Chapter 1 : blog.quintoapp.com - plastic

This book shows the relationship between processing parameters and product performance by examining morphology in terms of texture and orientation. The structure and characterization, thermal and melt properties, shaping methods, and deformation and fracture are explained.

May 3, by Friedrich Widdel, Max Planck Society Each day, we produce enormous amounts of rubbish, and a large part of it consists of plastic. This very durable material ends up in our oceans. This is not without consequences for our oceans and its inhabitants. Bottles, bags, packaging and technical molded parts made of plastic are lightweight and resistant to water and decay. While such qualities are highly valued during usage, it is a different story when it comes to depositing plastic refuse in the environment. Here, the blessing of durability becomes the curse of imperishability. At first glance, the problem simply appears to be one of an aesthetic nature. Because as ugly and dirty yet colorful heaps of plastic may be, plastic itself is non-toxic. The graver aspects of our plastic world only become apparent upon closer inspection â€" aquatic species that perish in nooses made of plastic waste or fish that ingest the tiniest plastic fragments, which could then be fed back into the human food chain. Evidence suggests, for example, that plastic softening agents could have a harmful long-term effect on fertility. And the impact of plastic refuse on an organism when it decays into tiny particles has yet to be established. Whereas microorganisms, such as bacteria and fungi, are sometimes used to break down toxic substances in the environment, such as petroleum, plastic refuse has yet to be successfully disposed of. All decay-inducing organisms reach their limits with plastic; otherwise the material would not be so durable. This is easily explained from a chemical perspective. All plastic materials are polymers, chemically-speaking. Polymers consist of very long chains of molecular units which in turn consist of carbon as the defining element. This is almost always combined with hydrogen. Other elements include nitrogen and oxygen and in exceptional cases also fluorine and chlorine. The long molecular chains ensure the polymers are strong and durable and do not decompose in water. Polymers can also be extremely flexible and pliable, a valuable property not provided by mineral materials, such as clay and limestone, and only to a limited extent by metals. Polymers are not a human invention. Wherever robustness and shape retention but also toughness and flexibility are found in living organisms, this is down to natural polymers. Cellulose, a fibrous material made of sugar components, provides plants with their stability. Collagens and keratin are highly stable proteins â€" in other words, chains of amino acids â€" that give the skin or hair and bird feathers their stability. Perishable and non-perishable polymers However, neither cellulose nor keratin last forever. Outside of the living organism or after its death, these polymers are slowly decomposed by bacteria and fungi, i. A principle known as microbial infallibility becomes evident during this natural recycling process. For every substance formed by living organisms, there is at least one type of microorganism in nature which can break it down. However, plastics are not broken down in nature. Their chemical structure is foreign to nature and the principle of microbial infallibility does not apply here. Several synthetic chemicals, such as detergents from washing-up liquid or insecticides, can clearly be broken down by microorganisms albeit slowly. Degradability, despite being "foreign" to nature, is often explained by the fact that the chemical structure of artificial substances is similar to that of natural ones and is therefore attacked by degrading enzymes that have existed for a long time or have adapted through random mutation. So far there has been no indication of such degrading enzymes working on plastics. The enormous length of the chains probably presents a problem. If, for example, the polyethylene chain was significantly shortened, a petroleum hydrocarbon would be produced, an alkane which could easily be decomposed by oil-eating bacteria. The ideal plastic material â€" one which remains durable during usage but decomposes after disposal â€" remains a utopic dream. Biodegradable plastic does exist though â€" these are polymers made up of microorganisms or polymers produced synthetically but which contain natural substances as components, such as polylactic acids. Polyhydroxyalkanoic acids are polymers made of microbes. They act as stored nutrients for microorganisms in times of food shortages and lie in the bacterial cells as compact little balls. These stored foods often possess very favorable technical properties. They are ideal for transparencies, bags and bottles. However, they are

