Semiconductors and Cyborgs

Sophia Acord, sociology

Graphite

Applications of Graphene:

Graphene is used in various fields such as medicine, computer science, textiles, carbon nanotubes, and more. Graphene's unique properties make it an excellent candidate for applications in technology, medicine, and energy storage. For example, graphene-based sensors can detect cancer cells and monitor the concentration of certain chemicals. It can also be used in the production of high-performance electronics and solar cells.

What is Graphene?

Graphene, a form of graphite, is a single layer of carbon atoms arranged in a hexagonal lattice structure. It consists of a sheet of carbon atoms bonded in a honeycomb lattice, giving it unique physical and chemical properties. Graphene is extremely thin, lightweight, and strong, making it an ideal material for various applications. It is also an excellent conductor of electricity and heat, which makes it suitable for use in electronics and thermal applications.

What’s Your Personal Engagement?

If you ever found yourself wondering how to use graphene in your daily life, consider the possibility of using it in your clothing. For example, wearable technology that integrates graphene into textiles can provide various benefits, such as improved conductivity, enhanced durability, and better insulation. Graphene-based fabrics can also be used in the development of smart clothing that can detect and respond to environmental changes.

Graphene, which occurs naturally in graphite, is a thin sheet of carbon atoms arranged in a hexagonal lattice structure. Graphene is unique for its electrical and thermal properties. It is a promising material for a wide range of applications, including electronics, energy storage, and biomedical devices.
Polymers & the Plastic Paradigm

University of Florida, Impact of Materials on Society

Polymers

The History:
- 1504: British engineer discovers the Maya civilization in Central America. The British find children playing with balls made of rubber from the local rubber trees.
- 1839: Charles Goodyear discovers vulcanization, by combining natural rubber with sulfur and heating it to 250 degrees Fahrenheit.
- 1887: Leo Baekeland creates Bakelite, predominantly used as an electrical insulator.
- 1917: X-ray crystallography is invented allowing M. Polyanyi to discover the chemical structure of cellulose. This discovery added to the understanding of chain molecules.
- 1920: German chemist Hermann Staudinger publishes “Uber Polymerisation.” Introduces the public to polymer theory.
- 1927-today: Large scale production of synthetic rubber, plastics.
- 1930: Polyethylene is invented.
- 1939: Wallace Carothers at Dupont creates Nylon.
- 1941: High density and low density Polyethylene is created.
- 1970: James Hramov develops a suitable high temperature polymer “Kevlar.”

Polymers 1976:

In 1976 the polymer/plastics industry produced steel as the nation's most widely used material per unit volume. We now manufacture more plastic than steel, aluminum, and copper combined.

According to a recent release from Plastics Europe, teams of over 100 plastic manufacturers claim that they are responsible for 90% of all the polymer production across the 27 EU member states.

The Big Six

- Polypropylene (PP)
- Polyvinyl chloride (PVC)
- Polyethylene terephthalate (PET)
- Polyethylene (PE)
- Polyethylene – low density (PE-LD), linear low density (LLDPE), and high density (HDPE)

Local Impacts

I recently worked with FWC (Florida Fish and Wildlife Conservation Commission) on a number of projects ranging from land GIS mapping, gopher tortoise burrow surveys, and monitoring and upkeep of designated bird breeding areas. The least tern is a small endangered shore bird who nests on beaches throughout Florida's coastline.

What does this have to do with plastics?

While spending a lot of time out by the shoreline conducting these chores we would inevitably come upon piles of trash. These mounds would gather from across the beach about one-hundred yards apart. The majority of this waste was, of course, plastics. The beaches are privately owned government land near the Hide Point Beach on the south east coast of FL. Strong currents and frequent coastal storms make the beaches here a collection trap for human consumer plastic waste.

After collecting heaps of large plastic debris I began to look closer. After taking a 5 x 5 surface sample I began combing and separating the plastic debris. Harder (max. 3/10 in. or 75mm) and small fragments made up a majority of the plastic collected.

These particles are an environmental disaster. The chemicals leached have entered the human food chain. They are detectable in rain water as well as most industrialized water supplies. The shift to polymer was a silent revolution, transforming and shaping the built world we enjoy today. Phthalates such as BPA (Bisphenol A) or DEHP (Di-2-ethylhexyl phthalate) are measurable in the tissues of homo sapiens. The impact of this material is chronic, meaning you are constantly coming into contact with it. From the moment you wake up, the clothes you put on, and the bed you inevitably fall back into owe their cozy affordability to polymerization.

