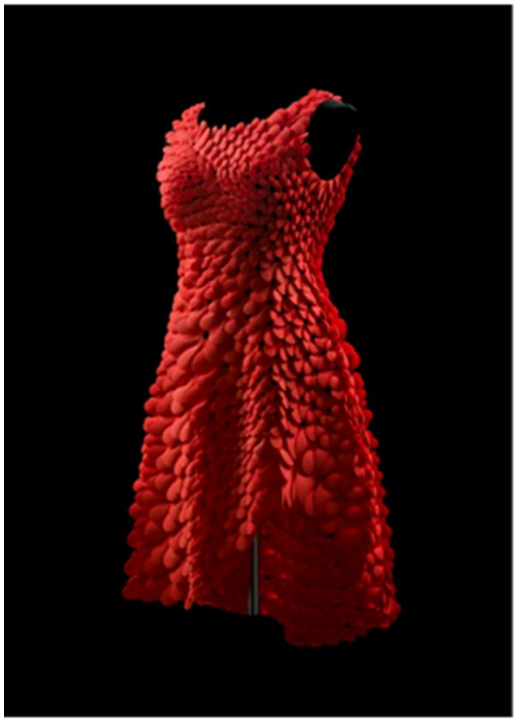

## 3D Printing

The world is a place of nonrenewable resources and that is clearer today than ever before. Additive manufacturing and compliant mechanisms are developing techniques that engineers can use to efficiently use the resources that they are provided. By creating machines and tools that can bend with minimal parts, there will be a lower demand for the resources that are crucial to save. This paper will present the uses and some properties of 3D printed materials as well as compliant mechanisms and how they can be used in conjunction with each other.

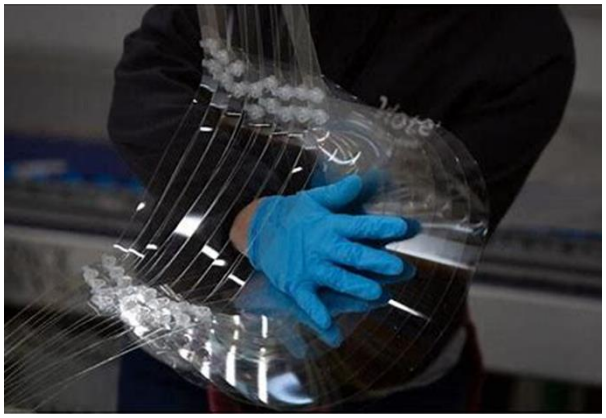


## 4D Printing

4D printing is an innovation on 3D printing that introduces the dimension of time to 3D printing's additive manufacturing methods and allows for the creation of dynamic objects that can morph over time and respond to their environment. The field has grown rapidly and has the potential to change many engineering disciplines from biomedical, to civil, and mechanical engineering. This paper will give a broad overview of the field and discuss its potential to affect the various engineering disciplines. A brief overview of the technology will show how the technology is connected to additive manufacturing and 3D printing. The definition of 4D printing will be explored along with some of different categories of 4D printed structures, and different stimuli that a 4D printed object can be made to respond to. The properties shared between the various 4D structures will be described. The commonly used process for 4D printing will be explained. Some of the proven and proposed future application for this relatively new technology will be explored. Finally, some of the current research in this area will be highlighted to show where the technology has currently progressed to.

## Aluminum and Aluminum Alloys

Aluminum and aluminum alloys are light weight, cost effective, strong, ductile, corrosion resistant, and good electrical and thermal conductors. Aluminum is and has always been a desirable material to use for several purposes, such as structures, power lines, small electronics, household appliances, cars, trucks, trains, airplanes, and spaceships. This paper goes into detail on the chemical, physical, mechanical, electrical properties of aluminum and some of its alloys, as well as talking about its manufacturing processes, uses, and cost.



## 3D Printing Fighting COVID-19

During the abrupt and ongoing COVID-19 Pandemic, almost over 10 million flights worldwide were canceled. This disrupted the supply chain of all types of goods such as, personal protective gears, medical health devices, raw materials, food, and other essential equipment's. There was a high demand for health and medical related goods during this period globally. The production using normal manufacturing techniques were affected because of the lockdowns and disruption in the many systems including transportation. This created the need of small, and rapid manufacturing combined along with a smart computer aided design (CAD). The availability of 3D printing technologies and open-source CAD design made it possible to overcome this need. In this article, we present an extensive review on the utilization and advancement of 3D printing technology in the days of pandemic. 3D printing combined with CAD design helped overcome the disruption caused by the lockdown of manufactures, specifically the medical fields. We observe the advancement of 3D printing for future needs because of how well it handled emergency situations due to the COVID era. We present a review of profuse benefits of 3D printing particularly in emergency situations such as a pandemic. Furthermore, some relevant design aspects and overview of 3D printing is discussed. Finally, this article highlights the areas that can help to control the emergency situation such as a pandemic, and critically discusses the use of 3D printing not only during situations like such but also for future manufacturing benefits.

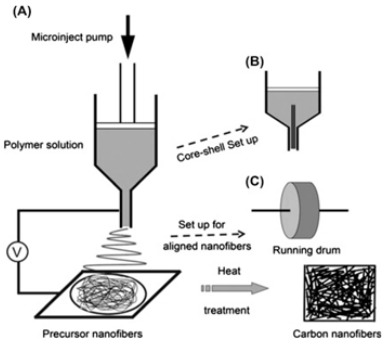

The Six Principles of the Health & Wellbeing Framework

## Smart Green Buildings

Climate change has been an escalated topic for debate among recent political spectrums. Structures such as businesses, hospitals, schools, and homes possess a significant impact to climate change between their carbon footprints and other factors. The objective of this project was to gain a better understanding of "Smart Green Buildings" (SGB). The buildings are "smart" because they contain some technologically advanced features much like an iPhone is called a "smart" phone. The buildings are "green" because they possess the goal of environmental sustainability [1]. This goal was achieved by some research, specifically its meaning, benefits, and challenges to producing SGB on a global scale. As expected, the results indicated that SGB are in fact beneficial to the environment and the world's continued survival. However, there are still many boundaries such as political, financial, and personal interests that conflict with executing and expanding SGB. Below are the World Green Building Council's (WorldGBC) overall principles for this concept.

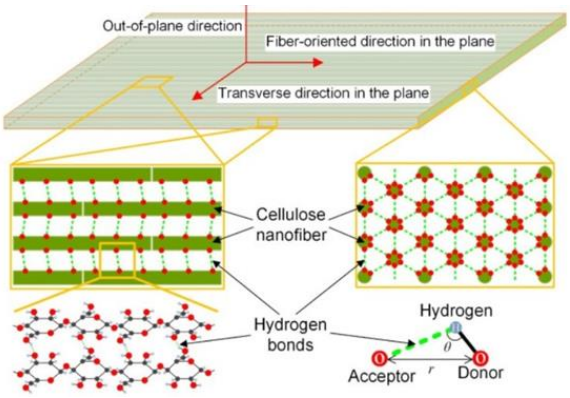

## Hydrophobic Substances

To see water evade from certain materials appears as a magic trick, but it is truly just a marvel of science. These materials have hydrophobic properties meaning to repel or separate from water or other liquids. The following paper analyzes all aspects of different hydrophobic materials: applications, properties, manufacturing process, materials, and costs. Each of the following sections take a dive into all the information regarding hydrophobic materials. Hydrophobic materials are substances that are made up of molecules that do not bond to water molecules. Examples of hydrophobic molecules include alkanes with long strands of carbons, fats, and oils. Applications include clothing, car detailer, chemical separation, etc.