more expensive than purely synthetic plastics and cannot be used where resilience to decomposition is required. What next for plastic? The best way to dispose of plastic is still complete combustion at the moment. The energy value of most plastics is as high as that of oil and it therefore produces significant amounts of useful heat. If the plastic material only consists of carbon, hydrogen and oxygen, only carbon-dioxide and water vapor are produced. The complete combustion of nitrogen-containing plastics would probably not present a problem either because only nitrogen gas would be generated in addition. Surplus atmospheric oxygen and high temperatures are required to ensure effective controlling of the combustion process. However, if there is not enough oxygen and the temperature is too low, the plastic cokes into black carbon and other hazardous products. They do not burn on their own or burn poorly, but produce fluorine or chlorine compounds in heat in the presence of burnable substances and can even emit chlorine gas. Special procedures are required here during which the products must be further transformed or bonded. The simplest and most cost-effective way of stemming the flow of refuse into the oceans is obvious â€" restrict consumption and increase the recycling rate. Plastic which is not disposed of in the environment in the first place does not have to be laboriously broken down or collected later.

Chapter 2 : Elasticity â€" The Physics Hypertextbook

The basic structure of plastics is explained, along with the characterization of both polymer and plastics products. Thermal and melt properties relevant to processing are considered, and the principal shaping methods are outlined, highlighting the large number of variables.

Comparative Tracking Index Additives Blended into most plastics are additional organic or inorganic compounds. The average content of additives is a few percent. Many of the controversies associated with plastics actually relate to the additives: Stabilizers Polymer stabilizers prolong the lifetime of the polymer by suppressing degradation that results from UV-light, oxidation, and other phenomena. Typical stabilizers thus absorb UV light or function as antioxidants. Fillers Many plastics[citation needed] contain fillers , to improve performance or reduce production costs. Dioctyl phthalate is the most common plasticizer. Colorants Colorants are another common additive, though their weight contribution is small. Toxicity Pure plastics have low toxicity due to their insolubility in water and because they are biochemically inert, due to a large molecular weight. Plastic products contain a variety of additives, some of which can be toxic. For example, plasticizers like adipates and phthalates are often added to brittle plastics like polyvinyl chloride to make them pliable enough for use in food packaging, toys , and many other items. Traces of these compounds can leach out of the product. Some compounds leaching from polystyrene food containers have been proposed to interfere with hormone functions and are suspected human carcinogens. In some cases, small amounts of those chemicals can remain trapped in the product unless suitable processing is employed. In , it was reported that "almost all plastic products" sampled released chemicals with estrogenic activity, although the researchers identified plastics which did not leach chemicals with estrogenic activity. The European Union has a permanent ban on the use of phthalates in toys. In , the United States government banned certain types of phthalates commonly used in plastic. Plastic pollution , Marine debris , and Great Pacific garbage patch Most plastics are durable and degrade very slowly, as their chemical structure renders them resistant to many natural processes of degradation. There are differing estimates of how much plastic waste has been produced in the last century. By one estimate, one billion tons of plastic waste have been discarded since the s. The presence of plastics, particularly microplastics , within the food chain is increasing. In the s microplastics were observed in the guts of seabirds, and since then have been found in increasing concentrations. Climate change The effect of plastics on global warming is mixed. Plastics are generally made from petroleum. If the plastic is incinerated, it increases carbon emissions; if it is placed in a landfill, it becomes a carbon sink [40] although biodegradable plastics have caused methane emissions. Producing silicon and semiconductors for modern electronic equipment is even more energy consuming: The problem occurs because the heat content of the waste stream varies. Pyrolytic disposal Plastics can be pyrolyzed into hydrocarbon fuels, since plastics include hydrogen and carbon. One kilogram of waste plastic produces roughly a liter of hydrocarbon. Depending on their chemical composition, plastics and resins have varying properties related to contaminant absorption and adsorption. Polymer degradation takes much longer as a result of saline environments and the cooling effect of the sea. These factors contribute to the persistence of plastic debris in certain environments. However, due to the increased volume of plastics in the ocean, decomposition has slowed down. It is estimated that a foam plastic cup will take 50 years, a plastic beverage holder will take years, a disposable nappy will take years, and fishing line will take years to degrade. In a team of Japanese scientists studying ponds containing waste water from a nylon factory, discovered a strain of Flavobacterium that digested certain byproducts of nylon 6 manufacture, such as the linear dimer of 6-aminohexanoate. Pre-exposure of the plastic to ultraviolet radiation broke chemical bonds and aided biodegradation; the longer the period of UV exposure, the greater the promotion of the degradation. Plastic eating microbes also have been found in landfills. One such house was found to be harmfully degraded by Cyanobacteria and Archaea. Plastic recycling Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, although the purity of the material tends to degrade with each reuse cycle. There are methods by which plastics can be broken down to a feedstock state. The greatest challenge to the recycling of plastics is the difficulty of automating the sorting of