Designing the Future

Since the days of stone tools around 2.5 million years ago humans have created. In doing so, we started to discover new materials, new ways of working these materials, and ultimately changing our own materials.

Materials science is becoming, to say the least and polymer production is as at all time high. We are surrounded by our things. We rely on our things, and our things rely on us. Polymer technology has taken us quite literally into other worlds. Allowing fiction to design and create some of the most powerful tools imaginable.

As an anthropologist I am left with a sense of awe pondering the true impact of materials. When we study past and present civilizations we focus on the tools and materials present to extract inferences as to how the society functioned. We are defined by the tools and materials we use. We have built entire cultures around particular materials. We are encrusted to our things and they’re not going back now.

We as a University must focus on bridging the communications divide between scientific fields. To truly understand the human condition we must rational and work towards a fully integrated interdisciplinary network. To build a sustainable future we must start with discovering the past. Materials science and the humanities are becoming more complimentary each day especially in the industrialized world. With a growing dependence on information technology we have created the perfect sounds for complementary study. Materials today have left the industrial tools and found their way into our homes. With the growing availability of material technology we are individually defining how we ourselves define our tools.

How will the future of materials define us?
The Perception of Plastic

Photo Essay Project

Introduction
Plastics are widely used in a variety of applications in the world today. They are easy to produce with very low cost. They are also readily customizable and therefore are able to have such a wide range of applications. Plastics are made of polymers, which are long chains of molecules in repeating units. Therefore scientists can take advantage of this property in order to create materials that have great durability and flexibility. These plastics can also be reinforced with other materials in order to fit the demand and need of society.

The Impact Paradigm
Material: Plastics are polymers with additive to improve its properties in the desired way. Polymers are a long chain of molecules that have repeating units. Plastics have a high strength to weight ratio, are resistant to corrosion, can be colored or transparent, have good durability, and are water resistant, and are low cost.

Historical: A natural form of a polymer was gutta percha, which was a natural rubber. This along with bitumen and silk were among the first polymers that were used. The plastic age started in the 1930s with Goodyear who worked to improve the quality of rubber. Later in the 1930s, Fawcett and Gibson accidentally polymerize ethylene and this eventually led to the discovery of the applications of low density polyethylene (LDPE) and polypropylene (PP), which are both used to make Tupperware.

Technological: Scientists were able to learn how to synthesize many different polymers and this opened the door to a wide range of applications. Some of these applications are found in Tupperware, clothing, carpeting, medical devices, rope, care batteries, waste baskets, pharmacy prescription bottles, Teflon, nylon, neoprene, etc. Because of the low production cost, water resistance, and versatility, plastics replaced many traditional materials such as wood and metal in many of their former uses.

Societal and Cultural: Today, packaging is the largest single use of plastics, due to its weight, flexibility, and sealing qualities. However, there are many environmental implications of plastic materials, since they are non-renewable materials. High volumes of plastic materials are consumed each year (100 million tons), but only a small percent of it is actually recycled (<10%). Not only is the final product harmful to the environment, the materials that are used to create plastics are equally as dangerous and can create toxic waste. Compared to paper grocery bags, it costs less and consumes less energy to create plastic bags, however a single plastic bag can take up to 1000 years to degrade. Because plastics cost very little to produce, there is a social stigma of plastic being viewed as cheap and not high quality.

The Use of Plastic in Credit Cards
Traditionally, credit and debit cards are made of plastic. This is because the card itself is not valuable. All the perceived value of the card comes from the intangible sum of money that is linked to it. Credit cards are not stolen for the card itself, but for the virtual access to money. However, recently many banks have started making special credit cards that are made of precious metals instead of plastics. Examples include Chase’s Sapphire Preferred Card, American Express’ Centurion Card, and Sherbrenk’s Visa Infinity Gold Card. Varying in degrees, these special credit cards are only available to those who qualify; loyal card holders with a lot of money in the bank. Cards like these are described to have “the plush factor,” and definitely attracts much attention in all these cards. These cards are advanced and designed to display that they have more value, both literally and virtually.

