

**Smart Packaging: A Comprehensive Overview**

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**ABSTRACT**

Intelligent packaging is a new technique used in packaging industry. It is a specialized field of packaging where special information is printed on package. Intelligent packaging is need of hour into day life. The market growth of intelligent packaging is growth at exponential ratio. The intelligent packaging given addition value to the package which directly passes information about the product in variable condition of time, temperature etc. the aim of this research paper is to study about the various techniques used in intelligent packaging. Intelligent packaging is becoming essential part of packaging. Their fore it becomes very important to study this topic.

**Keyword:** *Intelligent Packaging, TTI, RDIF, Barcode, Gas indicator.*

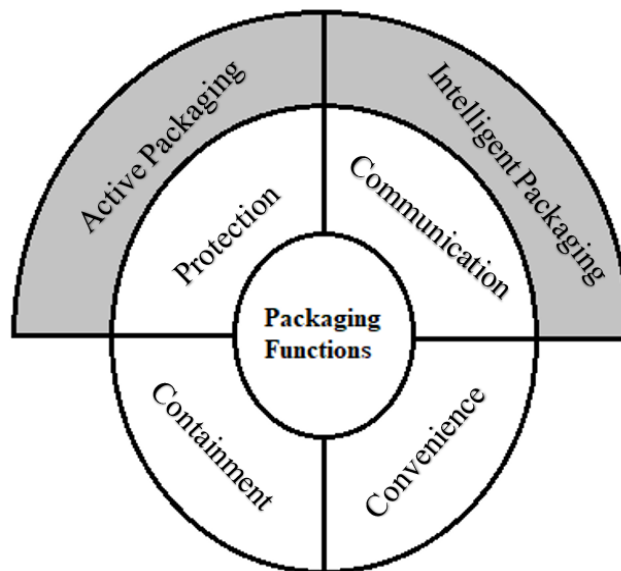
**I. INTRODUCTION**

An intelligent packaging is an emerging technology that uses the communication function for promotion, for safety, for instruction. The basic function of an intelligent packaging classified into categories: -

1. Protection
2. Communication
3. Convenience
4. Containment (Paine 1991,Robertson 1993)

Every customer become more health conscious and demand better than the food industry needs to improve the quality and safety of its products and improve quality than introduce with a new package. These packages shall be protect of the product and provide the convenience as well as information.

The term Active Packaging, Intelligent Packaging and Smart Packaging refers to packaging system used with food, pharmaceuticals & other types of product. They help extend self-life, monitor freshness, display information on product, and improve convenience.



*Figure 1. Model of packaging functions<sup>[3]</sup>*

## II. DEFINITION OF INTELLIGENT PACKAGING

1. CEST Center for Exploitation of Sci. & Tech.): -  
An intelligent packaging components or inherent property of pack, product / product configuration which confers intelligent appropriate to the function and use of Product itself.
2. Pault, Howard (Trigon Smart Pack): -  
Has to important attributes:- (1) It must be able to monitor the conditions of the package user and (2) It is made to control to the maximum extent the conditions of the product inside the package.
3. Yam, Kit, L Krumhar, K C and Karel, M: -  
Act as an intelligent massanger or as an intelligent link package technique containing an internal or external indicator for the active product history quality determination.
4. Brody, Aaron L. Deniel, Carol David (CEST):-  
It is one that sense the environment and /or is able to convey information to the user.
5. Dainelli, Dario (Cryovac Sealed Air Corporation): -  
Package material able to monitor the conditions to which food is packaged, thus provide information on its quality.
6. De Krwjf, Nico: -  
Concepts that monitor the condition of packed food to give information about the quality of the packaged food during transport & storage.

### Intelligent Packaging Technologies

1. Time-Temperature Indicator\ Quality Indicators
2. Gas Indicators
3. Barcodes
4. Radio Frequency Identification Tag

### Time-Temperature Indicator\ Quality Indicators (TTI)

Time-Temperature Indicator is very important technology in packaging industry. Time indicator changed with respect to time as well as the temperature indicator changed with respect to temperature. Time indicator showsexpire date of the product for example: - A product label printed with grey ink properties (which is changed with respect to time) and substrate. When this product wash will be expired then this label color is changed.

Temperature indicator is defined as which changed with temperature. When change the color of package of product according to increased or decreased the temperature of place. This type of package is printed by the thermos-chromic ink. In the United State, these indicators are used in chilled ready-made meat and dairy food such as ice cream. These indicators changed on the product label and not the actual temperature of product.

There are many types of time temperature indicators:-

1. Oxygen TTI
2. Carbon Dioxide TTI
3. Color TTI
4. Pathogen indicator
5. Freshness TTI
6. Leak indicators

### Oxygen TTI

The oxygen indicator is very important in the Time-Temperature Indicator. The oxygen indicator is a tablet based indicator. The oxygen indicator is used for check the oxygen free or not with change of color. When the oxygen level is more than 0.5% in the package then the tablet color is **blue** and when the oxygen level is near about 0.1% in the package the tablet is **pink**. The oxygen indicator is thermal, light and oxygen sensitive.