## Applications of Carbon Fiber

Carbon fiber is a dynamic material that has been found to be useful for its combination of mechanical and physical properties. The properties that are found to be most useful are its strength to weight ratio, high thermal and chemical stability, biostability and durability. This report covered how and why based on the properties of carbon fiber, PAN-based and nano carbon fibers, and the effect on the fields of aerospace, medical, and automotive.



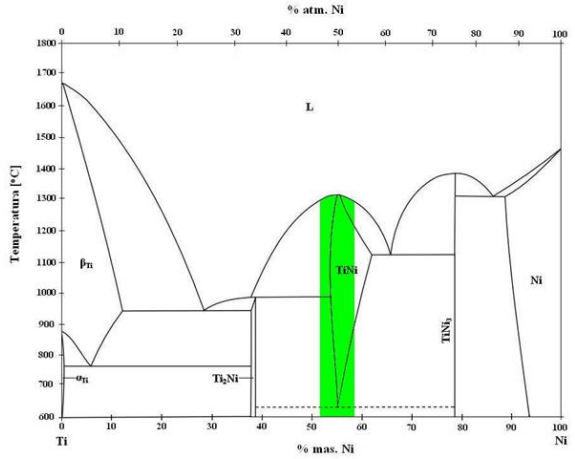

## Cellulose Nanopaper

The materials within today's world are much different than they were in the past years. Eras ago when the reference of materials came about, the most common materials were thought of. These materials were most likely wood, rock, water, dirt, or clay. As time went on these materials were developed into much greater things. Shortly following, materials such as clay and concrete were derived, and a new form of structure was developed. These items made for much stronger houses as they were much sturdier and solid than the average piece of wood. Many new and different materials are learned and created every year. No longer relating to simply structure, materials are used in just about everything and can also relate to much more. Today materials most commonly refer to metals, gases, plastics, and much more. Due to technological advancements over the years, materials can also be created at a microscopic level. One up and coming material that may be a life changer is Cellulose Nanopaper. Cellulose nanopaper is a composite material that is manufactured not found. This material can be manufactured in many different ways depending on what the usage and strength needed would be. For instance, Cellulose Nanopaper can be manufactured to be thick and strong or soft and flexible. Because of the chemical and physical properties of Cellulose Nanopaper, it is in testing to be flame resistant. On the other end of the spectrum Cellulose Nanopaper can also be used as a drug delivery method. In simple terms it can be used in the makeup of pills or capsules for medicine. It is easy to see the wide spectrum of usage for this material based off of only these

two uses. As technology advances the uses and availability of Cellulose Nanopaper will only increase.

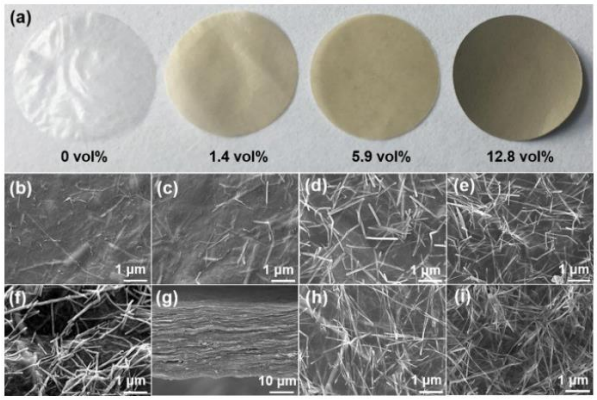
## Aluminum 2024

The mustang P-51 is an amazing aircraft that was used in the world wars, and it has truly changed the way aircrafts are made today. The mustang P-51 got its name because there were many different transformations that the aircraft went through. What makes it so special is the engineering and materials that went into creating and manufacturing the aircraft. From wheels, to wings, to the structural all the way to the shell of the aircraft. The main focus will be the shell of the aircraft to inform readers of aluminum 2024 and the basic properties it has to offer. Aluminum 2024 is very ductility and at the same time has a lot of strength. Some other topics will include mechanical properties, structural properties, and physical properties this metal has to offer. How the manufacturing process of the Aluminum 2024 T3, and what makes it so incredible as the shell of the mustang P-51.[8]



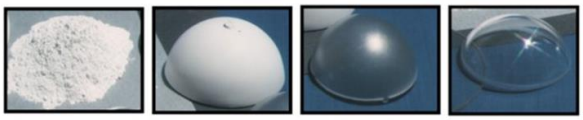

## Nitinol

Shape memory alloys are growing in popularity as more research is done, due to the unique properties, such as shape memory and super elasticity under stress. There are three major types of shape memory alloys, this report is concentrated on nitinol. This paper examines the applications and structures of nitinol as well as the physical and mechanical properties. This paper also summarizes the manufacturing properties and the cost analysis of the material.



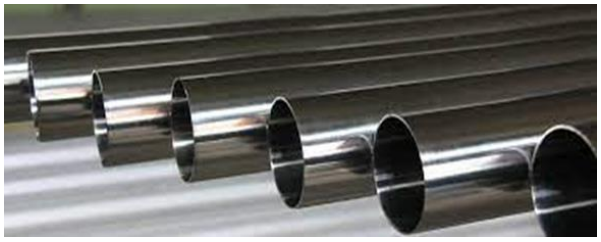

## Conductive Paper

With the advancement of technology, there is an increased need for new materials to accompany the new technologies. Among these new materials, they need to have incredible conductive power. Studying conductive papers and adding nanomaterials can significantly increase the properties of the material, hopefully making it more useable. This paper introduces conductive paper and explores the physical and mechanical properties it has. It will also analyze some of the exemplary characteristics that make the material unique. Among these is the tensile strength which can reach up to 49 MPa, the low density of 0.7 g/cm^3, and the incredible electrical conductivity of nearly 200 S/cm. This paper will also address the creation of these conductive papers as well as some of the materials necessary for the creation of conductive paper. In the end, the environmental impact of the conductive paper is analyzed to discover that conductive paper can cause significant damage to the environment.



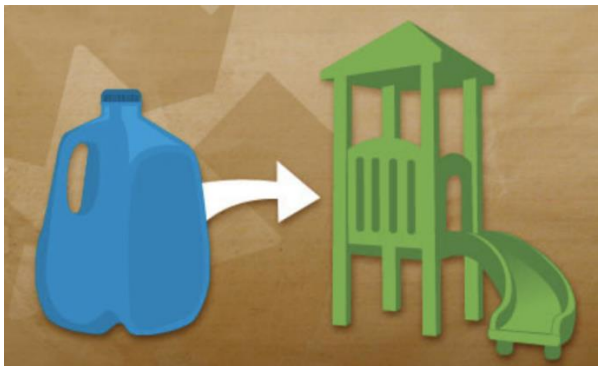
## Transparent Aluminum

A material that is optically see through and has more strength than the toughest of metals. Imagine the possibilities. Transparent Aluminum comes in here. A material so intense, that it is used as bulletproof armor in the military. Who would not want that strong of a substance, that is also completely see through? Imagine rolling through the apocalypse in a ball of transparent aluminum. It would be a movie in front of your very own eyes.



