

Developing injection molds for in mold labels using nanotechnology and comparing with self-adhesive labels.

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Research Abstract

Nanocomposites, a fusion of traditional food packaging material with nanoparticles are gaining active interest in food packaging sector. In addition to its remarkable antimicrobial spectrum, it displays a great mechanical performance and tough resistant characteristics ([Montazer and Harifi, 2017](#)). Nanocomposites are usually made up of a polymer matrix in a continuous or discontinuous phase ([Arora and Padua, 2010](#)). It is a multiphase material resulting from the amalgamation of matrix (continuous phase) and a Nano-dimensional material (discontinuous phase). Based on the Nano-material, the Nano-dimensional phase is generally characterized into Nano spheres or nanoparticles, Nano whiskers or Nano rods, nanotubes and Nano sheets, or Nano platelets.

The problem of the research represented in the poor resistance of self-adhesive labels to surrounding factors compared to their counterpart installed during molding and their relatively low quality, the high costs of self-adhesive labels and the increase in production stages and time, the presence of environmental problems when recycling labels locally, in addition to the difficulty of implementing relatively complex designs for packages with traditional molds.

The aim of the research is to spot light on the importance of using nanotechnology in injection molds, and compare the methods of fixing cards on plastic packages, and to determine which is better to develop them and increase work with them in the Egyptian market to achieve:

- Treating and protecting the final appearance of the packaging and making sure of that product and packaging identity is preserved.
- Reduce phases and runtime.
- Facilitate recycling operations.

Important results

By comparing the self-adhesive labels and in mold labels, we find that the same products over time were using labels and fixing them using self-adhesive on the packages. The packages are manufactured through three production stages and when they are recycled, the packages must be separated from the labels and the package covers, but recently local companies resorted to use the technology of in mold labelling, in order to save production cost, as well as reduce

production stages, increase the level of quality and protect the identity of the product and the packaging.

Important recommendations

1. Start of the field of label packaging using the technology of in mold labels because of its advantages in terms of time and cost reduction as well as labor.
2. The thickness of the labels should be reviewed, as it is not less than a certain percentage, which is from 57-67 microns, in order to ensure that the labels are stable inside the injection mold and do not melt and do not stick well to the surface of the packages.

Summary

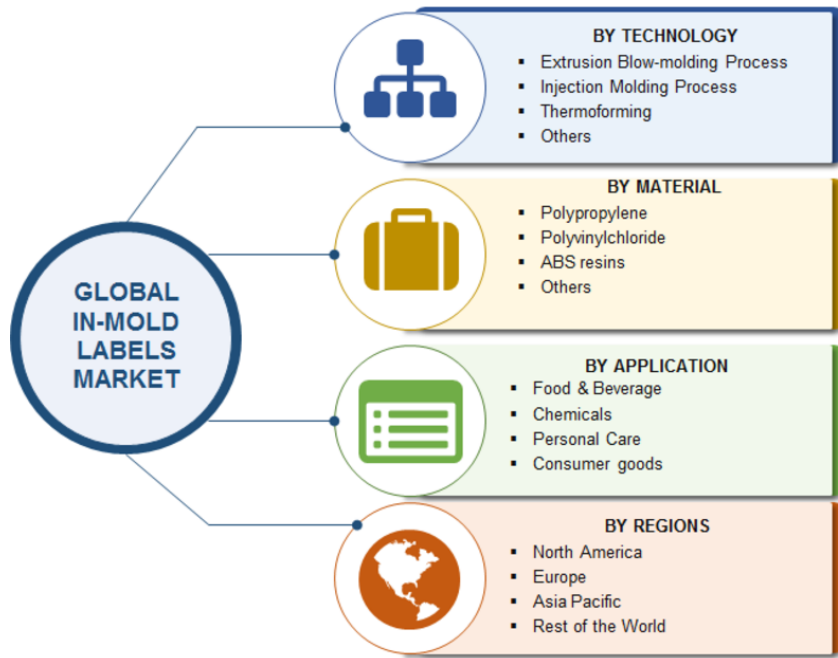
Introduction

The concept of nanotechnology was introduced in 1959 by Richard Feynman and the term “nanotechnology” was later coined by Norio Taniguchi in 1974. Nanotechnology mainly comprises of fabrication, characterization and manipulation of Nano-range (<100 nm) molecules. The application of nanotechnology in polymers involve the design, manufacturing, processing and application of polymer materials filled with Nano-particles and/or devices of Nano range.