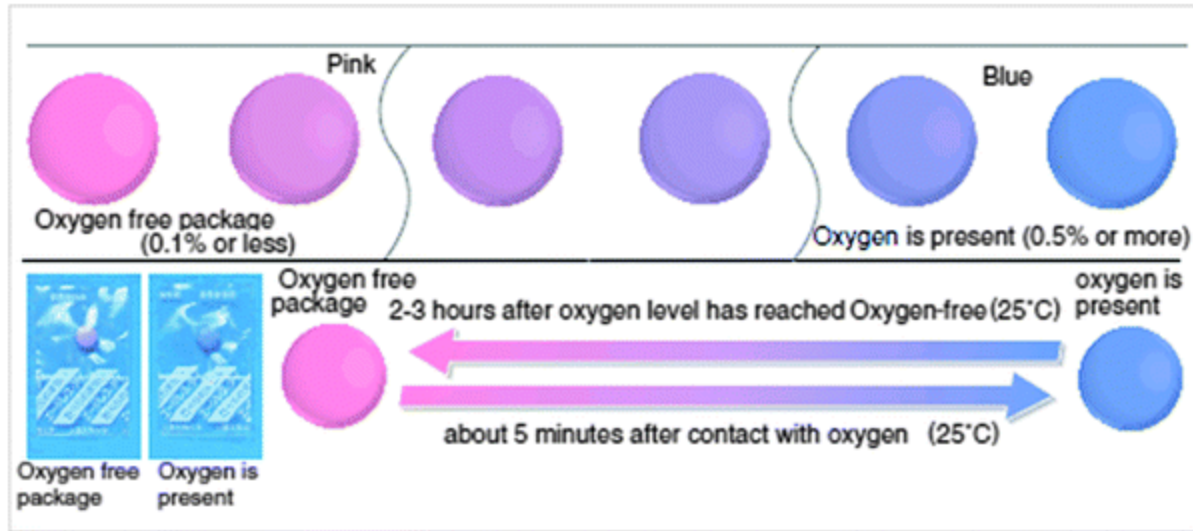


Figure 2. The color of Ageless Eye Oxygen Indicator Changes from Pink to Blue in the Presence of Oxygen.<sup>[14]</sup>

### Carbon DioxideTTI

The carbon dioxide indicator is also known as Bicarbonate indicator or Hydrogen carbonate indicator. The carbon dioxide is based on pH indicator. When the carbon dioxide level is more than 0.04% in a package then the ink color changed **red** into **yellow**. When the carbon dioxide level is less than 0.04% in a package then the ink color changed **red** into **magenta** and when the carbon dioxide level is very low in the package then the **red** color changed in **purple** color.

### Gas indicators

Gas indicators in the form of a package label or printed on packaging films can monitors changes in the gas composition, thereby providing a means of monitoring the quality and safety of food product. Oxygen indicators are the most common gas indicator for food packaging application, become in air can cause oxidative rancidity, color change and microbial spoilage. A number of oxygen indicators are designed to show color change due to leaking or temperature packaging (Krumhar and Karel 1992; Inone and other 1994). In this technology, a special characteristic substrate is used when the substrate contact with oxygen then change the property of substrate and give some useful result which describes the product is fresh or not.

### Barcodes

The barcode is very important in packaging industry. The barcode is the combination of white and black lines which have some information and readable only by optical character reader machine. The barcode represented data by varying the width and space of parallel lines.

### Structure of Barcode

The barcode has five important parts. These are:-

1. Quiet Zone
2. Start Zone
3. Data
4. Check Digit
5. Stop Zone



Figure 3. Structure of Barcode<sup>[15]</sup>

### Quiet Zone

The Quiet Zone is also known as Clear Area. The Quiet Zone is available on both sides of the barcode. If the margin is not wide enough, the barcode reader cannot scan the barcode area. The Quiet Zone area should be at least 10 times wider than the narrow bar width.

### Start/Stop character

Start character indicates the start of the barcode and Stop character indicates the end of the barcode. The start/stop character varies according to the various types of barcodes.

### Data

Data characters store all the data of the barcode.

### Check Digit

Check digit is a mathematical sum that is used to verify the accuracy of the other elements of the barcode.

## III. RADIO FREQUENCY IDENTIFICATION TAG

RFID is a wireless identification system that is capable of transferring stored data in the tag section to a reader using electronic and electromagnetic signals. The common RFID frequencies range from low (125 KHz) to UHF (850-900 MHz).

There are three types of RFID:

1. Passive
2. Semi-active
3. Active



Figure 4. RFID Tag<sup>[16]</sup>

### Passive

Passive RFID tags are very important in intelligent packaging. Passive tags have no internal power source. The passive tags receive their energy from the antenna and through the signal received from the reader.

### Semi-active

In semi-active tags, a small battery is used for providing energy.

### Active

In Active tags, an internal power source is used for providing energy. The Active tags is used for transmit long distance information.

#### Application

An intelligent packaging is used in food products. An intelligent packaging is used in pharmaceutical products etc.

#### IV. CONCLUSION

An Intelligent Packaging is a new branch of packaging in which deals with food safety, quality and convenience and pharmaceutical package with more intelligent way. In the future maximum product will be printed with some main feature of ink and substrate. After that containment & forgery will be stop and increase trust on the product and increase the sale of product. Intelligent packaging is widely used in United State, Japan, America, China and many other developed countries. An intelligent packaging is the combination of Packaging Science, Food Science, Nano Technology, Sensor, Information Technology and other disciplines. An intelligent packaging future is very broad and bright.

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