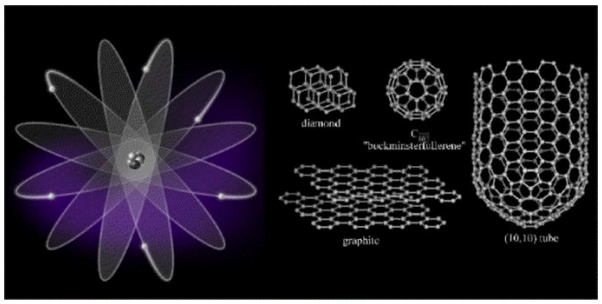
## 304L Stainless Steel

The sanitization of materials is becoming more and more important as time goes on. This led to the creation of a low-carbon version of 304 stainless steel. This paper looks at what makes 304L stainless steel so popular today amongst manufacturers. The mechanical, chemical, and physical properties are investigated to get the answer. The research showed that 304L has one of the highest Young's Modulus, and Shear Modulus, when compared to all austenitic stainless steels and all iron alloys. The research also showed that 304L has one of the highest specific heat capacities amongst all stainless steel, and iron alloys, while also having a relatively high thermal conductivity compared to other stainless steels. This allows for energy to be easily absorbed into the metal, while requiring a lot more of the energy to increase the temperature. 304L's chemical makeup allows for it to be corrosion resistant, even in extremely acidic and basic fluids.  It also has a low carbon content, which helps to reduce corrosion at weld points. This paper goes into detail about the specific properties of 304L stainless steel that make it popular amongst engineers in the food manufacturing field.



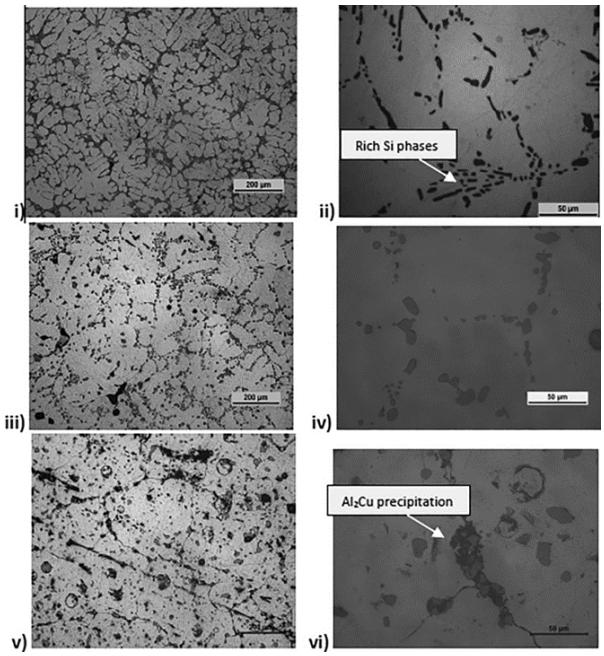
## Recycled Plastic

In on-going studies, recycled plastic has drastically affected the lives of animals and the overall wellbeing of the environment. In what ways do certain plastics have a greater effect than others? In research, it will be provided to show what human life can do to help prevent deaths of animals and indeed help themselves live in a healthier environment. Also, the way that plastic - when recycled, is taken care of and redistributed. Environmental factors as well as human factors applying temperature can also affect the overall wellness of plastic. More importantly, the redistribution of recycled plastic has helped eliminate harm and produced equipment and products for people. [1]



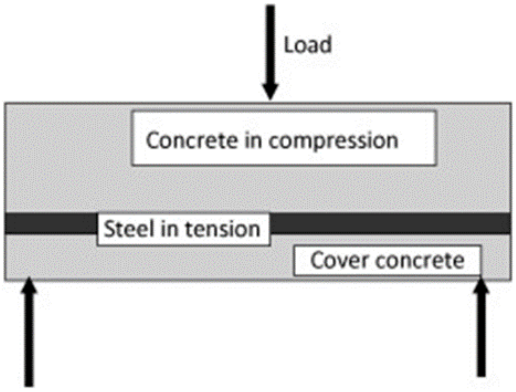

## Carbon Fiber

This brief paper reports on the topic of Carbon Fiber and how it grown in the world as a top material to use in place of other heavier and weaker materials. This paper will talk about how this material has become a staple in the sports world. Carbon fiber has become a main component in shoes that have helped Olympians beat many running and field event records, basketball players reach new heights, and the average joe meet life goals of just reaching new limits while running. Also, how in the auto racing world, carbon fiber has been a material used that has saved the lives of many drivers all over the world.




## A356 Aluminum Alloy

Aluminum alloys are being used more and more than before as certain properties of aluminum alloys are needed for certain industries. One industry that is using aluminum alloys is the automotive industry. Al-Si based alloys can be altered in ways that change their mechanical and physical properties. A356 is an Al-Si alloy with very good properties that these industries are looking for. Properties such as strength, hardness, conductivity, stresses…etc. are examined in this paper. These properties are looked at and managed through certain processes that can change the A356 microstructure which, in return, alters its properties. Some of these methods include heat treatment, mechanical vibrating, and multidirectional forging (MDF). It is also found that adding certain weight percentages of copper to A356 can increase its strength, elongation, and hardness. By using these methods, it was found that the change in microstructure also changed mechanical properties. Alloy modification can change an alloys mechanical property to best fit the situation at hand. It is important to understand how the alloy behaves under certain circumstances to be able to modify the alloy. These results show how this is performed under these studies.

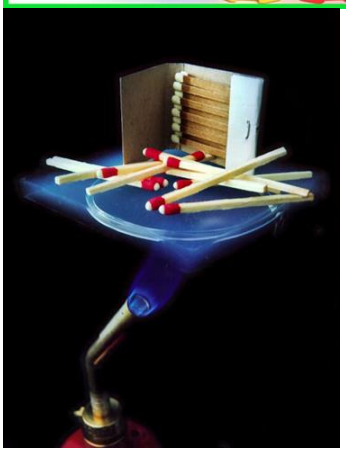



## Steel Reinforced Concrete

The contents in this paper are going to discuss the properties and qualities of steel reinforced concrete. Physical properties such as density and chemical properties such as yield strength and tensile a strength are talked about. The influences that steel and concrete have on each other and how they perform together is an important point of discuss in this paper. I will also talk about the manufacturing process and cost analysis on the concrete. My interest in civil engineering had led me to do research on reinforced concrete. It is extremely popular in the construction industry.

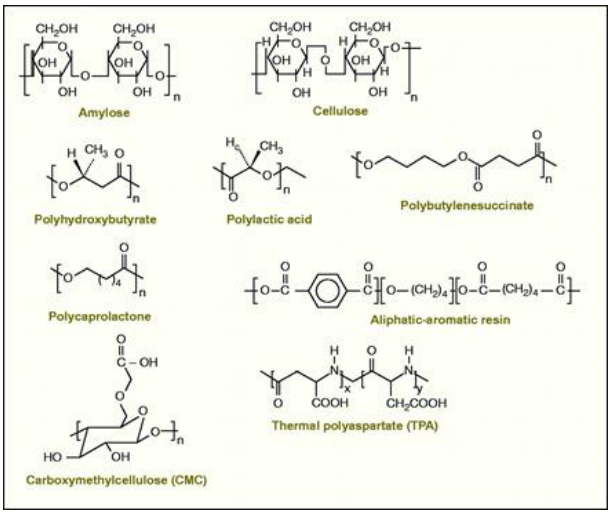

## Recycling

Recycling is tied to economics as well as an environmental hope. As an economic activity, recycling represents recovery of residual value from waste product. As far as environmental purposes, the difference could be the extinction of different animals and plants or saving all of those mentioned. Do your part.



