Application of nanotechnology in food packaging pdf

Nanotechnology is one of the most promising scientific fields of research in recent decades; it could revolutionize the global food system. The demand for safe food products is a major challenge for the food packaging industry with the idea of developing and producing new packaging solutions that can maintain the safety and quality of products. This chapter discusses some of the most pressing applications and problems of nanotechnology in food packaging, including nanocomposites, which enhance the barrier properties of packaging film, nanoparticles as powerful antimicrobials, controlled delivery nanosystems, and nanomanships and nanoacterial analyses to detect food-related analytes (small organic molecules). Problems in assessing risks and safety in food research were also highlighted. As nanotechnology is still a relatively new technology, there are security issues that draw attention to international norms to make it safer for industry and consumers to adopt the tool. The download background work of the entry of PDFNanotechnology has evolved into an interdisciplinary field of applied science and technology. Nanotechnology is the ability to work on a scale of 1 to 100 nm to understand, create, characterize and use material structures, devices and systems with new properties derived from their nanostructures. Because of their size, nanoparticles have a proportionately larger surface area and therefore more surface atoms than their micro-scale counterpart. In the nanoscale range, materials can represent a variety of electronic properties, which in turn affects its optical, catalytic and other reactive properties. Nanotechnology currently uses two construction strategies: the top-down approach and the bottom-up approach. Commercial nanomaterial production now involves a largely top-down approach, in which nanometric structures are derived from reducing the size of bulk materials through milling, nanolithography or precision engineering. Size usually refers to the functionality of food materials, smaller sizes, meaning a large surface area, preferably for several purposes. On the other hand, the newer bottom-up approach allows the construction of nanostructures from individual atoms or molecules capable of self-assembly. Self-flowering relies on balancing the pull and repulsion of forces between a pair of building block molecules to form more functional supramolecular structures. Currently, most of the materials used for food packaging are virtually undegradable, which is a serious global Problem. New bio-materials have been used to develop edible and biodegradable films as a great effort to extend shelf life and improve the quality of food while reducing the reduction Waste. However, the use of edible and biodegradable polymers has been limited due to performance problems (such as fragility, bad gas and vlagobar), processing (e.g. low heat distortion temperature) and cost. Several composites have been developed by adding strengthening compounds to polymers to enhance their thermal, mechanical and barrier properties. Most of these arm materials represent such poor interactions at the junction of both components. Macroscopic strengthening components usually contain defects that become less important because the particles of the strengthening component are smaller. Polymer composites are blends of polymers with inorganic or organic fillers with a certain geometry (fibers, flakes, spheres, particulate matter). The use of fillers that have at least one dimension in the nanometric range (nanoparticles) produces polymer nanocomposites (PNC). There are three types of fillers, depending on how many measurements are in the nanometric range. The nanoparticles of measurements, such as spherical silica nanoparticles or semiconductor nanoclusters, have three nanometric measurements. Nanotubes or moustaches are elongated structures in which two measurements are at the nanometer scale and the third is larger. When only one dimension is in the nanometer range, composites are known as polymer-layered crystal nanocomposites, almost exclusively obtained by intercaling of the polymer (or monomer subsequently polymerized) inside the galleries of the host's layered crystals. The uniform scattering of nanoparticles leads to a very large matrix/filler of the interfacial region, which changes molecular mobility, relaxation behavior, and subsequent thermal and mechanical properties of the material. Fillers with a high ratio of the greatest to the slightest dimension (i.e. the ratio of the sides) are particularly interesting because of their high specific surface area, providing better enhance effects. In addition to the effects of the nano-forces themselves, the interphase area of altered mobility surrounding each nanoparticle is induced by well-dispersed nanoparticles, which leads to the seepage of the interphase network in the composite and plays an important role in improving nanocomposite properties. In addition to strengthening nanoparticles, whose main role is to improve the mechanical and barrier properties of packaging materials, there are several types of nanostructures responsible for other functions, sometimes providing active or smart properties