plastic wastes, making it labor-intensive. Typically, workers sort the plastic by looking at the resin identification code, although common containers like soda bottles can be sorted from memory. Typically, the caps for PETE bottles are made from a different kind of plastic which is not recyclable, which presents additional problems for the sorting process. Other recyclable materials such as metals are easier to process mechanically. However, new processes of mechanical sorting are being developed to increase the capacity and efficiency of plastic recycling. While containers are usually made from a single type and color of plastic, making them relatively easy to sort, a consumer product like a cellular phone may have many small parts consisting of over a dozen different types and colors of plastics. In such cases, the resources it would take to separate the plastics far exceed their value and the item is discarded. However, developments are taking place in the field of active disassembly , which may result in more product components being reused or recycled. Recycling certain types of plastics can be unprofitable as well. For example, polystyrene is rarely recycled because the process is usually not cost effective. These unrecycled wastes are typically disposed of in landfills , incinerated or used to produce electricity at waste-to-energy plants. An early success in the recycling of plastics is Vinyloop , an industrial process to separate PVC from other materials through dissolution, filtration and separation of contaminants. A solvent is used in a closed loop to elute PVC from the waste. This makes it possible to recycle composite PVC waste, which is normally incinerated or put in a landfill. The global warming potential is 39 percent lower. This is why the use of recycled material leads to a significantly better ecological outcome. Society of the Plastics Industry devised a now-familiar scheme to mark plastic bottles by plastic type. Under this scheme, a plastic container is marked with a triangle of three " chasing arrows ", which encloses a number denoting the plastic type:

Chapter 3 : Physics of plastics - 7 pdf files | Past Papers Archive

When you wander around the internet, sometimes you can find some crazy stuff. Check this out: It's an old account of a weird phenomena created by giant plastic sheets at 3M blog.quintoapp.com short.