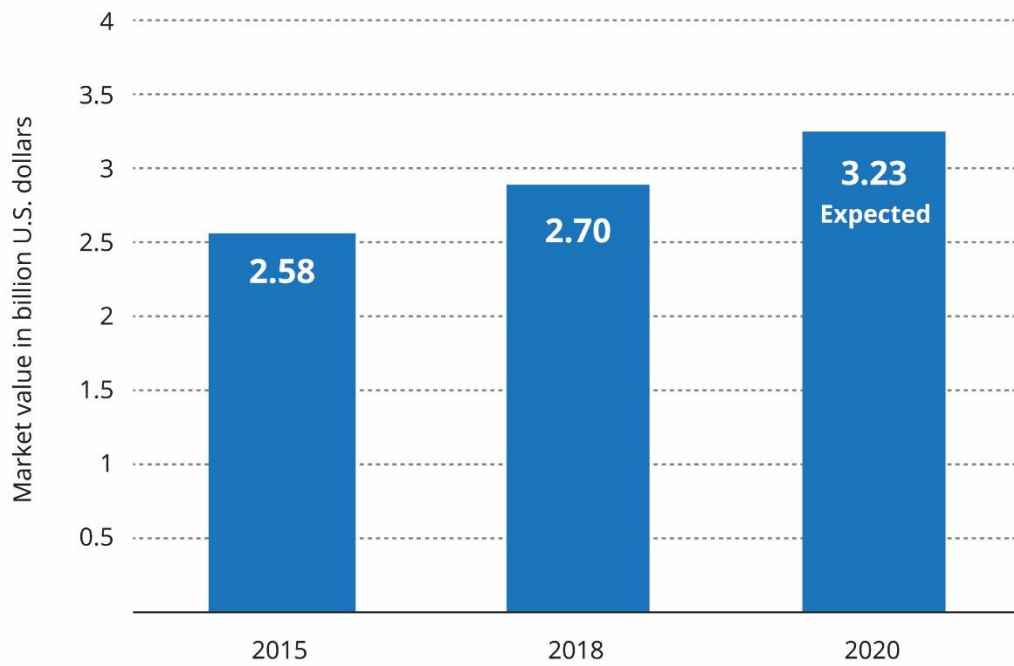
The introduction of polymer nanotechnology in food packaging aims to improve the principal features of traditional packaging systems i.e., containment (ease of transportation and handling), convenience (being consumer friendly), protection and preservation (avoids leakage or break-up and protects against microbial contaminants, offering longer shelf life), marketing and communication (real-time information about the quality of enclosed food stuffs, besides the nutritional constituents and preparatory guidelines).

Theoretical Research:

The different types of self-adhesive labels depend on the material of the labels in addition to the adhesives and removal layers used in the self-adhesive labels. They have a varied range of specifications, and they are characterized by strength, stability, water resistance or slipping and are considered the first choice for each of the pharmaceutical sector alcoholic beverages and many other sectors. The sectors of medicine, chemical compounds and cosmetics use self-adhesive labels on a variety of packages. In the field of medicines (ampoules), approximately 60,000 packages/hour can be produced, where each package is labeled with its own self-adhesive label. It is noted that both the registration number and production date and the expiration date is added to the label before it is attached directly to the package. After sticking, there are many control and inspection systems that review the data on the labels and put the labels on the packages, and sometimes the medication leaflet may be attached to the package by means of a self-adhesive label.



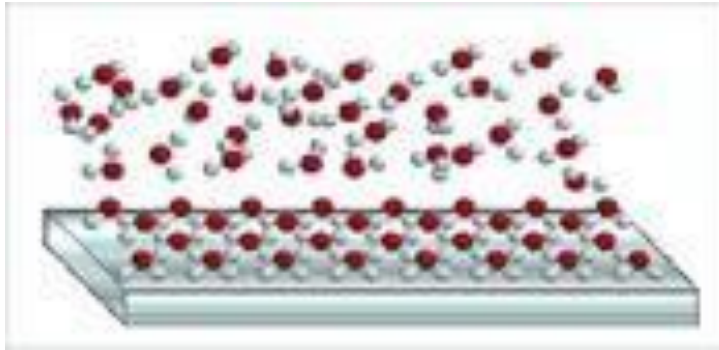
Shape (1): Market Classification of in mold labels.



Shape (2): Growth rate of in mold labels

Using nanotechnology in injection molds

The packaging process is considered one of the basic stages in the post-production stage to ensure the ease of handling the products. The purpose of the packaging process is to be an easy handling unit that helps keep the products intact during the transport, storage and marketing phase for as long as possible, and also protects the fresh product from mechanical damage. During transportation and handling, in addition to its importance in the product identification process, where the necessary data can be placed on the packaging, including (type, class, weight or number, country of origin, brand, and sometimes the product contains Nanometric materials).

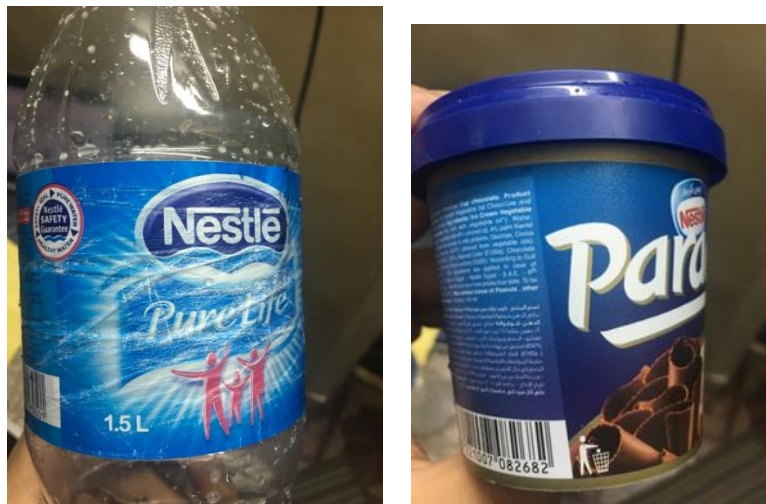


Shape (3): Forming a nanoscale barrier from nanoparticles.