of the packaging system, such as antimicrobial activity, immobilization of fermentation, and biosensivity. Functional nanomaterials can extend shelf life, reduce the demand for preservatives and provide sanitary surfaces that are easy to clean and can hinder accumulation or formation Antimicrobial packaging is the most common Nanomaterials. As a simple passive barrier, antimicrobial packaging can reduce the growth of harmful microbes. The inclusion of nanomaterials in the packaging materials of the capsule will provide a light, durable and low-yielding nanocomposite gas, contributing to the quality of food by extending the shelf life, preserving taste and aroma and reducing contact with microorganisms. Encapsulation of products in packaging materials is necessary for transportation, protection, labeling and advertising. In recent years, nanotechnology has found countless applications in the food industry. Food encapsulation requires protection, resistance to falsification and special physical, chemical or biological needs. Packaging encapsulation is essential for preserving food to make them safe and marketable. Innovations in food encapsulation packaging can lead to quality packaging and show consumers a friendly approach in determining shelf life, biodegradable period and other information. Nanotechnology has been used to produce stronger and lighter materials, improve biodegradability or recyclables, incorporate sensors or indicators for consumer information, or for traceability or authentication (product safety to avoid fraud). Nanotechnology may also pose new risks as a result of their new properties using a wide range of nanomaterials (NM), and many of them may well be harmless; however, others may pose a risk to human health. Many countries recognize the need for food safety for nanomaterials, existing limited data and information on their possible health effects. For this reason, numerous nanotechnology initiatives, commissions or centres have been launched by governments, academia and the private sector around the world to ensure the rapid development of nanotechnology, promote economic growth, maintain global competitiveness and enhance innovation potential. Overall though, these new technologies, if managed and regulated correctly, can play an important role in improving the global food system for the benefit of human health and well-being. This chapter will lead to a final, comprehensive assessment of existing and upcoming applications of nanotechnology in the food packaging sector. Nanostructured materials have unique physical and chemical properties that open up opportunities to create new and high-performance materials that will have a decisive impact on food packaging and storage. The most studied nanoparticles will be presented in accordance with their main functions/apps in food packaging systems. Some may have multiple applications, and sometimes applications may overlap, such as some immobilized enzymes that may act as antimicrobial components, oxygen scavengers and/or biosensors. However, trends in food packaging The following basic applications (Figure 1): (1) Nanoreinforcement: the presence of nanoparticles in the polymer matrix can significantly enhance the properties of packaging (flexibility, gas barrier properties, temperature/moisture stability) and thereby improve the shelf life of packaged foods; (2) Active food nanosystem packaging: the presence of nanoparticles allows packaging to interact with food and the environment and play a dynamic role in food conservation; (3) Intelligent food nanosystem packaging: includes the presence of nanodevices in a polymer matrix designed to probe biochemical or microbial changes in food and/or monitor the environment surrounding food. They can also act as protection against fraudulent imitation.Fig. 1 Trends in food packaging using nanotechnology Ability to improve the characteristics of polymers for food packaging by adding nanoparticles led to the development of various polymer nanomaterials. Nanoreinforcement techniques are used to improve viability and durability by filling gaps in packaging materials. This has led to the development of various nanoparticles of reinforced polymers, also called nanocomposites, which usually contain up to 5% of the w/ in nanoparticles. The improved barrier properties of most polymer nanocomposites use improved peat diffusion or gas permeation. These wall-like nanocomposites cause gases to pass longer paths to dissipate through the coatings. The presence of nanoparticles with high side ratios in the package drastically reduces the rate of transmission of gases such as oxygen, carbon dioxide and water vapor crossing the packets. The nanoparticles within the polymer nanocomposites can also bring many active areas with better amplifying effects. In addition, the variety or change in the size and quantity of nanoparticles per unit of polymer volume will have a significant impact on the properties of polymers. Although several nanoparticles have been recognized as possible additives to improve the performance of polymers, the packaging industry has focused mainly on layered inorganic solids such as clay and silicates, due to their availability, low cost, significant improvements and