Although the use of metal in the cards in place of plastic to indicate a greater value points to the social impact on the perceived value of materials. Because metals are rarer, to make a credit card out of metal instead of plastic, while unnecessary, upgrades its worth. The Chase Sapphire Preferred Card is advertised to be a card “of a different color”. The advertisement shows a procession of very cheap products (such as a toothbrush) being spray painted in gold, and then at the end, there is an image of the Sapphire Preferred card. The tagline of the ad is that “not all things that are gold are worth more,” which is somewhat ironic in that they are promoting the card under a name with ties to gemstones (sapphires), which are also very much highly valued.

The Use of Plastic in Laptops
Another application of plastic is in laptops and tablets. Plastics are traditionally seen as cheap and shoddy; however, many more companies are now using plastics in the creation of the outer casings of laptops tablets. This is in the interest of the manufacturer because plastics are both easier and cheaper to manufacture. Switching over from metal to plastic is also in the interest of the consumer because plastics are much lighter than metals. These plastics are reinforced with fiber glasses or coated in aluminum to make them stronger and appear more attractive (as in less of a plastic look and more of a shiny, metallic, and glossy look). Many companies provide data which show that these plastics can be just as strong as metals.

Conclusion
As the two examples of the usage of plastic in credit cards and laptops have shown, even though there is a technology developed to make plastic the more economically favorable material in many applications, the social influence on the material impacts its range and depth of impact. Because plastics are very low cost to make, products made with plastic are viewed as cheap and having little worth. However, new materials are relatively much more rare and costly than plastics, so they are more valued than plastics are. This is a very good illustration of how materials not only have physical properties, but also social properties. Therefore, in order to produce, develop, and market new materials, there must be an awareness to the scientific advancement as well as an awareness to the social advancement of the material.

Hodges’s Entanglement Theory states that humans depend on things, things depend on humans, and humans depend on things that depend on humans. The truth of this theory is apparent in the two examples with plastics. However, one aspect of these examples that is not covered in the Entanglement Theory is that it is important to note is the entanglement of things depending on other things. We see this relationship in the dependence of the Chase Sapphire Card and the arctic to gemstones to give the card greater value. These relationships show just how not only that humans are entangled with materials, but that materials are often also entangled with other materials.

Sources
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Source: Doit! 11/1/2011 (2014) By: Dr. Jones
GLASS

Glass is an amorphous solid whose properties vary from weak to strong, as steel, thicker than metal to thinner than hair. It is shattered spontaneously to bullet-proof, red to gold to blue. Originally discovered in nature made from volcanic ash, the first ever use was for hunting. Humans have since discovered various ways to manipulate the properties to use to their advantage.

Windows and Lenses

Every building and human structure has a window. Glass windows let the light in because it is transparent, keep the cold out because it is an insulator, and protect us from the elements while letting us connected to the outside. Stained glass is not art, but it creates a feeling of beauty and mystery. Images that reflect the sun's light. Stained glass allows us to see things beyond the human eye.

Material & Historical

We know windows in our homes and workplaces as transparent and understanding of the world outside. Insulating properties keep the heat in. Glass with imperfections cause the glass to reflect light and diffuse colors. Glowing stained glass was first created during the second century and blackened glass is now commonplace. Convergent lenses magnify and are used in telescopes and as corrective lenses for eyesight.

Fiber Optic Cables

Glass fibers, or fiber optic cables, are now replacing copper wires for communicating more information at a tremendously faster speed. Fibers, thinner than a strand of hair, allow a signal to bounce off the walls throughout the cable to the other end, sending messages at the speed of light.

Storage

Glass is chemical and heat resistant. Glass is utilized in kitchenware because of its durability and reflectivity and high heat tolerance.

Technological & Material

Glass containers are chemically resistant and therefore sterile and easy to clean. They do not absorb colors, unlike iron and clay vases. Soda-lime glass is malleable, resistant to cracking, stress, and easily produced. It has a larger capacity of storage and retail cooking. Glass can withstand higher temperatures and sudden temperature changes. Therefore, it is used in the kitchen to cook and can be stored in the freezer. Right away, it is also used in all equipment.