Physical mechanisms[edit] Plasticity under a spherical Nanoindenter in Copper. All particles in ideal lattice positions are omitted and the color code refers to the von Mises stress field. Plasticity in metals[edit] Plasticity in a crystal of pure metal is primarily caused by two modes of deformation in the crystal lattice: Slip is a shear deformation which moves the atoms through many interatomic distances relative to their initial positions. Twinning is the plastic deformation which takes place along two planes due to a set of forces applied to a given metal piece. Most metals show more plasticity when hot than when cold. Lead shows sufficient plasticity at room temperature, while cast iron does not possess sufficient plasticity for any forging operation even when hot. This property is of importance in forming, shaping and extruding operations on metals. Most metals are rendered plastic by heating and hence shaped hot. Planes may slip past each other along their close-packed directions, as is shown on the slip systems page. The result is a permanent change of shape within the crystal and plastic deformation. The presence of dislocations increases the likelihood of planes. Reversible plasticity[edit] On the nanoscale the primary plastic deformation in simple face centered cubic metals is reversible, as long as there is no material transport in form of cross-glide. When this happens, plasticity is localized to particular regions in the material. For crystals, these regions of localized plasticity are called shear bands. Plasticity in amorphous materials[edit] Crazing[edit] In amorphous materials, the discussion of "dislocations" is inapplicable, since the entire material lacks long range order. These materials can still undergo plastic deformation. Since amorphous materials, like polymers, are not well-ordered, they contain a large amount of free volume, or wasted space. Pulling these materials in tension opens up these regions and can give materials a hazy appearance. This haziness is the result of crazing , where fibrils are formed within the material in regions of high hydrostatic stress. The material may go from an ordered appearance to a "crazy" pattern of strain and stretch marks. Plasticity in martensitic materials[edit] Some materials, especially those prone to Martensitic transformations, deform in ways that are not well described by the classic theories of plasticity and elasticity. One of the best-known examples of this is nitinol , which exhibits pseudoelasticity: In the case of iron, the martensitic phase transformation from bcc to hcp phases induces significant work hardening. This applies to open cell foams where the bending moment is exerted on the cell walls. The foams can be made of any material with a plastic yield point which includes rigid polymers and metals. This method of modeling the foam as beams is only valid if the ratio of the density of the foam to the density of the matter is less than 0. This is because beams yield axially instead of bending. In closed cell foams, the yield strength is increased if the material is under tension because of the membrane that spans the face of the cells. Plasticity in soils and sand[edit] Main article: The causes of plasticity in soils can be quite complex and are strongly dependent on the microstructure , chemical composition, and water content. Plastic behavior in soils is caused primarily by the rearrangement of clusters of adjacent grains. Plasticity in rocks and concrete[edit] Main article: At high temperatures and pressures, plastic behavior can also be affected by the motion of dislocations in individual grains in the microstructure. Mathematical descriptions of plasticity[edit] Deformation theory[edit] An idealized uniaxial stress-strain curve showing elastic and plastic deformation regimes for the deformation theory of plasticity There are several mathematical descriptions of plasticity. Although this description is accurate when a small part of matter is subjected to increasing loading such as strain loading , this theory cannot account for irreversibility. Ductile materials can sustain large plastic deformations without fracture. However, even ductile metals will fracture when the strain becomes large enough - this is as a result of work hardening of the material, which causes it to become brittle. Heat treatment such as annealing can restore the ductility of a worked piece, so that shaping can continue. Flow plasticity theory[edit] Main article: Flow plasticity theory In , Egon Orowan , Michael Polanyi and Geoffrey Ingram Taylor , roughly simultaneously, realized that the plastic deformation of ductile materials could be explained in terms of the theory of dislocations. The more correct mathematical theory of plasticity, flow plasticity

theory , uses a set of non-linear, non-integrable equations to describe the set of changes on strain and stress with respect to a previous state and a small increase of deformation.

Chapter 4 : Plastics and the curse of durability

Physics of plastic deformation tic deformations, of course, the rotation effect and the associated spin is the essence of the theory, and the subject is considered in detail in the next section. On returning to (14) we view it along with (13) and (12) as the basic vehicle for accom- plishing the micro-macro transition.

Microcrack Model This model says that microcracks cause bonds to break sequentially rather than simultaneously. The diagram shows that a microcrack involves pre-existing broken bonds along a partial plane of atoms. An applied stress is not felt by the broken bonds and it is transferred to the first available bond. Microcracks thus create a stress concentration because the bond at the crack tip has to take up the stresses blue lines from the broken bonds. As shown, the bond at the tip is stretched by the stress concentration and is at the point of breaking. When it breaks, the stresses are passed to the next bond further increasing the concentration of stress, and so once started, the crack will run through the material causing it to break apart. Theory for the elliptical crack A microcrack can be modelled in cross-section as an ellipse. This gives a calculation for the stress concentration factor. The diagram shows half an ellipse with a semi-major axis "c" and semi-minor axis "d". It can be shown in another course from the geometry that the stress at the crack tip is given by: Now the effective radius at the elliptical tip is: The stress concentration depends directly on the square root of the length of the crack, and depends inversely on the square root of the radius of the crack. The stress concentration increases with the length of the crack decrease of the crack tip radius For brittle materials the radius at the crack tip is equal to the interatomic separation so microcracks are especially dangerous. Example S9 GaAs is a brittle material that forms a cubic zinc sulphide crystal structure. If the lattice constant, a, for GaAs is 0. The unit cube has lengths, a, along each side. The stress concentration is given by A crack of length of 8. This would multiply the applied stress by 12 times. As illustrated in the middle graph there is: After the yield point, there is permanent slippage, i. The slippage becomes extensive in the easy glide region. Then there is resistance to slip as slip planes and defects tangle. This is called "work hardening" because the material stiffens up. Multiple slipping planes in 3D around the axis, causes necking, as shown on the right. Ductile rupture happens soon after necking. Any model for plastic yield will involve shear slipping. Homogeneous shear model This model says that all the atoms along a slip plane are pushed simultaneously to the critical shear strain. Assume for convenience that the atoms are close packed hard spheres each with the same diameter, b. As seen in cross-section the atoms form equilateral triangles. If the atoms are pushed past the critical point, shown on the far right, then they will all fall into the next valley and there is irreversible change. In the critical shear strain position the atom planes are now a distance b apart. Shear strain and normal strain can be calculated for this situation. The table below shows measured critical stresses and strains. Notice that the critical strains are already given in percentages.