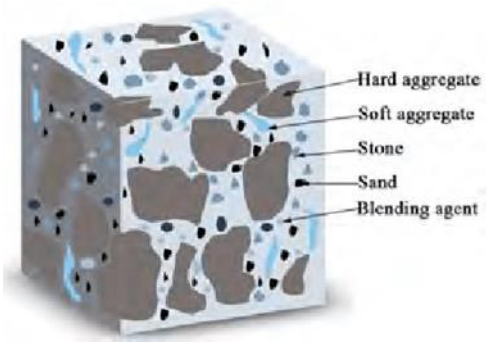
## Aerogel

At the end of the day, aerogel is an interesting material to consider, due its many applications. Insulation, chemical absorption, thickening agents in paints and cosmetics are just a few. The “frozen smoke” has a variety of physical and mechanical making it the perfect material where it can be used. If cost is a problem, it comes with its own solution.




## Bioplastic

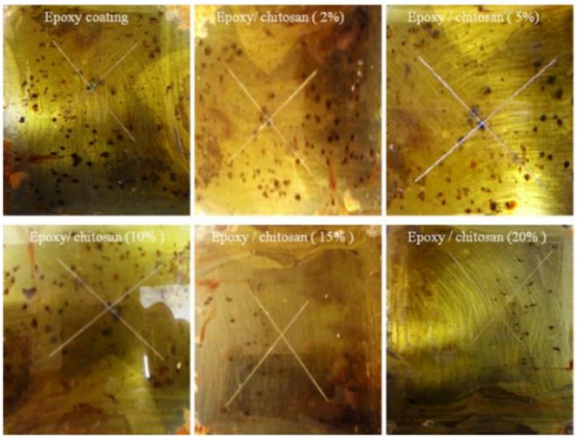
The biggest form of pollution in the current world is plastic. Plastic is everywhere from bags at the grocery store to the bottles that we drink out of. The objective of this paper is to show how bad plastic is to the planet, and how new technology is changing the plastic used daily. Bioplastic was created by scientists with a purpose of being broken down easier to have less impact on the world around. These bioplastics are made with the purpose of breaking down more easily than traditional plastics and for the most part are made of green materials. Some of these plastics are edible too so that things like water bottles and soda bottles could be both eaten and drank by the consumer. The new bioplastics have been shown to decrease the amount of time it takes to decompose the plastic while increasing the uses of plastics. This new technology helps improve the world by allowing for less pollution in the ecosystem. This not only helps the looks of the world but also drastically impacts the ecosystem. With such a wide variety of uses this technology’s uses are limitless.




## Green Concrete

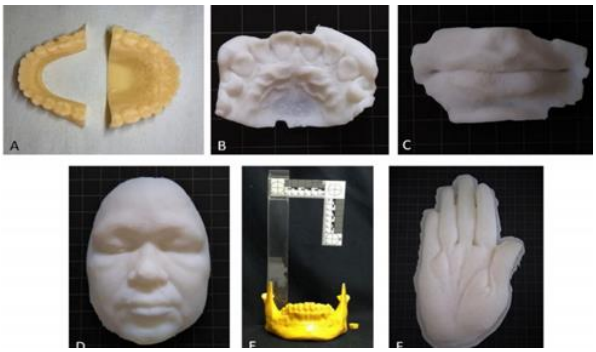
Green concrete is a material that aims to replace original Portland cement concrete. This is due to its positive environmental impact while retaining the same or similar structural, physical, and mechanical properties. This makes it one of the world’s most important building materials. Green concrete significantly reduces the production of carbon dioxide compared to Portland cement concrete. This paper briefly introduces how green concrete can be made primarily through the addition of fly ash, and the effect this has on the structure of the concrete and its physical properties such as electrical conductivity, thermal conductivity, and thermal expansion. It

also introduces green concretes mechanical properties such as elastic and plastic deformation as well as the young's modulus and tensile strength.




## Artificial Skin

There are many emerging biomaterials in the field of tissue engineering, this paper will specifically examine chitosan-based biomaterials. The applications of this material include complete restoration of damaged tissue, both structurally and functionally. There is a large demand in the medical field for new treatments for skin tissue damages because standard methods, such as skin grafts, pose a risk of tissue rejection and infection. Chitosan-based biomaterials are known for their antioxidant, anti-inflammatory, antimicrobial, hemocompatible, biocompatible, and biodegradable abilities, in addition to strong physical and mechanical properties. Different forms of chitosan-based biomaterials such as hydrogels, sponges, films, and nanofiber membranes can be used to maximize the applications within artificial skin. This paper highlights the outstanding characteristics of chitosan that make it a unique and beneficial biomaterial for artificial skin.




## Biodegradable Polymeric Acid

Biodegradable Polymeric Acid, known as PLA, is becoming one of the most well-known materials used in 3D printing due to its low price, high strength, and the fact that it can be printed at low temperatures. It will significantly improve in the prosecutors' case in forensic science by being able to bring "physical" evidence into the court room to better represent evidence such as broken skulls, upper and lower dentition for morphometric analysis, or even murder weapons. This paper briefly describes PLA's basic physical and mechanical properties, along with the manufacturing process and cost analysis. This paper also brings up possible ways to better PLA in the future with the combination of other various materials.

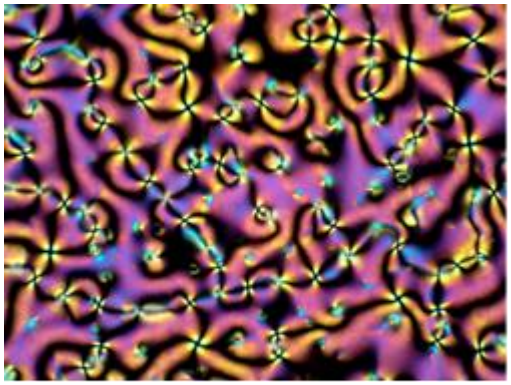
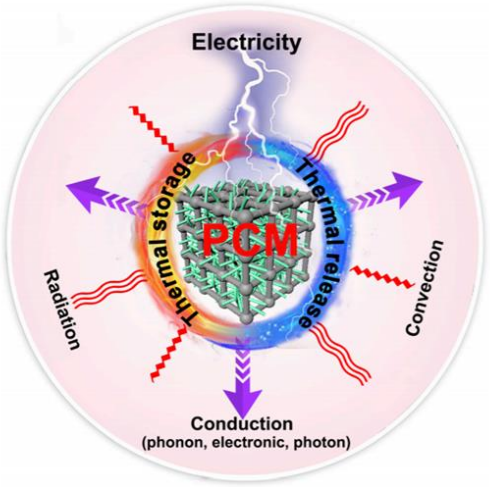