Historical

First used as a container in the fourth millennium B.C., glass or glass-like objects were not utilized by the common people until vessels were mass produced in the 1700s with the invention of glass-blowing.
At what time did the material become enabling?

Silicon, an element discovered in 1823, has had an enormous impact on modern technology. It makes up roughly 27.7% of Earth’s crust, making it very abundant. Silicon has a very high melting point, 1414°C, allowing for many applications such as transistors. It is produced by heating sand with carbon to temperatures exceeding 2200°C.

What technology did the material enable?

Perhaps one of the most important impacts of silicon has had in the world is that it has given us many possibilities to learning and education. And so that is the reason of the third and final aspect below. Through the use of computers and calculators, all of which are powered through the use of silicon, the entire world has benefited greatly as we are now capable of sharing information across the globe in a matter of seconds. Silicon is the building block of the modern spread of information throughout the globe.

This allows for a smarter, more informed community through things such as YouTube, Wikipedia, Wikileaks, Twitter, Facebook, and even weather forecasting. Clearly, the impact of silicon in our society is like no other element. It has allowed for the spread of not only information but curiosity; what I mean by this is that it has had the power to spark an innate want to learn and better the community by doing simple things such as exposing a teenager in a third world country to computer programming.

In which realm of society did the materials development have an impact?

Silicon has also shaped an entire industry as well as the lifestyles of everyone revolving around silicon. Silicon Valley, which is located in the southern region of San Francisco, is an area in which there are hundreds of industries which revolve around the production and manufacturing of silicon.

Pictured on the left is a rough image that displays where modern technology is advancing. Silicon Valley is the home of many billion dollar companies such as Apple, Google, Oracle, etc. A common belief is that there is a limit to Moore’s law of transistors, however billions of dollars go into companies in Silicon Valley in order to enhance technology and allow for further improvements in our everyday life.

The transistor is considered by many as the fundamental building block of the information age. It allows for the recording of information in computers, calculators, and radios.

By definition, technology is anything that simplifies a previous method. I see no other word to better describe everything that the production and manufacturing of silicon has done to the world. It is through elements such as silicon, bronze, glass and many others that we really see first hand the impact of materials science on the human race and all of our daily interactions. Additionally, it is imperative for us to realize not only the impact that silicon has had in society but also how society has shaped the production, manufacturing, and use of silicon to fit into our standards and needs.


Source: http://xu2.3.nchc.edu.tw/smedia/ZgkyMDEFyLeEyLzA0L2ZL2bdMw0XRlhaKnZmFVY1gkJNTB4NTM3eWpCWpeZzWsd6ba3kx87k77/how-students-use-technology-infographic-c84f34277.jpg

- EMA1004
Materials Impact on Society
Paper is made from cellulose (mainly wood). Cellulose is held together by lignin, which chemically binds cellulose together. Lignin is very hydrophobic and two special processes are done to sever cellulose and lignin. These two process are mechanical and chemical pulping. Mechanical pulping involves wood to be boiled and ground between stones. This method has a higher yield, is cheaper, and causes less pollution. Chemical pulping uses sodium sulfide to break down the lignin and cellulose. This process makes more durable paper.

My personal shelf of books. 24 Nov 13

1. What is the general abundance of the material?
Paper is very easily made and as a result, is very cheap. The abundance of wood and other materials that are used to make paper, make it easy to produce and easily acquired. I can buy as much paper as I want and it won’t break the bank. Its abundance also enables so much more than just easily communicating with one another but also can serve as a means of entertainment.

2. What people groups were involved in the start of its use?
Originally, the Chinese were the first to make paper in the 2nd century. Other regions also developed their own type of paper based on the materials accessible to them. The Egyptians had papyrus and the Europeans had parchment, each with their own advantages and disadvantages. Over time we can see people developed different techniques for making paper to meet their needs. For me, I have very durable lightweight pieces of paper to make my books long lasting.

3. What technology did the material enable?
Paper became the medium for sharing ideas. Since sharing ideas became so important, the printing press was invented to make it faster to spread knowledge. Without paper, printers would not exist. Most households have a printer, including my own.

4. In which realms of society did the material’s development have an impact?
Paper had and has the ability to impact all parts of society because of its ability to share information. The biggest impact for me however, is in the educational realm of society. Paper allows me to read and learn about various cultures as an anthropology major. 90% of my classes are heavy on reading and writing. Paper is the perfect medium for me to do these things. If I had to carry around a clay tablet just to take a few notes, being a student would be very difficult.