Chapter 5 : Plastic dictionary definition | plastic defined

While an older () technical reference, this book is very high quality with lots of useful information on plastics properties and manufacturing methods. It is written for materials and manufacturing engineers.

It is one of the most measured parameters and often reported on technical data sheets of plastics and rubbers. Hardness of ductile materials is essentially a measure of their plastic properties. In the case of yield and tensile strength, a more or less linear correlation between hardness and mechanical strength is often observed see Figure below. However, the hardness of a material is not always a good predictor of other properties such as strength or resistance to scratches, abrasion, or wear, and therefore, should not be used alone for product design. For example, at low hardness or strength levels, it is expected that the two quantities have a nonlinear correlation. The hardness of plastics and rubbers is often measured by the Rockwell or Shore durometer hardness methods. Both methods provide an empirical hardness value, which do not necessarily correlate with other physical properties. The Rockwell hardness is usually chosen for "harder" materials such as steel, polycarbonate, polystyrene, polymethacrylates and acetal where the creep of the polymer has a lesser effect on the result, whereas the Shore durometer is often preferred for softer materials, such as soft polymers, elastomers, and rubbers. First, a small preload is applied, and the apparatus is zeroed, then a larger load is applied and removed. After a short time with the preload still applied, the remaining indentation is read from the scale. In the case of Shore hardness, a spring-loaded needle is placed against the rubber or plastic and pressure is applied. The depth of indentation not only depends on the hardness of the material but also on its viscoelastic properties, the shape of the indenter, and the duration of the test. There are several Shore hardness scales for measuring the hardness of different materials. The most frequently used scales are Shore A and Shore D. The Shore A scale measures rubbers and gels that are very soft. Some semi-rigid plastics can also be measured on the high end of the Shore A scale. The shore D hardness scale measures the hardness of hard rubbers, semi-rigid plastics and hard plastics. The Rockwell hardness scales use different size steel balls and different loads. The three most common scales used for plastics are Rockwell E, M, and R; other Rockwell hardness scales are used for metals, with Rockwell A, B, and C being the three most common scales. The correlation between the different Rockwell scales used for plastics is rather poor and, therefore, conversion between the scales is discouraged, that is, both the geometry of the indentor and the applied force influence the measurements. Relationship between Strength and Hardness of Amorphous Polymers.

Chapter 6 : Physics of Plastics - Hanser Publications

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

Chapter 7 : Lecture Notes | Polymer Physics | Materials Science and Engineering | MIT OpenCourseWare

This book shows the relationship between processing parameters and product performance by examining morphology in terms of texture and orientation.

Chapter 8 : Plasticity | physics | blog.quintoapp.com

Physics for Civil Engineering. This is an introduction to Electricity, Strength of Materials and Waves. Lecture 12 (Brittle and Plastic Failure).

Chapter 9 : Plasticity (physics) - Wikipedia

A pleasure boat made in plastic in the form of a Swan. Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects.