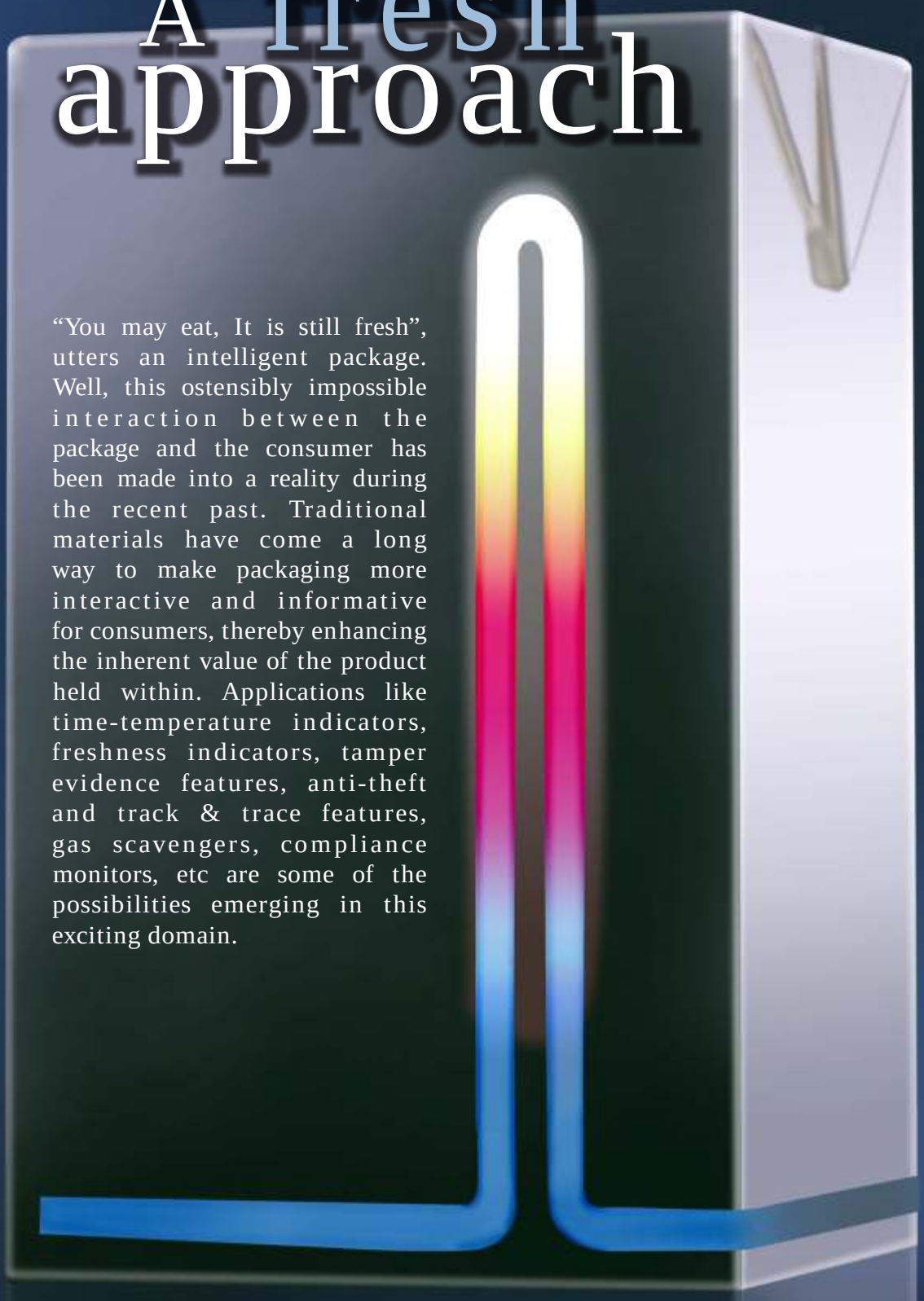
New-age materials

A 'fresh' approach

"You may eat, It is still fresh", utters an intelligent package. Well, this ostensibly impossible interaction between the package and the consumer has been made into a reality during the recent past. Traditional materials have come a long way to make packaging more interactive and informative for consumers, thereby enhancing the inherent value of the product held within. Applications like time-temperature indicators, freshness indicators, tamper evidence features, anti-theft and track & trace features, gas scavengers, compliance monitors, etc are some of the possibilities emerging in this exciting domain.



Courtesy: Tetra Pak

Chandrashekhar Modi

The packaging scenario is undergoing rapid transformation with respect to the features incorporated into a package to make it more interactive and in sync with the needs of the consumers. This has led to the emergence of a whole new range of materials and processes that help in this arena, as the package integrates innovative functions in addition to conventional ones like 'contain' and 'protect'.

"When one considers smart packaging it seems to cover everything in addition to normal passive packaging. This includes active packaging and smart/intelligent packaging. Active packaging is the addition of another component into the package, with the purpose of enhancing the performance of a package; whereas, smart/intelligent packaging includes an internal or external sensor to inform about the history of the pack and the current state of the contents. Certainly, after the food is completely harvested, one can resort to smart packaging to further increase the yield. In India, we must consider packaging that is smart and economical that will enable us to maximise the usage of what is already produced. Correct application of active packaging will greatly assist to reduce food wastage and the costs associated with it," explains Rohitt Mistry, chairman, Holotechs.

Rohitt Mistry
chairman, Holotechs

Today, several smart packaging developments are a little ahead of time and hence have not found market acceptance. Costs and logistics issues add to the constraints. However, as costs reduce and the awareness increases more and more smart packaging systems will be employed.

Taking cues from the nature

Companies, today, are in a constant endeavour to improve the bottom line and reduce prices. Certain smart systems that are capable of monitoring and indicating the condition of the packaged foods are bound to reduce wastage, as only foods that are not fit for consumption would be discarded.

According to some experts, smart packaging finds some cues from the nature. Nature has intelligently packaged food products and by merely looking at them or by feeling them, one can judge the freshness within. "Nature has incorporated visual or aroma change in fruits and vegetables to warn us of their degradation. For instance, by merely looking at the banana's skin, one can judge whether it is ripe or not. The freshness of coconut water can be known without opening the shell, ie by tapping the shell. Thus the product has an intelligent packaging gifted by nature," explains Subba Bangera, managing director, Sidel India Pvt Ltd.

Further, there are two aspects to packaging as far as extending the freshness of perishable products is concerned. First is what it does to the food and second, the information that it can convey about the food product. Each of these can be tailored to specific needs on specific food products.

Explains Dr Joseph Hotchkiss, director and professor, School of Packaging, Michigan State University (MSU), "One school of thought rules out this possibility and vouches for a more 'generic' packaging. But a look at the variety of films that are used to package sleeves reveals a whole line of films, each tailored to a specific type of cheese. The same technology could be extended to several other products in the future."

Fresh-cut farm products are one of the fastest growing segments of the modern retail format. Conventional film bags are generally not capable of coping with the high respiration rates of pre-cut vegetables and fruits, leading to early

Subba Bangera
managing director, Sidel India Pvt Ltd

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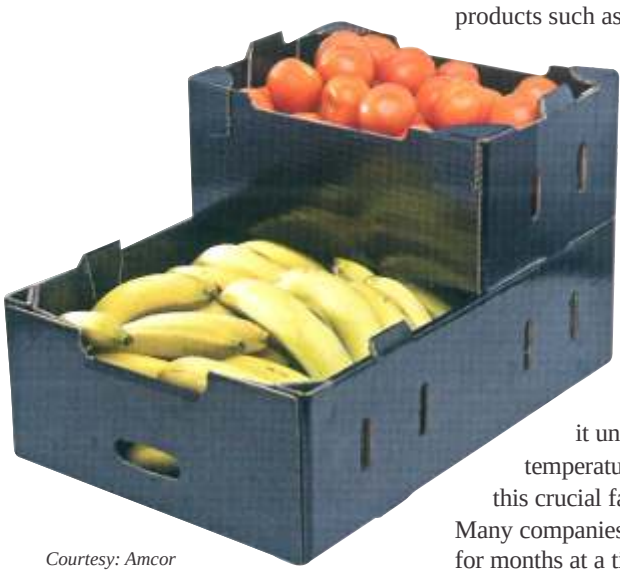
product deterioration. Novel breathable polymer films having acrylic side-chain crystallisable polymers are tailored to change phase reversibly at various temperatures from 0-68°C. As the side-chain components melt, gas permeation increases dramatically, and by further tailoring the package and materials of construction, it is possible to finetune the carbon dioxide to oxygen permeation ratios for particular products.

Oxygen scavenging is yet another area, falling under the domain of active packaging. Oxygen scavenging package consists of a matrix polymer like PET and an oxygen-scavenging component. The oxygen scavenger absorbs the excessive oxygen by getting oxidised itself and protects the food product from within. The system can remain active for periods of up to two years providing protection to oxygen sensitive products such as beer, wine, fruit juice and mayonnaise throughout their shelf-lives.



Courtesy: Amcor

Time-temperature indicators

The longer a food product is kept in poor conditions ranging from extreme heat to freezing temperatures, or both, the more likely it is to experience damage that could make it unsafe to consume. Time temperature indicators (TTIs) take this crucial factor into consideration. Many companies warehouse packaged food for months at a time, potentially exposing it to extreme temperature conditions. Usually, if food has been exposed to dangerous temperatures, it becomes apparent after the package has been opened. However, this is not always the case, and it is also an inefficient way to detect potential damage to the food.