*Figure 1.1: Image showing what 'common' liquid crystals appear as [12].*

## Liquid Crystals

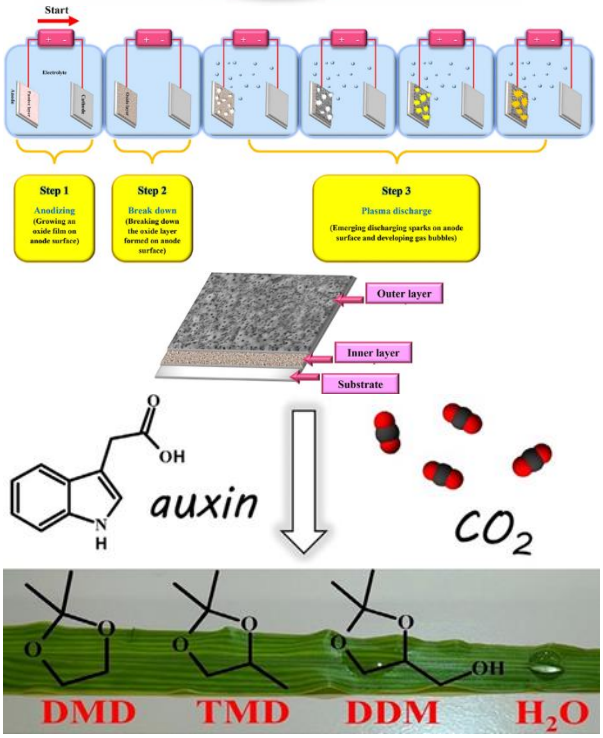
Liquid crystals (**Figure 1.1**) are used in various electronic devices such as computer monitors, televisions, and smart phones. Thus, the paper will dive into the multiple properties these crystals have. Liquid crystals are "matter in a state that has properties between those of conventional liquid and those of solid crystal" [6]. Liquid crystals are relatively new to scientific discovery, but what is known is that they do not have a defined state. They occur between the solid and liquid state of matter. Liquid crystals have several properties of solids and several properties of liquids. There are three phase states that occur with increased temperature change. The first phase is the Smectic phase, where there is a "layer-like arrangement as well as translational and rotational motion of molecules" [5]. When the temperature increases more, the Nematic phase occurs. This phase is where the molecules diffuse out of a lattice structure. As the temperature increases, the liquid crystal reaches its final phase, the chiral phase. The molecules become perpendicularly twisted.

This paper will focus on the above listed phases as a whole and will examine the physical and mechanical properties of liquid crystals that have been discovered thus far.




## Phase change materials

Phase change materials are very useful in today's world because of their ability to store energy. Phase change materials (PCMs) are also very useful in today's world due to their ability to remain stable at a wide range of temperatures. They have many uses in the renewable energy world such as uses in solar energy, thermal energy storage, and many more. There are many groups of phase change materials. They each have specific and unique properties that make them useful in our society.




## Ceramic coating

Ceramic coating is a long-term exterior substance that is applied to your vehicle to act as a protector. It is liquid formed, and when it dries hard, it will form a hard layer on top of the paint leaving now eye visible defects. Ceramic coating consists of silicon dioxide, which is gathered through quartz. This material provides blemish and damage protection while keeping your car cleaner and shaped up longer than it was intentionally modified for. Ceramic coating creates resistance against water tear and gives a glossy shine.

## Artificial Photosynthesis

Photosynthesis is one of the most effective solar energy conversion systems on Earth, where organisms convert sunlight into useful energy. This process is largely responsible for maintaining the life on Earth by controlling the oxygen content in the atmosphere. The goal of creating a semi- or fully artificial system for harvesting energy would hopefully replace fossil fuels with solar fuels. Artificial Photosynthesis research has been at the forefront of modern technology for decades, as fossil fuels continue to deplete and start the threaten the amount of useable energy the population has left. Solar energy has great potential as a sustainable energy source, but it must be captured and transformed into useful forms as done by natural photosynthesis. The results of trying to create these semi-artificial or fully artificial systems have posed the challenge of creating a clean, cheap, renewable process that is more efficient than the process performed by nature.

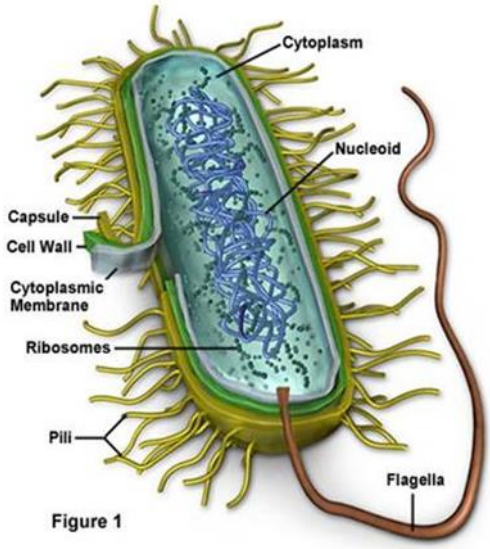
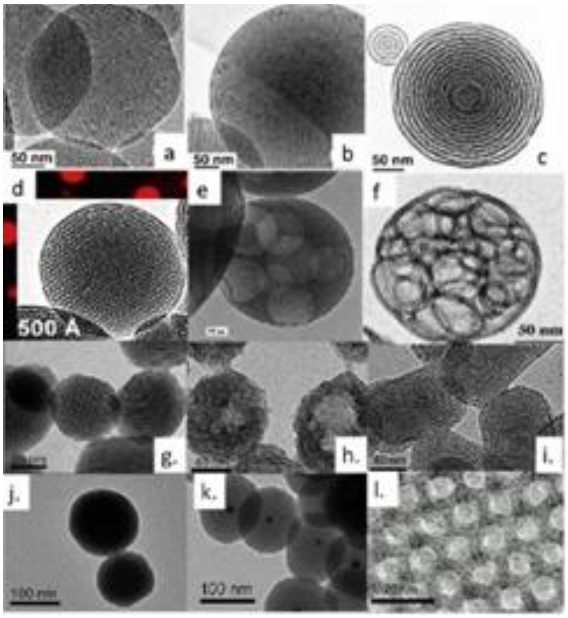


Figure 1

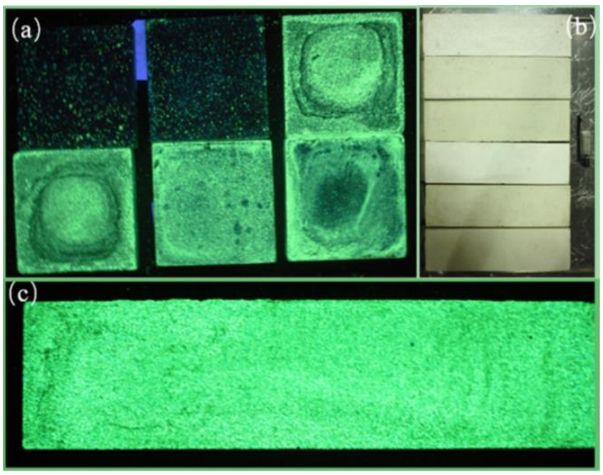
## Nanorobotics

Nanorobotics is the engineering field of nanobots and is the idea of designing and building of nanobots to help those who are sick to heal. The objective of this project is to have a better understanding of our chosen field of study that we picked. This was achieved through researching our chosen topic and trying to understand who they work and why they work to get and understanding of why they are being built/used. What I learned from this project is that the field of Nanorobotics is still new and in the workings of being fully used in the real world the use of nanobots have bine in medica help like treating cancer and other medica issues.



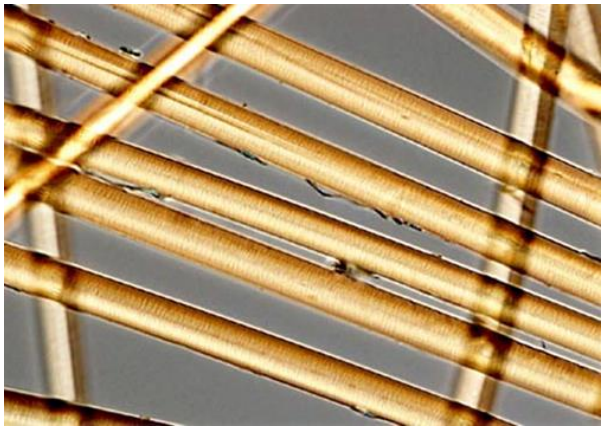

## Nanoparticles

Smart Materials in Medicine will improve medicines efficiency. These smart materials are called nanoparticles. There are three major types of nanoparticles being researched right now. Each with their own pros and cons. These nanoparticles will be able to target an infection and deliver the medicine straight to it. This will increase the efficiency of the medicine because the dose will be more concentrated. These nanoparticles are being researched for cancer treatment as well as tuberculosis and HIV. Today, many common infections are becoming drug resistant. This is because the overuse of common antibiotics. In order to counteract this drug resistance, higher dosage or more frequent dosages are being used. This can cause a toxicity in the body. Nanoparticles will be able to directly target these infections. This will allow doctors to not overdose the body with common antibiotics. These nanoparticles are being cleared with the Food and Drug Administration and are showing real promise in research. Out of the three kinds of nanoparticles, two of them naturally occur. With these naturally occurring materials, a question of allergic reactions come to play.



