a tissue similar substance that helps stimulate the body to make new tissue that assimilates the silk and causes reformation of bones without the rear of heavy metals, infection, poisoning or body rejection. A patient with silk/silica replant will have a better chance for natural recovery than ever before and without any need for future visits to the hospital for post-operation treatments. Moreover, these new bones may prove to be stronger than the original bones themselves, making a person have super strong bones.

4. RESULTS AND DISCUSSION

Silk is a desirable material for both beauty and fashion. It is durable and strong but has drawbacks. By using new modern nanotech silk, a person will get the benefits of strength and beauty with no problems from wrinkles, discolorations from water or sweat strains or the strains of oil or water-based liquids that might spill on a person when wearing the silk cloths.

Bones are a majors support for the body, but when they break they need to be repaired. Minor repairs are no problem but major repairs can result in infections, and if steel bars are put in , rejection and allergies can result as well as slow growth and little strength. With new silica /silk bone structures; bones will not only grow back faster but have no allergy or rejection problems and can be stronger than the original bones.

In summary nanotech silk work can benefit the world in both internal and external ways.

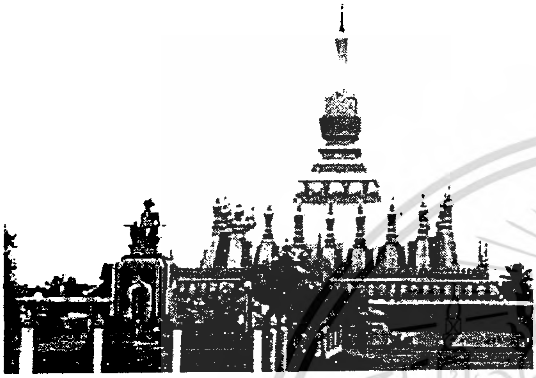
5. REFERENCES

Internet Citations

[1] www.http://www.azonano.com/news.asp?newsID=2494
[2] www.http://www.crnano.org/benefits.htm
[3] www.http://www.earthsky.org/shows/show.php?date=20060718
[4] www.http://www.phys.ntnu.no/complex/nanotechnology_e.php3
[5] www.http://www.vegansociety.com/html/animals/exploitation/silk_worm.php

International Conference On Applied Science (ICAS-2006) Vientiane, 5-7 November 2006

Call For Paper



On the occasion of coming 10th year Anniversary of the National University of Laos (NUOL) as well as Faculty of Science and under academic cooperation between Faculty of Science, NUOL and Faculty of Science, King Mongkut's Institute of Technology Ladkrabang (KMITL), we will organize the 1st International Conference on Applied Science (ICAS) in Laos (Vientiane) on Nov 5-7, 2006. In the conference there will be included the sessions such as Mathematics, Physics, Chemistry, Biology, Computer , Environment Science, Statistics, and Engineering. Regarding this matter any of your contributions and any type of your participations will be appreciated us very much and will be provided the idea, methodology, and the way how should science in developed countries contribute, help and encourage their colleagues in developing countries in order to bridge the connections over the gap and to keep science alive under hardship conditions. Any information to be regarded the conference, please, contact us:

- Dr. Theerawat Mongkolaussavarat : Dean Faculty of Science, KMITL (kmtheera@kmitl.ac.th)
- Dr. Somkiat Phasy :Dean Faculty of Science, NUOL (sphasy@yahoo.com)
- Dr. Preecha Yupapin : Vice Dean Faculty of Science, KMITL (kypreech@kmitl.ac.th)
- Dr. Somchanh Bounphanmy : Deputy Dean Faculty of Science, NUOL (sbounphanmy@yahoo.com)

The organizing committee cordially invites paper submission. Manuscripts are subjected to be revised by referees and all accepted papers for both oral and poster presentations will be published in Laos Journal on Applied Science, LJA (Special issue). Manuscripts must be typewritten using a text processing software program such as Microsoft Word for Windows, the single-spaced manuscript is requested for final submission. The format of full paper submission is available on the web site:
www.kmitl.ac.th/science/icas2006/papersubmission.php

Venue

The conference will be held in Vientiane, Laos PDR. The hotel is situated on the central part of Vientiane taking about 30 minutes from Vientiane International Airport by car.

Official Language

ICAS 2006

- Call for papers
- Paper Submission
- Registration
- Venue
- Transportation
- Organizers
- Tour around Vientiane
- Luang Prabang

Paper Submission Information

- Full papers submission deadline
  31st August 2006
- Notification of paper acceptance
  15th September 2006
- Camera-ready paper due
  15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

The official language of the conference is English.

Conference Themes

The conference will cover a full range of science and engineering and environment science research areas.

ICAS-2006

International Conference On Applied Science (ICAS-2006) Vientiane, 5-7 November 2006

Paper Submission

All papers have to submit by email to secretariat,: International Conference on Applied Science (ICAS-2006). A single file containing complete manuscript must also be sent by attached file e-mail to the Secretariat of the Conference:

At.
- khnualsa@kmitl.ac.th **with cc to**
- sbounphanmy@yahoo.com **and**
- khamphout4@yahoo.com

Instruction for Authors
- RTF
- PDF

Paper Submission Information

- Full papers submission deadline 31st August 2006

- Notification of paper acceptance 15th September 2006

- Camera-ready paper due 15th October 2006

Conference Proceeding

All accepted papers will be published in the Laos Journal on Applied Science(LJA), Volume 1 Number 1 as a special issue. .