The use of nanotechnology to cover the injection molds works to treat the filling part of the molten resin, and it also creates challenges for packages with relatively complex designs, ease and speed of manufacturing processes, and facing the high prices of raw materials for molds and resin, and a nanometer is known to be 1 billionth of a meter and is used in some measurements visible only by Very high magnification. For example, a sheet of paper is 100,000 nanometers thick, and a person's hair can reach 50-180,000 nanometers, and there are 25,400.00 nanometers per inch.

Practical research:

The practical side includes an analysis of some packages covered with old self-adhesive labels and packages covered with labels installed during new molding, and the impact of this difference on the handling process, functionality and aesthetic performance of the products and their recycling after use.



Shape (5): Effect of washing process for in mold label and self-adhesive label.

Research Results:

The goal of using labels as a special means of communication in packaging is to transfer information and data easily from the product to the consumer, and for the consumer to obtain what he/she wants to buy easily, as the wonderful design that attracts the consumer, and the labels contain all the information and data related to the product, and to protect it against product counterfeiting or production and expiration dates.

Comparison	Self-adhesive labels	In mold labels
Production workflow	3 Steps <ul style="list-style-type: none"> • Label printing. • forming containers. • add labels to containers. 	2 Steps <ul style="list-style-type: none"> • Label printing. • Forming containers and add labels inside the mold within molding process.
Installing	Using adhesive.	During molding process.
Recycling	Need to separate the label of container.	Doesn't need to be separated of containers.

In mold labels are able to resist many conditions of use to which the packages are exposed to more than their self-adhesive labels, such as the possibility of separating them from the package and thus losing the identity of the product and the ease of counterfeiting the package.

The use of nanotechnology in developing injection molds for packages with cards attached to them during molding gives the resulting packages greater durability, quality and better resistance to many factors. It also leads to a significant increase in the operating life of the injection mold to exceed 300 thousand operating cycles, and increases the mold's heat tolerance, which reaches up to 650°C allowing the use of a wide variety of materials inside the injection mold.

Recommendations

The researcher recommends that the following recommendations should be implemented to obtain polypropylene plastic packages on which during molding are fixed the pre-printed polypropylene cards of excellent quality using nanotechnology.

1. Start of the field of label packaging using the technology of in mold labels because of its advantages in terms of time and cost reduction as well as labor.
2. The thickness of the labels should be reviewed, as it is not less than a certain percentage, which is from 57-67 microns, in order to ensure that the labels are stable inside the injection mold and do not melt or do not stick well to the surface of the packages.
3. The student also recommends that the containers should be stacked immediately after being molded well in preparation for testing.
4. Care must be taken to carry out periodic maintenance work for the electric charging device and to ensure that it works properly during operation and injection of containers.
5. It is necessary to review the mold temperature and the melting point of the raw resin before starting to mold the containers.
6. It is necessary to determine the operating cycle time for each package to be operated with the appropriate robot.

7. The implementation of quality tests in accordance with international standard specifications on the resulting packages.

References:

1. eamrw 'usamat - rafae judat tibiaeat alkurut albilastikiat dhatiat allasaqi ealaa makinat filiksughrat dayiqat - risalat dukturat ghayr manshurat - kuliyyat alfunun altatbiqiat - jamieat hulwan - 2012.
2. muhamad jamal aldiyn - ziyadat kafa'at 'iintaj albitaqat lileubuaat albilastikiat biaistikhdam tiqniat bitaqat altathbit 'athna' alsabi fi alsuwq almahaliyi - risalat majistir ghayr manshurat - kuliyyat alfunun altatbiqiat - jamieat hulwan - 2018.
1. Mark Keeton, A History of In-Mold Labeling, in Less Than Five Minutes, Taylor communications, 2014.
2. [Kate Bertrand Connolly](#), Strong growth is forecast for in-mold labeling through 2019, Labels, 2015.
3. <https://www.statista.com/statistics/682106/global-market-size-of-in-mold-labels>
4. <http://www.kenanaonline.net/page/1431>
5. <http://www.conserve-energy-future.com/recyclingplastic.php>
6. <https://www.moldmakingtechnology.com/articles/nanotechnology-benefits-to-the-mold>
7. <https://www.frontiersin.org/articles/10.3389/fmicb.2017.01735/full>
8. <https://www.databridgemarketresearch.com/reports/global-in-mold-labels-market>.