relative simplicity of processability. Polymers, which include clay nanoparticles, are among the first polymer nanomaterials to be marketed as improved materials for food packaging. Several different polymers and clay fillers can be used to produce clay-polymer nanomaterials. Nanoclay is commonly used by Montmorioritis (MMT), which is a relatively cheap and widely available natural clay derived from volcanic ash/rocks. When well dispersed in the matrix, the clay limits gases and provides significant improvement mainly in the properties of the barrier gas barrier The homogeneous scattering of most clays in organic polymers is not so easy because of its hydrophilic surface. Organocly, products from interactions between clay minerals and organic compounds, have found important applications in polymer nanocomposites. Organocly is cheaper than most other nanomaterials because they come from readily available natural sources and are produced at existing full-scale production facilities. Organontmorionitis (oMMT) was produced, for example, by exchanging inorganic MMT ions with organic ammonium ions, improving MMT compatibility with organic polymers, leading to more regular layering in structures, and reducing water absorption by nanocomposite. These improvements have led to the development of nanoclay polymer nanomaterials for potential use in various food packages, such as processed meat, cheese, confectionery, cereals, boiling products in a package, as well as in extrusio coatings for fruit juices and dairy products, or joint extrusion processes for the production of beer bottles and carbonated beverages. Many studies have reported the effectiveness of nanoclai in reducing the permeability of oxygen and water vapor of several polymers. Silnesem nanoparticles (nSiO2) have been reported to improve the mechanical and/or barrier properties of several polymer matrixes. Wu et al. (19) noted that the addition of nSiO2 to the polypropylene (PP) matrix improved the strained properties of the material - not only strength and module, but also elongation. Improvements in strenuous properties, again including lengthening, resulting in the addition of nSiO2 have also been reported for the starch matrix and starch/polyvinyl alcohol matrix. It has been found that SiO2 can form a winding pathway for gases when used as nanofillers in food packaging. SiO2 nanofillers can also improve the strained property of nanocomposite films. Carbon nanotubes (CST) can consist of a single-stone single-wall nanotubes (SWNT) or a number of concentric tubes called multi-wall nanotubes (MWNT), which have extremely high side ratios and an elastic module. Kim et al modified ant by injecting carboxic acid groups on their surfaces to improve their intermolecular interaction with poly (ethylene-2.6-moth) (PEN). The CNS, even in concentrations of up to 0.1 W.), significantly improved thermal stability, as well as the traction strength and module PEN. Other polymers have been found to have improved their strength/module by adding ANT, such as PVOH, polypropylene and polyamide. Cellulose, the building material of long fibrous cells, is a very strong natural polymer. Cellulose nano-ophibers are inherently inexpensive and widely available material. They are also environmentally friendly and light when burned and require low energy consumption in the manufacturing industry. All this makes cellulose nanosuits an attractive class of nanomaterials for the development of inexpensive, light and highly appropriate nanocomposites. Cellulose nanoreinforcements are reported to have a big impact in improving polymer matrix modules (27, 28). Currently, nanoscale clay is the most common commercial application of nanoparticles and accounts for almost 70% of the market volume. The industrial use of nanoclai in multi-layered film packaging includes beer bottles, fizzy drinks and thermo-formed containers. Nanoclays embedded in plastic bottles and nylon food films tighten packaging and reduce the permeability of gas keeping oxygen-sensitive products fresher and extend the shelf life. Bayer polymers have created an inexpensive nanoclay composite interior coating for cardboard cardboard cardboard to keep the juice fresher. PET beer bottles using nanoclay produced by NanocorR are distributed by ColorMatrix. Beer storage time in regular PET bottles is about 11 weeks and increases to about 30 weeks when the nanoclay barrier is used. Nanocomposite films enriched with silicate nanoparticles or nanocrystals have elevated barrier properties and can be used for plastic beer bottles (e.g. Nanocor®), which were reported in the US last year but not yet in the EU. In addition, cellulose nanopowers have proven to be an alternative to the preparation of inexpensive, light and highly appropriate nanocomposites. Active packaging is designed to intentionally incorporate components that will release or absorb substances in or out of packaged food or the environment surrounding food. Unlike conventional food packaging, active food packaging can not only act as a passive barrier, but also interact with food in some desirable ways, such as releasing desirable compounds such as antimicrobial or antioxidant agents, or by removing certain harmful factors (such as oxygen or water vapor). The effects of such interactions are usually associated with improved shelf life or sensory characteristics of food. Antimicrobial nanosystems can be divided into two groups according to their mechanism of action: where antimicrobials are released from nanocapsule into the head space of the package to interact with the product surface (Figure 2a); and where the antimicrobial compound is immobilized on the surface of the packaging using nanocomposite materials (Figure 2b) .fig. 2 (a) Controlled release of nanosystems of antimicrobial compounds caused using various stimuli and included in the grocery package. (b) Immobilized antimicrobials with Nanocomposite materials; Direct contact between pathogens and nanosystem is necessary for action These systems are used to develop active packaging in the form of sachets or active plastic film films nanocapsules, which are enclosed in the interior of the packaging. They can be divided into two groups: indirect and direct antimicrobial activity. Nanosystems with indirect antimicrobial activity include oxygen and moisture scavengers, ethylene removal and carbon dioxide sinks/emitters. They are considered indirect antimicrobial agents because, although their main activity is to reduce damage due to ensimatic deteriorating reactions and changes in the internal atmosphere (reduced oxygen and moisture), they inhibit the growth of aerobic bacteria. Several nanoparticles, including TiO2 nanoparticles, were used to produce the scavenger's oxygen films. Some silver-based nanoparticles, which have antimicrobial activity, are also able to absorb and decompose ethylene. Removing ethylene from the packaging environment helps to extend the shelf life of fresh foods such as fruits and vegetables. Head artifacts with direct antimicrobial activity include antimicrobial volatile compounds such as metals and essential oils. Cyclodextrin-ether oil nanocapsule, which was used as a nanosystem of the head space to increase the shelf life of freshly cut products was described by Ayala-Savala et al. Another type of artifact of active antimicrobial packaging is that in which the antimicrobial compound is embedded in the bulk polymer in the nanocaurites and must migrate to the surface in order to interact with microorganisms. Various natural and synthetic polymers have been used as carriers; several reviews on the subject have recently been published. Mono and multi-layered antimicrobial packages using this technology have been developed. Typical multi-layered films consist of four layers: the outer layer, the barrier layer, the matrix layer (which is embedded in the antimicrobial) and the control layer. Several organic and inorganic compounds have been used as antimicrobials, including silver zeolites, organic acids and their derivatives, peptides, enzymes, EOs, parabens, bacteriocins, and volatile compounds, among others. One of the main drawbacks of this type of packaging is that heat-sensitive compounds cannot be used because they are inactivated during packaging processing. An interesting option is the use of nanoencapsulation of active compounds in the case of heat-sensitive additives before the inclusion of polymer extrusion in the process. The controlled release of the active compound into the packaging space is governed by several factors that heat, pH, relative humidity (RH), enmeptic activity, and physical changes of host, guest, or package, among others. The impact of these factors to chemical interactions between host and guest, such as hydrogen communication, Van der Walls interactions and other non-covalent interactions that depend mainly on polarity, molecular weight, polydispersity and cross-bonding of the host molecule, as well as its ability to pass a reversible phase transition. Among these factors, relative humidity appears to be most important in the release of antimicrobial compounds (26, 38). The controlled release of antimicrobial compounds (volatile substances) into the head space can be analyzed taking into account the kinetic model of zero order or first order. Two mathematical models are used to describe these kinetic processes. First, it is the Power Act (Eq. 1), and secondly, the Avrami equation (Eq. 2), defined by: $$$$X'kt'n'mathrm-P' $$$$$$$$X'1-e'-'k'mathrm-A$$$, where X is part of the release of a nanoencapsulate antimicrobial compound at the time; k is a constant release rate; n P is a diffuse release option; and n A is an Avrami or release mechanism. In both models, when n No. 0.5, an active agent is released by a fictitious diffusion mechanism. However, when n No. 1, it describes a zero-order release model using the Power Law model (release, not subject to concentration) or the first-order release model when analyzing the Avrami model. Recently, Ho et al. (Ho et al.) reported that with low RH both models could describe the release of ethylene from beta-cyclodextrin; however, with high RH (93%), the Avrami model described the system better. Similar results were observed in essential oils and isotiocyanate encapsulated in cyclodextrins. : (1) diffusion of the active ingredient through the polymer packaging material; (2) erosion of the polymer material, causing the dispersal of the active ingredient into the food; and (3) swelling or moisturization of the polymer material. The most commonly used equation for analysis of controlled release through the diffusion process is the Higuchi (Eq. 3) equation, which describes the square root of time-release kinetics (9:$$$ X'sqrt-DC_m'left (2'C'_i-'C'_s'right)t' $$, where D is the diffusion coefficient of the active ingredient; C m is the solubility of the active ingredient in the encapsular matrix; C i is the initial concentration of the active ingredient; and C s is the solubility of the active ingredient in the exterior. Limiting the condition you need to use equation, is that a pseudo-sustainable state is achieved, achieved, it turns out only when the initial concentration is much higher than the external concentration. For hydrophilic active ingredients where swelling and erosion play an important role, the Power Law (Eq. 1) model is used to describe the release of antimicrobial compounds into food matrix. There are several examples of antimicrobial packs in which the antimicrobial compound was immobilized by nanoassemblis in polymer using ion or covalent bonds. In order to attach antimicrobials, it is necessary to have functional groups in both polymer and antimicrobials. The presence of a flexible linking group is also desirable in order to give more flexibility to antimicrobials and therefore to increase its antimicrobial effect. Metal nanoparticles, metal oxide nanomaterials and carbon nanotubes are the most commonly used nanoparticles for the development of antimicrobial active food packaging. These particles function in direct contact, but they can also migrate slowly and preferentially with the food matrix. Silver, gold and zinc nanoparticles are the most studied metal nanoparticles with antimicrobial function, with silver nanoparticles already found in several commercial applications (table 1). Silver, which has high temperature stability and low volatility at the nanoscale, is known to be an effective antifungal and antimicrobial drug and is known for its toxicity to an array of microorganisms. The antimicrobial activity of silver nanocomposite has been associated with several activities, including adhesion and cell surface rupture; degradation of lipopolisaccharides; Increased permeability and the binding of silver to groups of electron donors in biological molecules containing sulfur, oxygen or nitrogen. Silver nanocomposites were obtained by several researchers, and their effectiveness of antimicrobials was recorded (59, 60). Table 1 Representative examples of the use of nanocomposites in food packaging (copyright © 2015 Elsevier Ltd.) Silver nanoparticles are also used in conjunction with zeolite minerals and gold nanoparticles. The use of a combination of silver/zeolite and silver/gold produces a greater antibacterial effect than silver alone, although no commercial application has currently been found. It is also important to emphasize that titanium dioxide (TiO2), zinc oxide (SNO), silicon oxide (SiO2) and magnesium oxide (MgO) are among the most studied oxide nanoparticles for their ability to be UV blockers and photo-catalytic disinfectants. Nanoscal chitosan reportedly demonstrates antimicrobial activity due to electrostatic interactions between positively charged chitosan molecules and negatively charged cell membrane molecules, permeability of the membrane. However, due to its possible cytotoxicity, the inclusion of chitosan in food packaging materials has not yet been It has also been reported that carbon nanotubes have antibacterial properties; Direct contact with the aggregates of these structures has been shown to affect the survival of E. coli, possibly because long and thin nanotubes pierce microbial cells, causing irreversible damage and leakage of intracellular material. On the other hand, there are studies suggesting that carbon nanotubes can also be cytotoxic for human cells, at least in contact with the skin. Once present in the food packaging material, the nanotubes may eventually migrate to the food. Therefore, it is be sure to know any possible health effects of being hit by carbon nanotubes. The main inconvenience of this kind of active packaging is that to suppress the growth of microorganisms, direct contact between fresh products and polymer is necessary. In addition, nanomaterials can migrate to food in active packaging after they are present in food packaging materials. Due to poor packaging performance and the subsequent migration of nanomaterials from packaging, the reception of products previously in contact with nano-packaging may be the route of impact. Smart packaging technologies have been explored to allow food to be saved for as long as possible. Intelligent food packaging is mainly designed to monitor the condition of packaged foods or the environment surrounding food. Nanotechnology benefits food safety mainly through the development of highly sensitive and inexpensive nanosensors. Nanosensors can respond to environmental changes during storage (e.g. temperature, relative humidity and oxygen exposure), degradation products, or microbial contamination. Nanosensors integrated into food packaging systems can detect changes associated with at times pathogens and chemical pollutants, thereby eliminating the need for inaccurate shelf life and thereby ensuring real-time food freshness status. Not only is it useful for quality control so that consumers can purchase foods that are at the peak of freshness and taste, but also has the potential to improve food safety and reduce the incidence of foodborne diseases. Recent progress shows that the current segment of smart packaging is dominated by oxygen scavengers, moisture shock absorbers and barrier packaging products, which account for about 80% of the market. Nanosensors can help in the event of an increase in temperature or in the presence of micropores or seal defects in the packaging systems, which can expose food to unexpected levels of oxygen, leading to undesirable changes. In fact, because of the short quality assurance, bakery and meat products have used the most nano-enabled intelligent packaging technology to date. Some of the most commonly used nanosensors in the food industry are described in the following sections. Sections. Indicators (TTIs) are designed to monitor, record and translate food safety. This is especially important when food is stored in conditions not optimal. They fall into two categories: one relies on the migration of dye through a porous material, which depends on temperature and time, and the second uses a chemical reaction (initiated when applying the label to the packaging), which leads to a change in color. These indicators allow consumers to feel confident about what they are buying and manufacturers to trace their products along the supply line. Timestrip® has developed a system (iStrip) for refrigerated products, based on gold nanoparticles, which is red at temperatures above zero. Accidental freezing leads to irreversible agglomeration of gold nanoparticles, leading to the loss of red. Several types of gas sensors have been developed that can be used to quantify and/or identify microorganisms based on their gas emissions. The gas nanosensor of metal oxides is one of the most popular types of sensors due to their high sensitivity and stability. Recently, polymer nanosensors have been used, which can quantify and/or identify microorganisms based on their gas emissions. These materials contain conductive particles embedded in insulating polymer matrix. Sensors will respond to gases from microorganisms by changing resistance. A typical example is the use of gold nanoparticles, which included enzymes to detect microbes. Perilene-based nanofabribrillas have the ability to indicate the damage of fish and meat by detecting gasious amines. Nanocomposites nO and TiO2 can also be used to detect volatile organic compounds. There is growing interest in developing non-toxic and irreversible oxygen sensors to ensure the lack of oxygen in oxygen-free food packaging systems, such as vacuum or nitrogen packaging. Lee et al. developed a color-zymetric oxygen indicator with UV activation that uses TiO2 nanoparticles to photosensitize the reduction of methylene blue (MB) in a polymer encapsulation environment using UV-A light. After UV exposure the bleaching sensor and remains colorless until exposed to oxygen when its original blue color is restored. The speed at which color is restored is proportional to the level of oxygen exposure. Another O2 detection sensor is the nanocrystalline SnO2, used as a photosensitizer. The color of these detectors gradually changes in response to a small amount of oxygen. The ability to determine whether food is contaminated with various bacteria, fungi, viruses or toxins that can cause foodborne diseases remains purpose of the study. Taking advantage of the unique electrical, magnetic, fluorescent and catalytic properties of nanomaterials, nanomaterials, detection strategies are increasingly abandoning traditional microbiological analysis methods, preferring to use nanomaterials themselves as a means of detection. In this sense, faster, more sensitive and cost-effective diagnostic analyses are being developed to help combat microbial snarls. Recently, Ayala-Savala et al. published a review of nanosensors of germ growth. Electronic language technology consists of sensory arrays to signal the state of food. The device consists of an array of nanosensors, extremely sensitive to gases released as a result of the damage of microorganisms, which gives a change in color, which indicates whether the food is deteriorating. Such nanosensors can be placed directly in the packaging material, where they will serve as an electronic language or nose by detecting chemicals released during microbial growth in food. Carrying polymers have been used as detectors in electronic nasal nanosystems. When the gas is adsorbed by nanosensor, the conductive organic polymer sensors demonstrate a change in resistance that is felt and delivered as an outlet. Kraft Foods has developed an electronic microdiv as a language that can be embedded in food bags. This new device can change color to indicate whether food has deteriorated due to the damage of microorganisms, with an array of nanosensors sensitive to the gases emitted from these microorganisms. Self-cooling packaging, which uses a chemical or physical process, such as gas evaporation, to keep the temperature inside the packaging cool, thereby keeping the