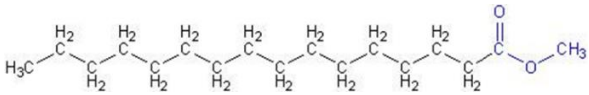

## Luminescent Cement

Luminescent cement composite material (LCCM) is formed using a percentage of reflective powder (RP) and luminescent powder (LP) with White Portland Cement [1]. This composite cement has the potential to add energy free lighting to areas that are difficult to light using electricity, yet where safety can be improved with light. This composite material has displayed increased compressive and flexural strength over the standard control material of White Portland Cement without additives [1]. The 28-day curing time of the composite had a maximum compressive strength of 45.6 MPa over the control material with a standard value of 42.5 MPa [1]. Similarly, the maximum flexural strength of the composite compared to the standard control material was 11.8 MPa and 6.5 MPa respectively [1]. The afterglow of the LCCM material has a visible brightness in the range of 0.02-0.2 cd/$m^2$ at 8 hours [1].



## Kevlar

Kevlar is one of the most emerging materials of the moment, and which, in turn, enjoy a versatile utility in different industrial and production fields. Kevlar has a unique combination of high strength, high modulus, toughness and thermal stability. It was developed for demanding industrial and advanced-technology applications. This paper is based on a detailed summary of this aramid fiber, analyzing each of its applications, highlighting which are its most essential uses for today's world and justifying the special peculiarity of the composition of its fibers. This document also comprehensively and precisely covers the exposition of the material's properties, both physical and mechanical, clarifying and introducing information such as its Young's modulus value, the elongation capacity of its fibers, and even the manufacturing and development process of this polymer.

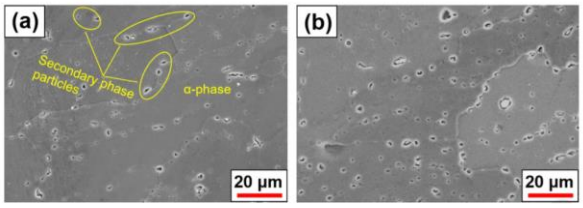


## Biofuels: Automobiles

The automotive industry is key to people's transportation. The vehicles put on the road are also one of the main reasons for the emissions increase the occurs every year. A key is to find a way to keep cars running with something other than gasoline. Biofuels is a way that can help keep the atmosphere cleaner. There is both bioethanol fuel which can be run in cars and biodiesel. There is yet to be a solution to allowing a car to run on strictly just ethanol but as of now you can run E85 which is 85% Gasoline and 10% Ethanol. This type of biofuel has a chemical structure $CH_3CH_2OH$ this will never change. Biodiesel has the same formula except it has an ester group attached to the end. Biodiesel is made up by using oils and fats. With this the number of emissions released varying depending on the type of oil/fat that is being used to produce it. If an oil used has a smaller molecular chain, it will produce a lower level of emissions the longer the chain the higher the emissions. When it comes to fueling your vehicle with these kinds of fuel yes it may be cheaper per gallon, you will also have to take in account it will lower your miles per gallon your car gets.  Work is still being done to try to figure out a way to use these renewable energy sources rather than using gasoline. Even with biofuels still not being perfect they still have many benefits. They lower the smog in cities, create safer air quality and lower emissions released into the atmosphere. Choosing to run this fuel in your car is your own personal preference but the world's goal is to help lower emissions and our gasoline supply will run out someday so this fuel will be the future.


## Green Nanotechnology

Nanomaterials can be found in all our products that we use daily. There is a global concern for pollution in our environment a growing need of more sustainable processes. Green nanotechnology was developed to synthesize nanomaterials and reduce the amount of energy used and waste produced. The paper presents a review of the methods of synthesizing green nanomaterials and their application in various fields. Green nanomaterials are synthesized from organic material such as plant and plant waste, bacteria, fungi, etc. The process of synthesizing green nanomaterials takes less energy and produces less pollution than synthesizing nanomaterials chemically. The physical and chemical properties of green nanomaterials enhance their ability to absorb toxins from the environment. More research needs to be conducted to lower the cost of synthesizing green nanomaterials.

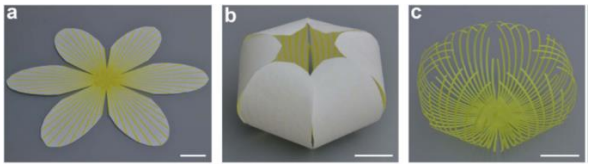



## Cryogenics

Cryogenics is the idea of subjecting objects to very cold temperatures. Despite this, not all things subjected to these temperatures act alike. To understand what happens at these cold temperatures, there must be an experiment performed with the materials. Therefore, an analysis of the materials under these harsh conditions is needed in order to see how it effects their parameters. What was found is that there are many different abilities of items that are changed. Anything from radial compressive stress increasing by a whopping 132% [1] all the way to thermal conductivity decreasing by 30%.

## Synthetic Wood

The research of synthetic wood was both challenging and rewarding. After sorting through an infinite number of advertisements and home depot links there was good solid information. Finding information worth learning was extremely hard, so reading through each and every article was crucial. As a result, synthetic wood proved to be a clear winner over natural lumber in many uses with a small downside of a larger cost. It is widely used and beneficial for so many uses for all levels of construction. This material was a breakthrough and will show up in homes all across the world for decades to come.

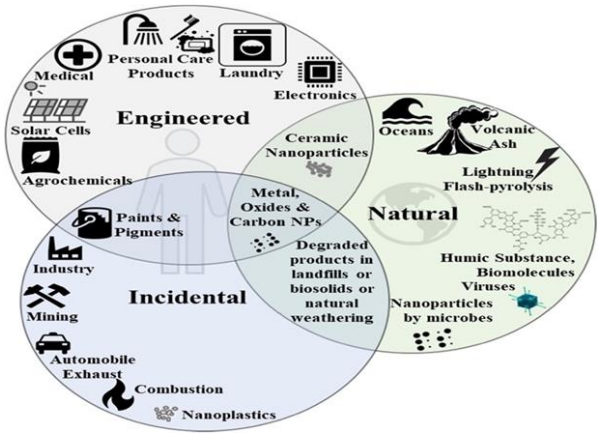



## 4D Printing

Additive Manufacturing or 3D printing is in simple terms, the process of building a part by layering material according to a programmed path. There are many ways in which this is achieved. The variations include material of the part and how the binding of each layer occurs. The adding of material only where it is needed reduces the waste of milling parts by subtracting up to 80% of the raw material. This process has received the attention of industries trying to cut costs. The emerging 4D printing is an evolution of the 3D printing. It utilizes the properties of composite materials to transform flat 3D prints into complex shapes over time by adding an external stimulus. This reduces material waste, production time, labor cost, and has an increased strength, which makes it a viable manufacturing process.