TTIs are devices that exploit a change in the physical or physiochemical property to produce irreversible evidence of exceeding a predetermined temperature threshold or record the cumulative time-temperature history. These generally function by physical, enzymatic or chemical reactions followed by a classical theory that correlates the rate of reaction to temperature.

"TTIs play a critical role in indicating the freshness and safety of the product which these monitor. These not only monitor but communicate visually or audibly which food product is safe to eat. In the case of those foods that should not be frozen, the TTIs will indicate whether the food is exposed to improper cold temperature. On the other hand, for foods that are sensitive to heat, TTIs smartly communicate the time and duration of high-temperature exposure," explains Bangera.

TTIs also allow manufacturers to trace their foods along the supply line, besides making consumers feel confident about what they are purchasing. TTIs usually take the form of a small badge which is adhered to the exterior of the packaging. They normally have a clear bar, which gets filled with colour as the food is exposed to an unsafe temperature. Even after removing the package from poor conditions, the coloured bar is retained, showing that the food was exposed, and also indicates the duration of exposure. Another type incorporates a circle, which slowly darkens as the food is kept in hot conditions.

'Nanotech' package

Imagine a package containing milk to change colour with the changing molecular composition of milk that is beginning to spoil or imagine an ice cream carton that would tighten its existing molecular structure to prevent heat from affecting the contents if it was left in the back of an automobile on a

sunny day. These are examples of the exciting possibilities that nanotechnology has in store for the packaging space.

Citing various applications in nanotechnology, Bangera says, "Nanotechnology is playing a crucial role in developing active and intelligent packaging. By incorporating mineral particles in nano size (less than the wave length of light) it is possible to create a form of labyrinth within the structure of the film, which physically retards the passage of gas molecules. In food packaging montmorillonite clay is being explored as the nano-component in a variety of polymers, viz, polyethylene, polyester, nylon and starch. Nanocomposite films exhibit excellent barrier properties for oxygen, carbon-dioxide, and moisture from reaching food inside the pack. Carbon nanotubes display powerful antimicrobial effect which can cause cellular damage to E Coli. Nano-sensors when integrated with food packaging can detect chemicals, pathogens and toxins in food. Nylon films are commercialised with improved gas barrier properties with nano additives."

Electronics for enhancing smartness

Electronics in packaging has become synonymous with RFID tags, which are fast replacing the barcodes printed on a package. While barcodes give information regarding production and shipping, RFIDs deliver much more beyond this function.

RFID provides wireless monitoring of food packages through tags, readers and corqputer systems. RFID systems also provide safety and security benefits by tracking the origin of food supplies, thus paving the way for organised retailers to integrate this technology to manage the supply chain.

"RFIDs serve an important purpose of protecting the product from counterfeiting due to the presence of 'track and trace' technology. The original products can be traced and counterfeits can be easily distinguished from the original ones with the help of these tags. These primarily deal with issues of brand protection and indicate a quality product. RFIDs are bound to become a part and parcel of every package in the future," explains Abhijit Chattopadhyay, deputy general manager - Strategic Initiatives & Business Development, Cognizance Packaging.

Dr Joseph Hotchkiss
director and professor, School of Packaging, Michigan State University

There are two aspects to the use of smart packaging for extending the freshness of perishable products. First is what it does to the food and second, the information that it can convey about the food product. Each of these can be tailored to specific needs on specific food products.

The cost trade-off

The most important factor that is critical to the success of smart package is cost-effectiveness. "Most of the smart packaging developments are a little ahead of time and market acceptance. Therefore, many of them have not been employed due to high cost and other logistics & market constraints. As costs reduce and public awareness increases, more & more smart packaging systems will be employed," reasons Mistry.

Commenting on the cost factor Bangera observes,"Price continues to be one of the constraints when it comes to

Courtesy: Ciba

Abhijit Chattopadhyay
deputy general manager - Strategic Initiatives & Business Development, Cognizance Packaging

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employing TTIs in packaging. In India, we may soon see legislation for fresh foods, thus making 'fresh check' labels mandatory. While the technology is available it is imperative to integrate it with the existing infrastructure."

In the past, evolution of smart packaging was hampered by the lack of low-cost material and power resources. However, due to the emergence of alternative and low-cost power sources like piezoelectric materials, organic photovoltaics and thin film batteries; sensors, displays and active RFIDs will see explosive growth in the near future.

On course for tomorrow

Innovations that are being incorporated with materials seem to have endless possibilities, besides being more interactive. "One could get a mobile alert of the expiry date of the food that is stored in the refrigerator. For instance, his mobile phone could have an inbuilt RFID reading device to inform him that the meat he is about to cook is not good. Or he could have beer from can at the right temperature because of a special ink on the can that would change colour at a certain threshold. Further, the soft drink bottle could have a special window on the label which would help detect the change in the gas content. Thus, there is no dearth of innovative possibilities. But one has to take into consideration the impact on environment when trying complex packages," concludes Bangera. MPD