food fresh, has been developed using nanotechnology. In addition, chips can use a flexible or thinly filmed photovoltaic element to cool food with thermoelectric materials. The same principle can be used to heat the packaging on its own. This technology will reduce the need for large-scale and long-term refrigerated refrigerated in the supply chain, although it could lead to higher costs. Recently, fullerene nanotubes have been found to improve the effectiveness of self-harm. Carbon dioxide and nitrogen can be used as refrigerants held by fullerene nanotubes at pressure slightly above atmospheric pressure. Self-eating beverages and a food container have adopted this technology, driven by fullerene nanotubes (World Patent number 0073718). Some companies are making efforts to develop smart packaging in the field of self-harm and self-harm. Nestle their research on coffee can that self-heating, just shaking. Caldo Caldo, Italian branch, branch, pursues similar technology for products such as coffee, cappuccino, chocolate and tea. Self-cooling technology is successfully used in the market cooling beer keg with zeolite heat pumps and endothermic reactions between sodium thiosulfate pentagidrat and water (www.idspackaging.com). Intelligent packaging containing immobilized enzymes such as lactase or cholesterol radish can be used to develop foods that require certain enzyme treatments for customers suffering from high cholesterol or lactose intolerance. Nanoscale immobilization of the s system will have a much higher performance, as they will increase the available surface contact area and change the transmission of mass, probably the most important factors influencing the effectiveness of such systems. As with any new technology that brings significant benefits to humanity, there are risks of adverse and unintended consequences of nanotechnology. Small sizes and subsequent large surface areas of nanoparticles lead to new and specific properties, but also make them biologically more active, which leads to unexpected consequences for interaction with biological systems. The smaller size also gives different biokinetic behavior and the ability to reach more distical areas of the body. Pollution is also another problem. These concerns have raised concerns about the potential adverse effects of nanotechnology on human health and the environment. Many countries recognize the need for food safety for nanomaterials, existing limited data and information on their possible health effects. There are currently no internationally agreed research protocols or standards. Data on particle size is not required, and some common nanomaterials, such as nanoclai and metal oxides, may thus be sanctioned, although not exactly in nanoscale forms. In the United States and the EU, administrative bodies are primarily adapting to the regulation of nanotechnology in food. With regard to nanomaterials, in October 2011, the European Commission adopted the Nanomaterial Recommendation, based on the published scientific basis for defining the term nanomaterials, by the Scientific Committee on Emerging and Newly Identified Health Risks. In addition, the Nano Network was established in 2011 with the main goals of promoting harmonization of assessment methods, methodologies, and synergies in risk assessment activities. At the 2014 meeting, the Nano Network updating the results of toxicological studies related to the oral route of exposure. In addition, to inform consumers about the availability of engineering nanomaterials in the The EU is the only identified region to have adopted new legislation under which all ingredients present in the form of engineering nanomaterials must be clearly listed as ingredients. The names of such ingredients should be accompanied by the word nano in brackets. This regulation applies from December 13, 2014, and the obligation to provide nutritional information will be in effect from December 13, 2016 (Article 18 of Regulation (EU) No. 1169/2011). The U.S. Food and Drug Administration (FDA) is one of the first government agencies worldwide to have the definition of nanotechnology and nanoproducts. However, the FDA has not adopted a regulatory definition, but it has identified points for consideration when deciding whether the FDA-regulated product contains nanomaterials or otherwise includes the application of nanotechnology: (1) whether the engineered material or final product has at least one dimension in the nanoscash (approximately 1 nm to 100 nm) or (2) whether the engineered material or end product has at least one dimension in the nanoscasse (approximately 1 nm to 100 nm) or (2) whether the engineered material or end product has at least one dimension in the nanoscasse (approximately 1 nm to 100 nm) or (2) whether the engineered material or end product has at least one dimension in the nanoscasse (approximately 1 nm to 100 nm) or (2) whether the engineered material or end product has a single dimension in the nanoscasse (approximately 1 nm to 100 nm) or (2) whether the engineered material or end product has at least one dimension in the nanoscasseh (approximately 1 nm to 100 nm) or (2) whether the engineered material or the end product has a single dimension in the nanoscash(including