## Metal 3D Printing

This is meant to be a review paper on some of the current studies and write ups of 3d printing (3DP) dealing with metals. Going by its more industry standard name of Additive Manufacturing (AM), this field has been rapidly advancing into one of the next major forms of both small- and large-scale construction. The particular subsector that has been subject to repeated study and testing has been that of 3D printing metals. Due to AM's "layer by layer" approach to constructing objects, we have been able create things that were not previously possible since we had to get some form of tool into certain points in order to construct it. This has posed many new design challenges while solving other old problems and putting 3DP into what would be considered a more niche section of the market. This paper will explore a brief history of the subject, the various methods we use to 3DP objects out of metal, and their pros and cons, along with several problems that have arisen. This will also contain information on applications and how the various pros and cons of AM relate to them.



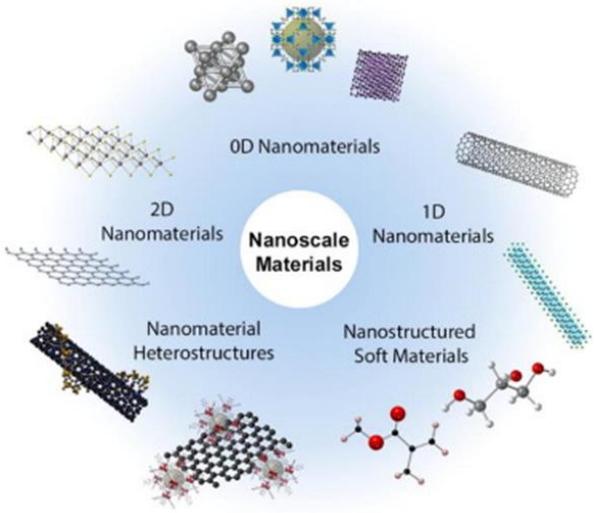

## Nanotechnology in Medicine

Nanotechnology is becoming a crucial driving force behind innovation in medicine and healthcare, with a range of advances including nanoscale therapeutics, biosensors, implantable devices, drug delivery systems, and imaging technologies. Universities also have begun to offer dedicated nanomedicine degree programs (example: MSc program in Nanotechnology for Medicine and Health Care). A nanotechnology-based system, for instance to eradicate cancer, needs four elements: 1) Molecular imaging at the cellular level so that even the slightest overexpression's can be monitored; 2) effective molecular targeting after identifying specific surface or nucleic acid markers; 3) a technique to kill the cells, that are identified as cancerous based on molecular imaging, simultaneously by photodynamic therapy or drug delivery, and 4) a post molecular imaging technique to monitor the therapeutic efficacy. This

paper introduces the many healthcare advances that may be possible through nanotechnology, ranging from fitness monitoring, prevention, diagnosis to therapy, and everything in between, as well as the problems existing in present research and a proposal for future studies.

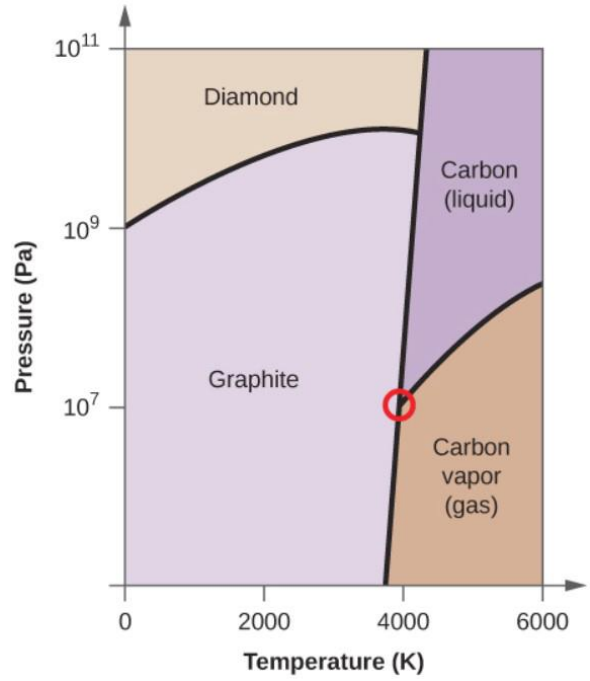

## Recycled Concrete

With environmentalism on the rise, the options to use greener materials in the construction industry can seem more appealing in modern times. Concrete is a mundane material that is used in almost every construction project ever done. Bridges, roads, and buildings all have some variation of concrete put into them. With the push to use produce less waste, materials such as recycled concrete using recycled aggregate (RCA) must be examined and considered as a viable replacement for concrete that uses freshly quarried natural aggregate (NA). This paper analyzed if recycled concrete can be a suitable replacement for NA based concrete. The physical and mechanical properties of recycled concrete were examined and compared to those of NA concrete, along with a cost analysis and the manufacturing process. The results indicated that RCAs have a lower density, thermal conductivity, tensile strength, and Young's modulus than NA. However, NAs were found to be more brittle than RCAs as seen in the stress-strain curves having their fracture point appear earlier in the curve. Through testing multiple concrete mixes and designs with varying percentages that when a mix has closer to 0% recycled aggregate, its properties will be closer to that of concrete made with pure natural aggregate.



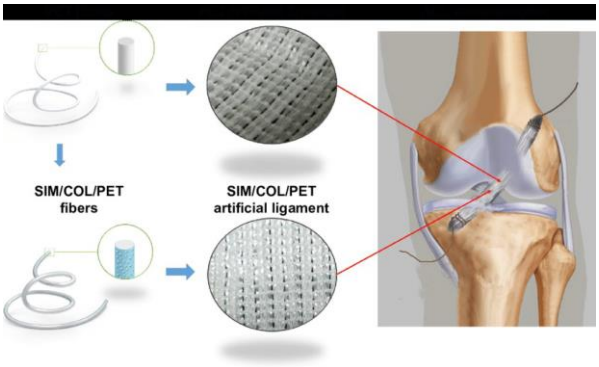

## Nanomaterials

Nanomaterials are very small and have been increasingly used by a wide variety of manufactures for their practical uses. Nanomaterials are lightweight and strong materials that have a significant potential for applications in a variation of fields like construction, automotive, and medical fields. Nanomaterials are often made using combustion reactions and manipulating individual atoms. Nanomaterials can have very different physical and chemical properties than their counterparts.



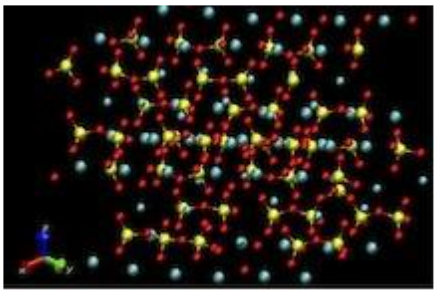

## Synthetic Diamonds in Industry

Diamond has solidified its importance to the manufacturing and tooling industry with its superior mechanical and physical properties. In this report I will detail both the importance and innovations of the field of synthetic diamond production with a specific focus on how the precision that new and emerging methods of production are affecting the use cases of synthetic diamond. This will be done by compiling research from the leading experts in the field into a concise summary of the material's current advancements.