ICAS 2006

Call for papers
Paper Submission
Registration
Venue
Transportation NEW
Organizers
Tour around Vientiane
Luang Prabang

Paper Submission Information

- Full papers submission deadline 31st August 2006

- Notification of paper acceptance 15th September 2006

- Camera-ready paper due 15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

International Conference On Applied Science (ICAS-2006) Vientiane, 5-7 November 2006

Registration

Registration Form

- MS Word
- PDF

Registration Fee

Participants	Before September 30th, 2006	After September 30th, 2006
(Thai & Laos)	5,000 Baht	6,000 Baht
Foreigners	350 US$	400 US$

Note that the registration will be completed after sending the registration form with the transaction document at khnualsa@kmitl.ac.th, khamphout4@yahoo.com, sbounphanmy@yahoo.com or via fax no. 662 3264354. All cash is wireless transferred to "SCIENCE CONFERENCE", Siam Commercial Bank, KMITL Branch at Chalongkrung Road, Bangkok, Account number is 088-2-34700-0 Swift code is SICOTHBK. In case Credit card you have to pay 5% more for charging.

Registration fee is include hotel between November 5-7, 2006 (check in on November 5 afternoon and check out on November 8 before noon) with 3 breakfast, 2 lunches, coffee breaks, 2 dinners and local transportation between Wat Tai airport, The relationship Thai-Laos bridge, conference place, and hotels

At.
- khnualsa@kmitl.ac.th **with cc to**
- sbounphanmy@yahoo.com **and**
- khamphout4@yahoo.com

Paper Submission Information

- Full papers submissio deadline
  31st August 2006
- Notification of paper acceptance
  15th September 2006
- Camera-ready paper due
  15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

International Conference On Applied Science (ICAS-2006) Vientiane, 5-7 November 2006

Venue of Conference and Accommodation

The Meeting will be held in Don Chan Palace is located in the center of Vientiane Capital, on Mekong River and far from International Airport Wattay about 7 km which is very closed to the President Office of Lao PDR, Vat Sisaket, Ho Phra Keo. The rooms will be reserved.
The Meeting will be held in multimedia rooms where there are available following facilities: online computers, photocopier, and printer.
Address: Unit 6 Piawat village, Sisatanak District, Vientiane Capital, Laos
Tel: (856-21) 244288, Fax: (856-21) 244111

Paper Submission Information

- Full papers submissio deadline 31st August 2006
- Notification of paper acceptance 15th September 2006
- Camera-ready paper due 15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

ICAS-2006

International Conference On Applied Science (ICAS-2006) Vientiane, 5-7 November 2006

Transportation

Tranportation from Bangkok To Laos

There is Bus and Train from BKK to Loas as follows:

Train : www.railway.co.th

a)BKK to NK(NongKai) about 750 Baht

b)Tuk-Tuk from train station to bus station at NK (30 Baht)

c) Air conditional Bus from NK to Vientiane (55 Baht) at Talad-Chao (1.5 KM to conference place) This bus will wait until you finish from custom and continue to Vientiane.

Bus (600 Baht + step C on above) from หมอชิต or Suvanaphumni airport to Udon

Plane (Suvanaphumni to Udon) + mini van (about 800-1000 per trip per van) to [illegible] Thai-Laos (Custom)

The transportation between the International Airport Wattay and hotel will be arranged by the organizers. A representative of Faculty of Science, NUOL will meet you at Airport with a sign saying "ICAS - 2006".

Emergency contact number

(1) Dr. Somchanh Bounphanmy
Dean assistant, Head of International Relation Unit
Faculty of Science, NUOL
Mobile: (856-20) 2449386
E-mail: sbounphanmy@yahoo.com

(2) Dr. Bounnam Pathounthong
Head of Research and Post Graduate Studies unit
Faculty of Science, NUOL
Mobile: (856-20) 5471476
E-mail: bounnamp@yahoo.com

(3) Dr. Khamphouth Phommasone
E-mail: khamphouth@guest.iop.vast.ac.vn
Mobile: (856-20) 5619625

Paper Submission Information

- Full papers submission deadline
31st August 2006

- Notification of paper acceptance
15th September 2006

- Camera-ready paper due
15th October 2006

Links

- KMITL
- Facutly of Science, KMITL
- NUOL

International Conference On Applied Science (ICAS-2006)
Vientiane, 5-7 November 2006

Contact of Organizers

1. Dr. Theerawat Mongkolaussavarat : Dean Faculty of Science, KMITL
   (kmtheera@kmitl.ac.th)

2. Dr. Somkiat Phasy :Dean Faculty of Science, NUOL
   (sphasy@yahoo.com)

3. Dr. Preecha Yupapin : Vice Dean Faculty of Science, KMITL
   (kypreech@kmitl.ac.th)

4. Dr. Somchanh Bounphanmy :Head of International Relation Unit of Faculty of Science, NUOL Dean assistant
   (sbounphanmy@yahoo.com)

5. Dr. Bounnam Pathounthong:Head of Research and Post Graduate Studies unit
   (E-mail: bounnamp@yahoo.com)

6. Dr. Khamphouth Phommasone
   (khamphouth@guest.iop.vast.ac.vn or khamhout4@yahoo.com)

ICAS 2006

Call for papers
Paper Submission
Registration
Venue
Transportation NEW
Organizers
Tour around Vientiane
Luang Prabang

Paper Submission Information

- Full papers submission deadline
  31st August 2006

- Notification of paper acceptance
  15th September 2006

- Camera-ready paper due
  15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

International Conference On Applied Science (ICAS-2006)

Vientiane, 5-7 November 2006

Tour around Vientiane

The tour is a part of conference that will take about one afternoon. The tour around Vientiane capital will be included the tour one most campuses of the National University of Laos and around Vientiane Capital.
Vientiane's major attractions are the serene Buddhist monasteries that dominate the center of town. The city has kept its timeless charm with tree-lined avenues, brightly painted temples and quaint French architecture. In Capital we could visit

Vat Sisaket, the oldest original temple in Vientiane. Built in 1818, Vat Sisaket is the sole survivor of an invasion in 1828. All other temples in the city have undergone extensive restoration. Vat Sisaket features remarkable frescoes and 6,840 Buddha images.

Ho Phra Keo, once the royal temple of Lao monarchy. Built in 1565, Ho Phra Keo has been used as a museum since 1970 and contains some of the finest Buddhist sculptures and artifacts in the country. Special displays include antique brass drums and palm leaf manuscripts.

Patousay, the victory gate also known as Anousavari. Constructed in 1958, its architecture is inspired by the Arc of Triumph in Paris.

That Luang Stupa. King Setthathirath built this great sacred stupa, considered as the national symbol, in 1566. Its central structure is 45 meters tall and echoes the curving lines of an elongated lotus. The original stupa was said to contain relics of Lord Buddha.

Dond Dok Campus of The National University of Laos. The National University of Laos is only one University in Laos which has established in June, 1995 by merging ten existing Higher Education Institutions and a Center of Agriculture. However, now NUOL consists of twelve faculties, one school called School of Foundation Studies and two Centers. Most of campuses are located around city circle of Vientiane capital except faculty of agriculture which is located in Na Bong campus about 21 km fare from city center.

Paper Submission Information

- Full papers submission deadline
  31st August 2006
- Notification of paper acceptance
  15th September 2006
- Camera-ready paper due
  15th October 2006

Links

- KMITL
- Facutly of Science,KMITL
- NUOL

ROR : Could r
quest.
ery: CREATE "n
ason Given: CRI
n't create mailb
le /home/kind/
mission denied

Current Folder: **INBOX**

Compose Addresses Folders Options Search Help

Sign
Squirrel

[Previous | Next] [Delete & Prev | Delete & Next] [Message List]

Reply | Reply All | Forward | Forward as Attachment | Delete (Bypass Trash)

Move to: INBOX
Mo

Subject: Accepted paper for ICAS 2006
From: khnualsa@kmitl.ac.th
Date: Sat, September 30, 2006 2:48 pm
To: khuntuk@hotmail.com (less)
khamphout4@yahoo.com
kmchanta@kmitl.ac.th
cmodemanee@gmail.com
fscitsv@ku.ac.th
Priority: Normal
Options: View Full Header | View Printable Version | เพิ่มรายชื่อ

Dear Author of the ICAS 2006 in Laos

Congratulations! After a peer review of 3 independent qualified referees, your paper, submitted for possible publication in the Laos Journal on Applied Science, has been accepted as an Oral presentation. Please submit the word file for the final version by Oct 7.

Therefore, please, accept the congratulations of the Organizers for the acceptance of your paper in the Laos Journal on Applied Science. For each accepted paper, one of authors has to make a registration and do either an oral presentation or a poster presentation for ICAS 2006 on 5-7 November 2006 at Donechanh Palace, Vientiane, Laos PDR. The deadline for registration is October 20, 2006. For the author who sends your registration form late, your accepted paper would not public in the Laos Journal on Applied Science. There are more than 100 accepted papers. Please do registration soon for reserve your room in the hotel. For the registration form without payment, you have to pay the late rate on site. There are two bank accounts in both Thai and Laos;

"Faculty of Science, NUOL, Bank Pour Le Commerce, Exterieur Laos at Pangkham Road, Vientiane, Account number is 010-01-4521008-30049-2 Swift code is COEBLA LA

"SCIENCE CONFERENCE", Siam Commercial Bank, KMITL Branch at Chalongkrung Road, Bangkok, Account number is 088-2-34700-0 Swift code is SICOTHBK. In case Credit card you have to pay 5% more for charging.

For Thai, we suggest paying to the last account for avoiding very expensive wireless transfer fee.

Who did not provide us full post address, please send us, we will send you the letter of invitation and other information about ICAS 2006.

For further inquiries on the conference, please contact Dr. Somchanh Bounphanmy (Tel +856 20 2449386, fax +856 21 770 173, Email: sbounphanmy@yahoo.com) – conference secretariat.

Thank you very much for joining ICAS 2006, again. We are looking forward to seeing you at ICAS 2006.

Sincerely yours,
secretariat

Download this as a file

National University of Laos (NUOL)

13 Southern Road, DongDok, Saythany District, Vientiane, Lao PDR.
P.O. Box: 7322, Tel/Fax: +(856-21) 770381.

INTERNATIONAL CONFERRENCE ON APPLIED SCIENCE
Donechanh Palace, Vientiane, Lao PDR.
5-7 November, 2006

Letter of Invitation

Dear Chantana Viriyavejakul,

On the auspicious occasion of coming 10th year Anniversary of the National University of Laos (NUOL). On behalf of the organizing committee, it is our great pleasure to invite you to participate the International Conference on Applied Science will be held at Donechan Palace, Vientiane, Lao PDR., from 5 to 7 November 2006 as an invited speaker, to present the title:*NANOADVANCED SILK*. The Conference as the part of the celebration program organized by the Faculty of Science as well as under academic cooperation between Faculty of Science, NUOL and Faculty of Science, King Mongkut's Institute of Technology Ladkrabang (KMITL), we would like to invite world-famous scholars in physics section, representative by Chantana Viriyavejakul as speaker.

We do believe that your presence will be essential for our expect fruitful conference.

If you have further inquiries on the conference, please contact Dr. Somchanh Bounphanmy (Tel +856 20 2449386, fax +856 21 770 173, Email: sbounphanmy@yahoo.com) or Dr. khampphouth, Email: khamphout4@yahoo.com

Thank you very much for your kind cooperation and look forward very much indeed to the pleasure and privilege of having your excellent presentation in this November.

Sincerely yours,

Assoc. Prof. Dr. Somkiat Phasy
Co- Chairperson of Organizing Committee
Dean of Faculty of Science, NUoL.

Scientific Program

1st International Conference on Applied Science (ICAS)
5 November – 7 November, 2006
Vientiane Capital, Laos

Sun. 5 Nov. 2006

Transportation from International airport to "Don Chan Palace" You will see a staff member of Faculty of Science, NUOL at the airport to lead you to the hotel by a bus chartered. Registration is performed in the Hotel.

Afternoon: Arrival and Check in

13.00-16.30	: Tutorial on Inexpensive Sun Photometers For Monitoring The Atmosphere Prof. Brooks, University of Drexel, USA
16:30 - 22:00	: Free

Mon. 6 Nov. 2006

8:30 - 9:00	**Registration**
9:00- 9:30	**Opening Ceremony**

*Conference address by Conference Co – Chairperson

- Assoc. Prof. Dr. Somkiat PHASY, Dean Faculty of Science, NUOL
- Prof. Dr Theerawat MONGKOLAUSSAVARAT, Dean Faculty of Science, KMITL

* Welcoming address by
  Honorary Assoc. Prof. Soukkongseng SAYGNALEUTH

* Opening address by
  The Deputy Minister of Ministry of Education.
  Prof. Dr. Sengdeuan LACHANTHABOUN

9:30-10:00	**Coffee Break and Group Photo**
10:00-12:00	**Special Lectures**
10:00-10:40	Aerosol Measurement using Sun Photometer: **Prof. Brooks**: University of Drexel, USA
10:40-11:20	Heading For Clean Development Mechanism On Reductions Of Greenhouse Gas Emissions In Japanese Domestic Livestock Industry: **Prof. Koichi KAKU**: National Institute of Livestock and Grassland Science, Japan
11:20-12:00	Trend of IT in Laos: **Prof. Dr. Saykhong Saynasine**, Vice President of NUOL
12:00-13:00	**Lunch in Hotel**

Afternoon Session:

Session I:	**Chemistry Session:** Chair by **Dr. Phousy INTHAPANYA**
13.00-13.30	Keynote/Invited Talk: **Prof. N. Rajapakse**, University of British Columbia, Canada Title: Fracture of Magnetoelectro-elastic Materials
13.30-14.30	ICASC-01-03 : Chutima Septhum, Bunchong Chuamuangphan, Pornpimol Muangthai
14.30-15.00	**Coffee Break**
15.00-16:30	ICASC-04-06 : Jaruwan Siritapetawee, Patchanee Charoenying, Santi Sakdarat
16:30-17:00	**Coffee Break**
Session II:	**Physics Session :** Chair by **Dr. Khamphout PHOMMASONE**
13.00-13.30	Keynote/Invited Talk: **Prof. Nguyen Vinh Quang**, Institute of Physics and Electronics, Vietnam Title: On The Formulations For The Completeness Of The Orthonormal Basis In Quantum Physics
13.30-14.30	ICASP-01-04: Prakorn Preechaburana, Chantana Viriyavejakul, Chittra Kedkeaw
14.30-15.00	**Coffee Break**
15.00-16:30	ICASP-05-07: Onanong Chamlek, Unchada Phuapaiboon, Manu Fuangfoong
16.30-17.00	**Coffee Break**
17.00-18:30	ICASP-08-10: Chatchawal Wongchoosuk, Surasak Chiangga, Nattanan Chabasri
Session III:	**Physics Session:** Chair by **Prof. Thitinai GAEWDANG**
13.00-13.30	Keynote/Invited Talk: **Prof. George Garnet Hoyes, NSRC**, Thailand Title: Upgrade of The Timing System and Pattern Memory of The Siam Photon Source
13.30-14.30	ICASP-11-14 : Prof. Khamphouth Phommasone, Pajak Saeung, Chewa Thassana Vienthong Xayavong
14.30-15.00	**Coffee Break**
15.00-16:30	ICASP-15-18 : Treedej Kitiauchawal, Araya Mungchamnankit, Sampart Cheedket Rungtawee Piyanunjaratsri
16.30-17.00	**Coffee Break**
17.00-18:30	ICASP-19-21 : Wanwisa Pattanasiriwisawa, Waraporn Nuntiyakul, Artorn Pokaipisit
Session IV:	**Mathematics, Computer and Statistics Session:** Chair by **Dr. Nualsawat HIRANSAKOLWONG** and **Prof. Dr. Makoto Doi**
13.00-13.30	Keynote/Invited Talk: **Prof. Makoto Doi** , Tokai University, Japan The Ruin Probability for the Storage Process
13.30-14.30	ICASMCS-01-04 : Dankmar Böhning, Prof. Anders Grimvall , Jirasak Chirathivat, Pornchai Charoenchaiamornkit,
14.30-15.00	**Coffee Break**
15.00-16:30	ICASMCS-05-08 : Saowaluk C. Watanapa, Uraiwan Inyaem, Rawiwan Tenissara, Bouasoth Xayachak
16.30-17.00	**Coffee Break**
17.00-18:30	ICASMCS-09-11 : Chantana Chantrapornchai, Paisarn Daungjak na ayudhaya, Pattrawut Chansangiam
Session V:	**Biology Session:** Chair by **Dr. Koichi KAKU** and **Assoc. Prof. Dr. Bouakaykhone SVENGSUKSA**
13.00-14.00	ICASB-01-03: Anupong Tankrathok, Yuwatida Pukcothanung, Apinya Phromviyo
14.30-15.00	**Coffee Break**

POSTER SESSION: 15:00-18:30

18:30- 22:00 Reception Dinner in Lanxang Hotel restaurant

Tues. 7 Nov. 2006

Morning Session:

Session I:	**Engineering Session:** Chair by Prof. Dr. David R. Brooks
8:30- 10.00	ICASE-01-04 : Kanok Janchittrapongvej, Unakorn Rattanasathian, Pitikate Sooraksa, Napaporn Thamrongwattanachai, Bunthit Watanapa
10:00-10.30	**Coffee break**
10:30-12.00	ICASE-05-08 : Sanya Khunkhao, Tun Arpautaipong, Narin Atiwongsangthong, Kanit Wattanavichien, Virot Pirajnanchai
Session II:	**Engineering Session:** Chair by Assoc. Prof. Dr. Preecha YUPAPIN
8:30- 10.00	ICASE-09-12 : Sompong Chareankid, Wattanasit Pimpao, Anucha Ruangphanit, Warakorn Nerdnoi, Artit Ridluan
10:00-10.30	**Coffee break**
10:30-12.00	ICASE-13-15 : Wutthinan Jeamsaksiri, Karoon Saejok, Smith Eiamsa-ard, Vichan Kongkiatpaiboon

12:00-13:00 Lunch in Hotel

13:00-18:30 visit city

18:30 - 22:30 Farewell Dinner-Closed the conference (Donchan Palace)

Wednesday 8 Nov. 2006: Check out from hotel before noon and Departure

Remark:

- Each session will take one room.
- For all accepted papers, whose name does not show as an oral presentation, we are welcome you as the poster presentations within **the poster session at 15:00-18:30 PM on Monday Nov 6.**

Poster session
(at 15:00-18:30 PM on Monday Nov 6)

Physics:

Pinpan Visal-athaphand
Preecha Yupapin
Piyarat Bharmanee
Kheamrutai Thamaphat
Ngamnit Wongcharoen
Thitinai Gaewdang
Somjai Chunjarean
Jakrapong Kaewkhao
Jintana Laopaiboon
Sounthone Singsoupho
Raewat Laopaiboon

Biology:

Aree Rittiboon
Chanpen Chanchao
Supattar Poeaim
Anurug Poeaim
Saiwarun Chajwanichsiri
Pariya Na Nakorn
Kalaya Laohasongkram
Kosum Chansiri

Chemistry:

Dr. Panneepa Sivapirunthep , Dr. Kunya Tuntivisoottikul
Mrs. Winyu Chitsamphandhvej
Dr. Malinee Chaisupakitsin
Saisamorn Lumlong
Weenawan Somphon
Puckpen Tipayamontri, Panor Asvarujanon
Jirada Singkhonrat
Sumate Tantratian
Mr. Suttisak Suknaisilp

Computer:

Wiyada Yawai

Engineering:

Miss Pawadee Meesapawong, Ampom Poyai
Chalerm Wanarak
Md. Zaved Hossain Khan
Nopphon Phongphanchanthra

Conference Time Table

Date	Time		Grand Ballroom	A Session I	B Session II	C Session III	D Session IV	E Session V	Poster hall
Nov. 5 2006	13.00	16.30	Tutorial						
	16.30	22.00	Free						
Nov. 6 2006	8.30	9.00	Registration						
	9.00	9.30	Opening Ceremony						
	9.30	10.00	Coffee Break and Group Photo						
	10.00	10.40	Plenary Lecture by Prof. Brooks						
	10.40	11.20	Plenary Lecture by Prof. Kaku						
	11.20	12.00	Plenary Lecture by Prof. Saynasine						
	12.00	13.00	Lunch in Hotel						
	13.00	13.30		Keynote	Keynote	Keynote	Keynote	Applied Biology	
	13.30	14.30		Applied Chemistry	Applied Physics	Applied Physics	Mathematics Computer Science Statistics		
	14.30	15.00		Coffee Break					
	15.00	16.30		Applied Chemistry	Applied Physics	Applied Physics	Mathematics Computer Science Statistics		Poster
	16.30	17.00		Coffee Break					
	17.00	18.30			Applied Physics	Applied Physics	Mathematics Computer Science Statistics		
	18.30	22.00	Reception Deinner in Lanxang Hotel Restaurant						
Nov. 7 2006	8.30	10.00		Engineering	Engineering				
	10.00	10.30		Coffee Break					
	10.30	12.00		Engineering	Engineering				
	12.00	13.00	Lunch in Hotel						
	13.00	18.30	Visit city						
	18.30	22.30	Farewell Dinner-Closed the conference at Donchan Palace						
Nov. 8 2006	8.00	12.00	Check out from the hotel before noon and departure						

List of participants ICAS 2006

No.	Name	University	Email
1	Amporn Poyai	Nectec, Thailand	amporn.poyai@nectec.or.th
2	Anders Grimvall	Linköping U,Sweden	angrim@mai.liu.se
3	Anucha Ruangphanit	Nectec, Thailand	anucha.ruangphanit@nectec.or.th
4	Anupong Tankrathok	Khon Kaen University, Thailand	tankrathok@yahoo.com
5	Anurug Poeaim	KMITL, Thailand	kpanurug@kmitl.ac.th
6	Apinya Phromviyo	Khon Kaen University, Thailand	4750200500@kku.ac.th
7	Araya Mungchamnankit	KMUTT, Thailand	opticslaser@yahoo.com , araya_mck@yahoo.co.th
8	Aree Rittiboon	KMITL, Thailand	kkaree@kmitl.ac.th
9	Artit Ridluan	Mahanakorn U, Thailand	smith@mut.ac.th
10	Bouasoth Xayachak	KMITL,Thailand	s7068011@kmitl.ac.th, xbouasoth@nuol.edu.la
11	Bunchong Chuamuangphan	Khon Kaen University, Thailand	4750200500@kku.ac.th
12	Bunthit Watanapa	KMUTT, Thailand	bunthit@sit.kmutt.ac.th
13	Chalerm Wanarak	KMUTT, Thailand	lerimy_lovely@hotmail.com
14	Chanpen Chanchao	CU, Thailand	cchanchao@hotmail.com
15	Chantana Chantrapornchai	Silpakorn U,Thailand	ctana@su.ac.th
16	Chantana Viriyavejakul	KMITL, Thailand	kmchanta@kmitl.ac.th, cmodemanee@gmail.com
17	Chatchawal Pensuk	KMITL,Thailand	kpsatra@kmitl.ac.th
18	Chatchawal Wongchoosuk	Mahidol U, Thailand	boy_nanotube@yahoo.com
19	Chewa Thassana	KMITL, Thailand	prajak_neer27@hotmail.com, kypreech@kmitl.ac.th
20	Chittra Kedkeaw	KMUTT, Thailand	opticslaser@yahoo.com , chittra193@hotmail.com
21	Cholyeun Hongpaisanwiwat	TU, Thailand	chhong@cs.tu.ac.th

22	Chutima Septhum	Suranaree U, Thailand	csepthum@yahoo.com
23	Dankmar Böhning	U of Reading, UK	d.a.w.bohning@reading.ac.uk
24	David R. Brooks	Droxel U., USA	brooksdr@drexel.edu
25	Denpong Inyaem	KMITNB,Thailand	uraiwaan@gmail.com
26	Ekalak Chaowicharat	Nectec, Thailand	karoon.saejok@nectec.or.th
27	Elixabete Murguia	IRIT-CNRS,France	elimurguia@yahoo.com
28	George Garnet Hoyes	NSRC, Thailand	garnet@nsrc.or.th
29	Heinz Holling	SQM, Germany	holling@uni-muenster.de
30	Jakrapong Kaewkhao	NakornPathom Rajabhat U, ThaiLand	mink052@yahoo.com
31	Jaruwan Siritapetawee	Ubon U, Thailand	jaruwan_siritape@yahoo.com
32	Jintana Laopaiboon	Ubon U, Thailand	Jintana_laopaiboon@yahoo.com
33	Jirada Singkhonrat	TU, Thailand	jsingkhon@gmail.com
34	Jirasak Chirathivat	CU, Thailand	atiwong@gmail.com
35	Kalaya Eaiprasertsak	TU, Thailand	fmanu@tu.ac.th
36	Kalaya Laohasongkram	CU, Thailand	Kalaya.L@Chula.ac.th
37	Kanit Wattanavichien	CU, Thailand	wkanit@chula.ac.th, kwattana@gmail.com
38	Kanok Janchitrapongvej	KMITL, Thailand	kcvanvis@kmitl.ac.th
39	Karoon Saejok	Nectec, Thailand	karoon.saejok@nectec.or.th
40	Khamphouth Phommasone	NUOL, Laos	khamphouth@guest.iop.vast.ac.vn, khamphout4@yahoo.com
41	Kheamrutai Thamaphat	KMUTT, Thailand	s903607@yahoo.com , opticslaser@yahoo.com
42	Kien A. Hua	UCF, USA	kienhua@cs.ucf.edu
43	Koichi KAKU	AFFRC, Japan	kouichi@affrc.go.jp
44	Kosum Chansiri	Srinakharinwirot U, Thailand	such2305@yahoo.com , kosum@swu.ac.th , kchansiri@yahoo.com
45	Kunya Tuntivisoottikul	KMITL,Thailand	ktkunya@kmitl.ac.th
46	Makoto Doi	Tokai, Japan	msdoi@sm.u-tokai.ac.jp
47	Malinee Chaisupakitsin	KMITL,Thailand	kcmaline@kmitl.ac.th
48	Manu Fuangfoong	TU, Thailand	fmanu@tu.ac.th
49	Muanghlua Rangson	KMITL, Thailand	kmrangso@kmitl.ac.th
50	Napaporn Thamrongwattanachai	KMITL, Thailand	dindangs@hotmail.com

51	Narin Atiwongsangthong	KMITL, Thailand	kanarin@kmitl.ac.th
52	Nattanan Chabasri	Mahidol U, Thailand	magic_moonnat@yahoo.com
53	Ngamnit Wongcharoen	KMITL, Thailand	kwngamni@kmitl.ac.th
54	Nimal Rajapakse	University of British Columbia, Canad	rajapakse@mech.ubc.ca, nrajapak@interchange.ubc.ca
55	Noppadon Suttisiri	KU, Thailand	fscissc@ku.ac.th
56	Nopphon Phongphanchanthra	Nectec, Thailand	nopphon.phongphanchanthra@nectec.or.th
57	Nualsawat Hiransakolwong	KMITL,Thailand	khnualsa@kmitl.ac.th
58	Nuttawut Tathong	KMITL,Thailand	pop2520@gmail.com
59	Onanong Chamlek	Mahidol U, Thailand	ch_onanong@hotmail.com
60	Opas Trithaveesak	Nectec, Thailand	amporn.poyai@nectec.or.th
61	Paisarn Daungjak na ayudhaya	Walailak U, Thailand	paisalgolf@yahoo.com, paisalgolf@hotmail.com
62	Pajak Saeung	KMITL, Thailand	kypreech@kmitl.ac.th, prajak_neer27@hotmail.com
63	Pakkinee Chitsakul	KMITL,Thailand	kcpakkin@kmitl.ac.th
64	Palat Chitsamphandhvej	KMUTT, Thailand	iwinhvej@kmutt.ac.th
65	Panneepa Sivapirunthep	KMITL,Thailand	panneepas@yahoo.com
66	Panor Asvarujanon	Srinakharinwirot U, Thailand	panor@swu.ac.th
67	Pariya Na Nakorn	TU, Thailand	pariya@tu.ac.th
68	Pataranun Chotsang	KMITL,Thailand	kcpatcha@kmitl.ac.th
69	Patchanee Charoenying	KMITL,Thailand	kcpatcha@kmitl.ac.th
70	Patrick Saint-Dizier	IRIT-CNRS,France	stdizier@irit.fr
71	Pattrawut Chansangiam	KMITL, Thailand	kpporama@kmitl.ac.th
72	Patummal Na Nakorn	TU, Thailand	pariya@tu.ac.th
73	Pawadee Meesapawong	Nectec, Thailand	pawadee.meesapawong@nectec.or.th
74	Pichet Limsuwan	KMUTT, Thailand	s903607@yahoo.com , opticslaser@yahoo.com
75	Pinpan Visal-athaphand	KMUTT, Thailand	pinpan.vis@kmutt.ac.th
76	Pitikate Sooraksa	KMITL, Thailand	s_sakorn@hotmail.com
77	Piyarat Bharmanee	KMUTT, Thailand	s903607@yahoo.com, bhapiyarat@yahoo.com
78	Poramate Pranayanuntana	KMITL,Thailand	kpporama@kmitl.ac.th
79	Pornchai Charoenchaiamornkij	KMUTT, Thailand	pornchah04@yahoo.com

80	Pornpimol Muangthai	Srinakharinwirot U, Thailand	pornpi@swu.ac.th
81	Prakorn Preechaburana	TU, Thailand	fmanu@tu.ac.th
82	Preecha Yupapin	KMITL, Thailand	sci_cen@yahoo.com
83	Proadpran Punyabukkana	CU, Thailand	Proadpran.P@Chula.ac.th
84	Puckpen Tipayamontri	Srinakharinwirot U, Thailand	puckpen@swu.ac.th
85	Raewat Laopaiboon	Ubon U, Thailand	raewatl@yahoo.com
86	Rawiwan Tenissara	NIDA, Thailand	rawiwan@nida.nida.ac.th
87	Rungtawee Piyananjaratsri	KMITL, Thailand	rungtawee@hotmail.com
88	Saisamorn Lumlong	Ubon U, Thailand	g3936619@yahoo.com
89	Saiwarun Chaiwanichsiri	CU, Thailand	saiwarun.c@chula.ac.th
90	Sampart Cheedket	NSRC, Thailand	sampart@nsrc.or.th
91	Santi Sakdarat	Suranaree U, Thailand	santi@sut.ac.th
92	Saowaluk C. Watanapa	TU, Thailand	saowalukw@hotmail.com
93	Sheau-Don Lang	UCF, USA	lang@cs.ucf.edu
94	Sirisak Techathawiekul	KMITL, Thailand	goodsiri@gmail.com
95	Siseerot Ketkaew	RU, Thailand	siseerot@eng.ru.ac.th, siseerot@hotmail.com
96	Smith Eiamsa-ard	Mahanakorn U, Thailand	smith@mut.ac.th
97	Soithip Koompaipol	Silpakorn U,Thailand	sornsartsuriyawong@hotmail.com
98	Somjai Chunjarean	Suranaree U, Thailand	pae055@hotmail.com
99	Sompong Chareankid	Nectec, thailand	sompong.chareankid@nectec.or.th
100	Sornsart Suriyawong	Silpakorn U,Thailand	sornsartsuriyawong@hotmail.com
101	Southone Singsoupho	Songkla U, Thailand	sountone@yahoo.com.au
102	Suebtrakul Suchat	TU, Thailand	fmanu@tu.ac.th
103	Sumate Tantratian	CU, Thailand	Sumate.T@Chula.ac.th
104	Sunya Khunkhao	Sripatum U, Thailand	sanya@spu.ac.th
105	Supaluck Amloy	TU, Thailand	fmanu@tu.ac.th
106	Supattar Poeaim	KMITL, Thailand	poeaim@hotmail.com
107	Surasak Chiangga	KU, Thailand	fscissc@ku.ac.th
108	Surasak Niemcharoen	KMITL, Thailand	kcvanvis@kmitl.ac.th

109	Sutatip Chavanavesskul	Srinakharinwirot U, Thailand	such2305@yahoo.com
110	Suttisak Suknaisilp	CU, Thailand	sssssth@yahoo.com
111	Suwatwong Janchaysang	KMITL, Thailand	suwatwong@hotmail.com
112	Teerakiat Kerdcharoen	Mahidol U, Thailand	teerakiat@yahoo.com
113	Teerasak Veerapaspong	Kasetsart U, Thailand	fscitsv@ku.ac.th
114	Thanomsin Distaporn	Srinakharinwirot U, Thailand	pornpi@swu.ac.th
115	Theerawat Mongkolaussavarat	KMITL,Thailand	kmtheera@kmitl.ac.th
116	Thitinai Gaewdang	KMITL, Thailand	kgthitin@kmitl.ac.th
117	Treedej Kittiauchawal	KMUTT, Thailand	K-treedej@hotmail.com
118	Tun Arpautaipong	KMITL, Thailand	olivertun@hotmail.com
119	Unakorn Rattanasathian	CU, Thailand	Proadpran.P@Chula.ac.th
120	Unchada Phuapaiboon	Mahidol U, Thailand	khuntuk@hotmail.com
121	Uraiwan Inyaem	KMITNB,Thailand	uraiwaan@gmail.com
122	Vichan Kongkaitpaiboon	Mahanakorn U, Thailand	smith@mut.ac.th
123	Viengthong Xayavong	Songkla U, Thailand	viengthong_x@yahoo.com
124	Vinh Quang	IOP, Vietnam	nvquang@iop.vast.ac.vn
125	Virote Pirajnanchai	RMUTT, Thailand	p_virote@rmut.ac.th
126	Wanwisa Pattanasiriwisawa	NSRC, Thailand	wanwisa@nsrc.or.th
127	Warakom nerdnoi	Mahanakorn U, Thailand	smith@mut.ac.th
128	Waraporn Nuntiyakul	KU, Thailand	fscitsv@ku.ac.th
129	Wattanasit Pimpao	Nectec, thailand	wattanasit.pimpao@nectec.or.th
130	Weenawan Somphon	NSRC, Thailand	weenawan@nsrc.or.th
131	Wilaiporn Worrachittanont	KMITL, Thailand	kwwilaip@kmitl.ac.th
132	Winyu Chitsamphandhvej	KMUTT, Thailand	iwinhvej@kmutt.ac.th
133	Wisut Titiroongruang	KMITL, Thailand	kcvanvis@kmitl.ac.th
134	Wiyada Yawai	KMITL,Thailand	wiyadayw@gmail.com
135	Wutthinan Jeamsaksiri	Nectec, Thailand	wutthinan.jeamsaksiri@nectec.or.th
136	Yuwatida Pukcothanung	Khon Kaen U, Thailand	4750200461@kku.ac.th

International Conference on Applied Science 2006 (ICAS 2006)

Vientiane, 5-7 November 2006

NANOADVANCED SILK

Chantana Viriyavejakul

Department of Industrial Education, Faculty of Industrial Education
King Mongkut's Institute of Technology Ladkrabang,
Chalongkrung Road, Ladkrabang, Bangkok 10520, Thailand

Outline

1 . Introduction
2. Nanotechnology
3. Silk
4. Super Silk
5. Super Bones
6. Result and Disscussion

1 . Introduction

- Silk is one of the world's most beautiful cloth. They are problems like hot and it gets wet from sweat and gets discolored. If silk is mixed with high-tech fibre, it can be better in many ways. New textiles and shapes such as improved bone can be made.

2 . Nanotechnology

Nanotech means going to the most basic level of a substance to make important. As Richard Feynman said.......

"The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big".
Richard Feynman, Nobel Prize winner in physics

3 . Silk

- Thai Silk Production
- The Silk Thread
- Fibre Properties

3 . Silk

- Thai Silk Production

In making silk, the live pupae are put in hot water and the silk is taken off in long threads to prepare for making cloth with the threads.

3 . Silk

- The Silk Thread

Silk is a single long fibre that is a product of worms and spiders for nests. It must be prepared for threads production by softening and made into long thread packages called spools. Spools are used to make yarn, a group of many threads.

3 . Silk

- Fibre Properties

The composition of silk is 75% fibroin, and 25% sericin, and threads are long, up to 900 metres. It has high lustre, or shine, and extreamely strong for it small size. It is easily colored.

4 . Super Silk

Silk' strength and flexibility make it a very important fibre in all kinds of industry. It has been designed to help strengthen and rebuild bones as well as its use in strong cloth. Mixing it with silica and protein, it becomes a better-than-bone replacement.

4 . Super Silk

Not only is silk stronger than and normal strings, it is also more compact and easily make into shapes needed. Present research in this area will soon be tested with animal fibre.

5 . Super Bones

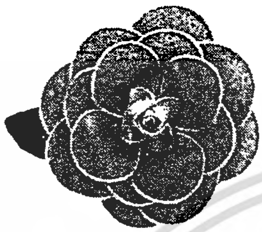
Natural Bones replacement is a problem for doctors now. However, with silk nanotech work involving silica, new bone material can be made that is non-allergenic and strong and is not rejected by the body. In addition the new bones are stronger than the original.

6. Result and Disscussion

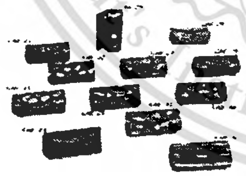
In conclusion, silk despite it natural beauty and durability, it has problems. With new age research work silk can be make into a super natural and even other substances like bone replacement. The world can benefit in both medical ways and the fashion world with nanotech advanced.

Silk


Silk



Silk



5. REFERENCES

Internet Citations

[1] www.azonano.com/news.asp?newsID=2494
[2] www.cmano.org/benefits.htm
[3] www.earthsky.org/shows/show.php?date=20060718
[4] www.phys.ntnu.no/complex/nanotechnology_e.php3
[5] www.surinthaisilk.com
[6] www.vegansociety.com/html/animals/exploitation/silk_worm.php

Thank you

Chantana Viriyavejakul
KMITL Bkk, Thailand 10520
kmchanta@kmitl.ac.th
cmodemanee@gmail.com