Active packaging - a brief overview

Active packaging refers to the incorporation of certain additives into packaging film or within packaging containers with the aim of maintaining and extending product shelf life. Active packaging has been used with many food products and is being tested with numerous others. Some of such are discussed briefly in following sections.

Oxygen scavengers: Oxygen can have considerable detrimental effects on foods. Oxygen scavengers can therefore help maintain food product quality by decreasing food metabolism, reducing oxidative rancidity, inhibiting undesirable oxidation of labile pigments and vitamins, controlling enzymic discoloration and inhibiting the growth of aerobic microorganisms.
The most well known oxygen scavengers take the form of small sachets containing various iron based powders combined with a suitable catalyst. These chemical systems often react with water supplied by the food to produce a reactive hydrated metallic reducing agent that scavenges oxygen within the food package and irreversibly converts it to a stable oxide. The iron powder is separated from the food by keeping it in a small, highly oxygen permeable sachet that is labelled Do not eat. The main advantage of using such oxygen scavengers is that they are capable of reducing oxygen levels to less than 0.01% which is much lower than the typical 0.3–3.0% residual oxygen levels achievable by modified atmosphere packaging (MAP).
In the last few years, the development of oxygen scavenging adhesive labels that can be applied to the inside of packages and the incorporation of oxygen scavenging materials into laminated trays and plastic films have enhanced and will encourage the commercial acceptance of this technology.

Carbon dioxide scavengers/emitters: The use of carbon dioxide scavengers is particularly applicable for fresh roasted or ground coffees that produce significant volumes of carbon dioxide. Fresh roasted or ground coffees cannot be left unpackaged since they will absorb moisture and oxygen and lose desirable volatile aromas and flavors. A mixture of calcium oxide and activated charcoal has been used in polyethylene coffee pouches to scavenge carbon dioxide but dual-action oxygen and carbon dioxide scavenger sachets and labels are more common and are commercially used for canned and foil pouched coffees in Japan and the USA. These dual-action sachets and labels typically contain iron powder for scavenging oxygen, and calcium hydroxide which scavenges carbon dioxide when it is converted to calcium carbonate under sufficiently high humidity conditions.

Ethylene scavengers: Ethylene (C_2H_4) is a plant growth regulator which accelerates the respiration rate and subsequent senescence of horticultural products such as fruit, vegetables and flowers. Many of the effects of ethylene are necessary, e.g. induction of flowering in pineapples, color development in citrus fruits, bananas and tomatoes, stimulation of root production in baby carrots and development of bitter flavor in bulk delivered cucumbers, but in most horticultural situations it is desirable to remove ethylene or to suppress its negative effects. Effective systems

utilize potassium permanganate ($KMnO_4$) immobilized on an inert mineral substrate such as alumina or silica gel. $KMnO_4$ oxidizes ethylene to acetate and ethanol and in the process changes color from purple to brown and hence indicates its remaining ethylene scavenging capacity.

Ethanol emitters: The use of ethanol as an antimicrobial agent is well documented. It is particularly effective against mould but can also inhibit the growth of yeasts and bacteria. Ethanol can be sprayed directly onto food products just prior to packaging. Several reports have demonstrated that the mould-free shelf life of bakery products can be significantly extended after spraying with 95% ethanol to give concentrations of 0.5–1.5% (w/w) in the products. However, a more practical and safer method of generating ethanol is through the use of ethanol-emitting films and sachets.

Moisture absorbers: Excess moisture is a major cause of food spoilage. Soaking up moisture by using various absorbers or desiccants is very effective in maintaining food quality and extending shelf life by inhibiting microbial growth and moisture related degradation of texture and flavor. Several companies manufacture moisture absorbers in the form of sachets, pads, sheets or blankets. The use of moisture absorber sachets is common in Japan, where popular foods feature a number of dried products which need to be protected from humidity damage.

Temperature control packaging: Temperature control active packaging includes the use of innovative insulating materials, self-heating and self-cooling cans. For example, to guard against undue temperature abuse during storage and distribution of chilled foods, special insulating materials have been developed. One such material is Thinsulate™ (3M Company, USA), which is a special non-woven plastic with many air pore spaces. Self-heating cans and containers have been commercially available for decades and are particularly popular in Japan. Self-heating aluminium and steel cans and containers for sake, coffee, tea and ready meals are heated by an exothermic reaction which occurs when lime and water positioned in the base are mixed.

Preservative releasers: There has been great interest in the potential use of antimicrobial and antioxidant packaging films which have preservative properties for extending the shelf life of a wide range of food products. One widely reported product is a synthetic silver zeolite which has been directly incorporated into food contact packaging film. The purpose of the zeolite is, apparently, to allow slow release of antimicrobial silver ions into the surface of food products. The major potential food applications for antimicrobial films include meats, fish, bread, cheese, fruit and vegetables.