the physical or chemical properties or biological effects associated with its measurement, even if these dimensions fall beyond the nano-scale range, to one micrometer. In 2014, the FDA issued a final guidelines paper on the use of nanotechnology in the food industry. The Final Food Guide warns manufacturers of the potential impact of any significant changes in the production process, including changes in nanotechnology to the safety and regulatory status of food substances. The guide also does not set regulatory definitions. Rather, it is designed to help the industry and others determine when they should consider the potential implications for regulatory status, safety, efficacy or public health impacts that may arise with the use of nanotechnology in FDA-regulated products. The FDA is working to develop the information needed to help it regulate nanomaterials in all of its programs effectively. The FDA's Nanotechnology Task Force, formed in August 2006, is tasked with identifying regulatory approaches that encourage the further development of innovative, safe and effective FDA-regulated products that use nanotechnology materials. Brazil, Mexico and Argentina are the main countries in the development of nanotechnology in Latin America, in terms of the number of research institutes established, infrastructure, the number of scientific and scientific publications, international conventions and the number of human resources working in this area. With regard to the normative status, in Brazil, under the Ministry of Science and Technology standardization is being formed to create an administration and a national nanotechnology system, as well as Nothing looks at safety. The goals, in particular, reveal Brazilian achievements in this area, partnership with other countries, and little is considered in aspects of the environment and social impact . In the case of Mexico, the Federal Government established a Working Group on Nanotechnology Regulations in 2011, in accordance with the requirements of policy makers, academics and industry representatives. The panel found that the Mexican legal framework already included a number of regulations useful as a first approach to nanotechnology. However, some specific issues had been identified that still needed further discussion and procedures, and the Federal Government had therefore prepared and finally adopted a number of guidelines. However, no specific legal changes are currently being developed, as the Guidelines are not subject to any problems and implementation mechanisms are not currently being developed. The challenges we face are enormous. In Argentina, the Ministry of Science and Technology has established nanotechnology as a priority for funding since 2003. In 2005, the Argentine Nanotechnology Fund (FAN) was established with a federal budget of $10 million for the next 5 years. In addition, in 2010, the National Agency for the Development of Science and Technology (ANPCyT) through its sectoral fund launched a new line of financing in three areas of nanotechnology: nanomaterials, nanointermedia and nanosensors. Despite these initiatives for the development of nanotechnology, there are currently no regulations in this matter. Nano-food packaging is a new generation of nanomaterial packaging technology that has become one of the most advanced areas in nanotechnology and is a radical alternative to conventional food packaging. The use of nanocomposites in food packaging has become the most developed area in the food industry. Nanocomposites promise to expand the use of edible and biodegradable films, as the addition of nanopowers has been associated with improved overall biopolimiers performance, increasing their mechanical, thermal and barrier properties, usually even at very low content. Thus, nanoparticles play an important role in making biopolimiers more feasible for several applications, including food packaging. In addition, several nanoparticles can provide the active and/or intelligent properties of food packaging materials, such as antimicrobial properties, the ability to purify oxygen, the immobilization of enzymes or the extent of exposure to any degradation factor. Thus, nanocomposites cannot not only passively protect food from environmental factors, but also include properties material so that it can really improve the stability of the food, or at least point to their ultimate inadeence to be consumed. However, there are many security issues associated with nanomaterials, as Size can allow them to penetrate the cells and eventually stay in the system. There is no consensus on the classification of nanomaterials as new (or unnatural) materials. On the one hand, the properties and safety of materials in its mass form are generally well known, but nanoscale analogues often have different properties than those on a macro scale. There is limited scientific evidence on the migration of most types of nanoparticles (PP) from packaging material to food, as well as their possible toxicological effects. It is reasonable to assume that migration can occur; therefore, it is essential to obtain accurate information about the impact of PP on human health after chronic exposure.

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