Concluding thoughts...

The impact of paper on my own life and life today is difficult to confine to a single paragraph. I could attempt to draw out an entanglement diagram but that would take too much time. Instead, acknowledging the tangible and personal affects is easier to point out. Having durable and easily producible books allows me and other students to learn, communicate our own ideas, and save those ideas in an easy way. Without paper, the world would not have had a medium to be able to do these things. As this need continues to exist, this fuels the reason to engineer new and innovative technologies that will act as tools to better our future. The drive to develop new materials that can store a nearly infinite amount of information on new “forms of paper” will continue to shape and change societies all over the world.


This is the “modern” version of paper: my laptop and Kindle. 24 Nov 13

1. What is the unique enabling properties of this material?
If abundance was ever an issue, it has been solved through the use of electronic sheets of paper. The unique property here is I can store thousands and thousands of sheets of paper in a very small confined space where its protected from weathering and things of that nature.

2. What events lead to the development of “electronic” paper?
The invention of computers and more importantly, the development of home computers has allowed for every person to write electronically and read electronically. This development has enabled me to do things like take notes in a very quick and organized way.

3. What role did the material play in the technology?
Historically, paper developed from rolled up scrolls, to hand transcribed bound books, to modern day Kindles. The need to write things down allowed engineers to expand the horizons beyond just a white 9 x 11 inch rectangle. Today I can read off my Kindle, take notes with my iPad and so much more because of the initial need to write things down.

4. How has this material impacted communication between people?
Paper has made it easy to communicate with people and electronic paper has made it all the more easier. I can send messages online in electronic letters and can easily communicate with anyone in the world. This ability has enabled us to connect with millions of people but then again none at the same time if we do not want to. This allows things like globalization to happen very easily.
Aluminum

Impact paragraph questions:
1. What are the unique (enabling) properties of this material?
2. What people groups were involved at the time of its first use?
3. What technology did this enable?
4. What were the financial implications of the new development?

Aluminum’s most enabling property is that it is very lightweight. Many car parts are made of it because it reduces deadweight and energy consumption while increasing load capacity. Due to aluminum being the most abundant metal in the Earth’s crust, it has the very unique and enabling property of being cheap. When the properties of lightweight and cheap are combined, the possibilities for its use are endless.

Pure aluminum alone does not enable many technologies. However, after it goes through the process of solid solution hardening, it becomes a very enabling metal. Its applications range from car parts and airplanes to rolls cans and aluminum foil.

Although aluminum was discovered before them, Hall and Herriott simultaneously came up with the process of extracting aluminum from other compounds in a cheap manner. They did this by passing an electric current through a non-metallic conductor to separate the conductive aluminum. With this work, they were able to take the price from $2,000 per kilogram to 18 cents a pound. This prompted Hall to start the Pittsburgh Reduction Company, which we know today as Alcoa.

The financial implications of aluminum go beyond its ability to be produced cheaply. It can also be recycled without degrading any of its properties. It is recycled at 5% of the energy cost of extracting it from compounds which drives the price down even more.

Chemically, physically and mechanically aluminum is very similar to steel, brass and other metals. It has the ability to be formed, machined, cast and melted. Aluminum is also an excellent conductor of heat and electricity. In relation to its weight it is almost twice as good of a conductor as copper which is why it is the most commonly used material for power transmission lines. Aluminum weighs about one third that of steel making it perfect for applications such as cars and aircraft. Aluminum is a very corrosion-resistant metal. It naturally forms a protective oxide coating which helps fight further oxidation. The ductility of aluminum plays a major role in its uses. Its ductility allows aluminum to be deformed close to the end of a product design. Aluminum is also colorless and impermeable. This is why it is used for glass, because it never discolors or takes out while also not being toxic itself. The key property for aluminum is that it is 100% recyclable and when recycled about 95% of energy is conserved compared to extracting new aluminum. Aluminum is also the most abundant metal in the Earth’s crust although it is rarely found in pure form because it is so reactive.