## Artificial Ligaments

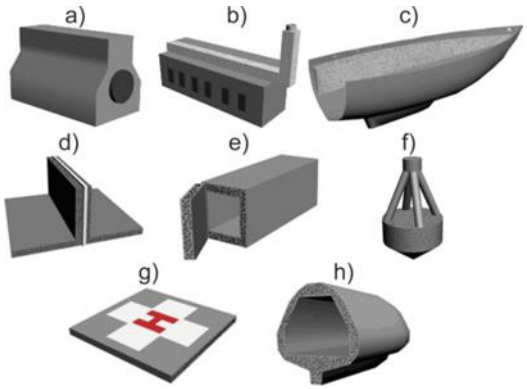
Artificial ligaments today are made up of synthetic polymers, one example being
polyethylene terephthalate, with coatings on top to ensure good biocompatibility of the
synthetic polymers. Artificial ligaments are also common in ACL repairs. Artificial ligaments
are characterized based on these three subsets: biomechanics (fatigue, static and dynamic),
chemical (structure and composition) and biological. Artificial ligaments are created and
undergo biomechanical examinations that consider of the strength of the construct,
creeping, resistance to tearing and fatigue of the ligament. An artificial ligament is a gradient
structure that is anchored in the bone channels and passes through the osteochondral and
fibro chondral zones. Since artificial ligaments have polyester and carbon fiber types, there
are braided together for flexibility and strength. The most important factor is porosity. The
porosity determines the rate that the human tissue will grow and encapsulate the artificial
ligament. Smaller circular fibers are better for human tissue to encapsulate over it.



## Eco Concrete

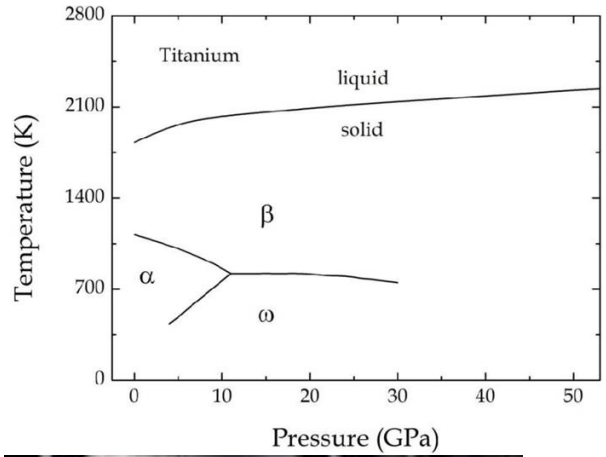
Concrete production has many harmful impacts on the environment which have led to the development of eco-concrete. The production of eco-concrete significantly reduces the carbon footprint of new structures built. This paper covers the properties and manufacturing process of eco-concrete and discusses how it is nearly identical to traditional concrete. It also discusses the distinguishing factor between eco-concrete

and traditional concrete which is the materials that are used. The positive impact of using waste materials in the production of eco-concrete is discussed in detail. Finally, this paper emphasizes that the largest benefit of using eco-concrete is reducing the amount of greenhouse gasses that are released during its production.




## Research Study on Syntactic Metal Foams

Syntactic metal foams are drawing much attention because of their good strength, high compressibility, and especially their advantageous mechanical and physical properties. Syntactic metal foams will significantly improve the world around us and will be used in a large number of applications. The paper shows how syntactic metal foams are extremely useful for multiple applications and that they are capable of withstanding many internal and external impacts from the environment. The paper summarizes research based on the advantages of using syntactic metal foams due to their strong, light weight structure, and the paper will also introduce the materials and processes required to produce these various syntactic metal foams.




## Titanium

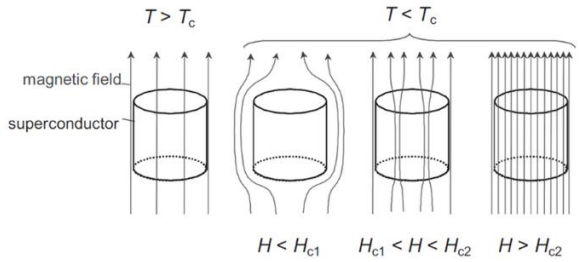
This report contains detailed information of the element and transition metal, Titanium. It also highlights the reasoning of me deciding to write about the material titanium. It goes over the reasons that the metal is important to various fields including the medical industry, aerospace programs, and automobile manufacturing and modification. Titanium is a precise material that has low toxicity and low electric conductivity, making it wonderful for the preceding fields, that an electrical interference would be life threatening.

## Fiber Glass

With its variety of applications and many uses, its no doubt fiber glass is dominating some of the manufacturing industry today. In the following study fiber glass was researched in many different areas and properties. Applications of fiber glass have been very beneficial for many industries such as the boating and marine industry, electronics industry and automotive. This paper highlights all fiber glasses properties and characteristics including the high ratio of weight to surface area, corrosive and electrical properties, and high strength compared to weight.


## Timbercrete

Second only to water, concrete is the most widely used substance on earth [1]. While there is little doubt cement will remain a top construction material well into the future, production has also left behind a massive carbon footprint. With the increasing awareness of how greenhouse gases affect climate change and human health, the purpose of this paper is to evaluate a functional material that could be a sustainable alternative option for concrete. A worthy eco-friendly product is Timbercrete, a blend of sawmill waste, cement, sand binders. Timbercrete is shown to have significant environmental benefits and engineering diversity. This paper outlines the physical and mechanical properties of Timbercrete, including specific heat values, thermal efficiency, strength, and durability.

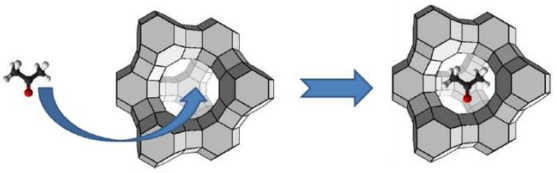



## Superconductors

Superconductivity is a phenomenon that occurs when certain materials are cooled to nearly absolute zero. A solid in a superconducting state has no electrical resistance when a current flows through it, and prevents magnetic field lines from entering the interior of the solid. Ever since the discovery of the first superconductive metal, scientists and researchers have been awed by their strange properties. Today, superconductors are being used in MRI's scanners, SMES machines, and even levitating trains. But researchers are still trying to find a material that superconducts at room-temperature. This would change how we use electricity forever and lead us towards a more efficient future. The intentions of this paper is to take a simple approach in explaining the complicated physics of superconductivity, and inform of the great potential superconductors have.

## Synthetic Wood

Synthetic wood (WPC) is growing in popularity to replace woodwork in North America due to structure and properties being significantly better than natural wood. Synthetic wood (WPC) will make lives easier for customers as in maintenance and the cost being cheaper for the customer. This paper briefly introduces synthetic wood's (WPC) basic properties and the applications in which synthetic wood (WPC) is a part of and the manufacturing of synthetic wood (WPC). This paper also presents how synthetic wood (WPC) is beneficial to the environment.



## Zeolites

Zeolites can be natural or synthetic materials. They are aluminosilicate minerals with rigid frameworks containing well-defined channels and cavities. These cavities contain exchangeable metal cations and can also host neutral guest molecules that can be removed and replaced. Based on the pore size and absorption properties, zeolites are among the most important inorganic cation exchangers and are used in industrial applications for water and waste water treatment, catalysis, nuclear waste, agriculture, animal feed additives, biochemical applications, and more. In addition, zeolites are very stable solids that resist the kinds of environmental conditions that challenge many other materials, as well as being a non-toxic option. They have high melting points and are able to resist high pressures. Zeolites also do not dissolve in water or other inorganic solvents and do not oxidize. The abundance of natural zeolites and the ease of producing synthetic zeolites make them an important material. Their many uses also makes them an important emerging material in the years ahead.