Aluminum is the 13th element on the periodic table. It has a crystalline structure which interlocks when cooled from a molten stage. Each crystal is isotropic and although the crystal randomly arrange the atoms within them align making the entire metal isotropic. Despite its regular lattice structure gaps often form between atoms. These gaps can cause fractures which is why aluminum alloys are always used instead of pure aluminum.

Returning to “Human-Thing Entanglement” we see how as a whole society we are completely intertwined with not only aluminum but all materials. Just as the Romans relied on concrete to make magnificent structures and Louis relied on gold and diamonds to show his prestige, our society relies on rare earth elements for our electronic X's and steel for our buildings among countless other materials. Our only problem with this extreme entanglement is that of our ability to be in control of materials and technology and not let them control us. It seems that often times we rely more on our technology than we do ourselves which could have potential catastrophic consequences in the future.

Aluminum is rarely found in a pure form in nature and for that reason, all aluminum must be extracted from compounds which contain it. The greatest part about aluminum is how efficiently it can be recycled. This helps in future impact because it will still be around but will not be detrimental to the environment. This plays a huge role in my life with what I am very “in” to recycling and it is very important to me. German car manufacturers BMW is said to make more energy efficient cars than the Toyota Prius because they use 100% recycled aluminum. This cuts 95% of the energy cost in production so it would make sense that all of our cars will be made from aluminum in the future.

Prior to the Hall-Herriott process of extracting aluminum it was limited due to being too expensive to produce. It was until then there was a way to have cheap electricity that aluminum could be produced at such a low cost. Before this it was worth as much as gold and Louis actually served his guest on aluminum plates because it was so rare.

There are almost no limits to the uses of aluminum, especially its alloys. These alloys (which are usually a compound of copper or silicon) are as strong as steel but half the weight giving it twice the specific strength. Aluminum also has the ability to be molded into any shape which is why it can be used in any industrial setting.
What are the enabling properties of the material?
Clay is very abundant and for that reason can be used in many things. Its relative abundance also translates to its cost, which is low and also lends the material to widespread usage. Because clay is very small particles suspended in water it is also available to almost everyone versus other materials that have cost and or geographical constraints. Clay has a very high plasticity when mixed with water which can lead to many applications. The unique property of clay is that it can be heated and transformed into a ceramic. Ceramics are impervious to water which is an important property if it is used in functional pieces. Also the insulator and porous properties lead to clay being able to absorb. Lastly clay can become very brittle once it has been fired.

What other processes does the material enable (how is the material entangled)?
Because of clays many properties it is a very important material in processing, manufacturing and waste reduction. In industrial processing clay is used to make paper and cement. Two very important products that we have also talked about this year. The impermeability of clay to water may be one of its most important properties because it enables the usage of clay in the natural sealing. Theses seals are important to dams and also to the protection of the ground from landfill seepage. Lastly, clay has a relatively high absorption due to its porous structure. This helps clay be entangled to many processes that society depends heavily on, such as the removal of heavy metals from water and the purification of air. Without the use of clay in these applications society would be impacted heavily, especially in the area of pollution.

To what extent is processing a part of the materials impact?
Clay as a material is a fine-grained soil suspended in water due to how small the particles are. When mixed with water these particles form clay and from there it can be used in many different things, i.e. building, medicinal practice and cooking. However most times it must be fired to create a tough structure that is impervious to water. The creation of things with clay is very personal to me in the way that it is used in ceramics. I have been throwing and hand building pottery for over two years. The processing of clay comes into effect in the way I work with it. Without a potter a piece of clay will never become a functional piece or even an artistic piece. The clay uses me to become something that can be functional, I spend time and energy transforming clay into shapes that are useable and then firing the clay. In return I use the clay to create pieces that myself and others can use, pieces that are artwork and also to relax.

To what extent is our relationship with the material?
Ceramic pieces are often functional ware. We use then to cook, to eat off of and to drink out off. We all must eat and our dependence on dining ware such as plates, cups and bowls is evident in our society. Because clay is the main materials in such utensils we depend heavily on it and since eating is such an essential part of everyday life we are entangled with clay in a very important way. Even when we are not eating off of ceramic ware, it is often used in cook ware such as Dutch ovens or in nonstick pans. Dating back to the civilization of Çatalhöyük clay balls were used in cooking to heat food.

Poster By: [Redacted]