Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Welcome to the NPTEL online certification course on modern food packaging technologies, regulatory aspects and global trends. We were discussing different types of plastic packaging materials and in continuation to that the next packaging material which are most commonly used is polystyrene. Polystyrene is an addition polymer of styrene, a vinyl compound where a hydrogen atom is replaced with a benzene ring. Polystyrene has many packaging uses and can be extruded as a monolayer plastic film, coextruded as a thermo-formable plastic sheet, injection molded and foamed to give a range of pack types. It is also copolymerized to extend its properties.

It is less well known as an oriented plastic film, though the film has interesting properties. It has high transparency that is clarity, it is stiff with a characteristics crinkle suggesting freshness and has a dead fold property. The clear film is used for curtain windows and white pigmented film is used for labels. The film is printable, it has a low barrier to moisture vapor and common gases making it suitable for packaging products such as fresh produce which need to breathe.

Polystyrene is easily processed by foaming to produce a rigid lightweight material which has good impact protection and thermal insulation properties. It is used in two ways, the blown foam can be extruded as a sheet which can be transformed to make trays for meat and fish, egg, cartons, a variety of fast food packs such as come shell shaped containers as well as cups and tufts. Thin sheets can be used as a label stock. The foam can also be produced in pallet or bead form which can then be molded with heat and pressure. This is known as expanded polystyrene or EPS.

It can be used as a transit case for fresh fish with thick walls of insulation. The polystyrene so far described is general purpose polystyrene. The main disadvantage as a rigid or a semi rigid container is the fact that it is a brittle. This can be overcome by blending with styrene butadiene copolymer. Styrene butadiene or styrene butadiene copolymer that is SBC and elastomer polymer the blend is known as high impact polystyrene or HIPS.

High impact polystyrene is also used in multilayer sheet extrusion with the variety of other polymers each of which contributes to the protection and application needs of the

product concerned. The food products packed with HIPS material include dairy products such as cream and yogurt based desserts, UST milk, cheese, butter, margarine, jam, fruit compote, fresh meat, pasta, salads etc. The styrene butadiene styrene butadiene is also a packaging polymer in its own right. It is tough and transparent with a high glass surface finish. Blown film has high permeability to water vapor and gases.

It is used to pack fresh produce, it is heat sealable to a variety of surfaces. The film has good crease retention making it suitable to twist wrapping sugar confectionery injection molded containers with an integral locking closure have a flexible hinge. Similar in these respects to PP. Now styrene butadiene copolymer is also a packaging polymer in its own right. It is tough and transparent with a high glass surface finish.

Blown film has high permeability to water and gases. It is used to pack fresh produce, it is heat sealable to variety of surfaces. The film has good crease retention making it suitable for twist wrapping sugar confectionery injection molded containers with an integral locking closure have a flexible hinge similar in these respect of PP. It is also be used to make thermo-formable sheet, injection and blow molded bottles and other containers with high impact resistance and glass like clarity. The relatively low density gives SBC a 20 to 30 percent yield advantage over other non styrenic clear resins.

The another important material is acrylonitrile butadiene styrene. ABS is a copolymer of acrylonitrile butadiene and styrene with a wide range of useful properties which can be varied by altering the proportions of the three monomer components. It is a tough material with good impact and tensile strength and good flexing properties. ABS is either translucent or opaque. It is thermo-formable and can be molded.

A major use is in this large shipping and storage containers. A tote boxes and it has been used for thin walled margarine tufts and lids. Ethylene vinyl alcohol is a copolymer of ethylene and vinyl alcohol. It is related to polyvinyl alcohol which is a water soluble synthetic polymer with excellent film forming, emulsifying and adhesive properties. It is a high barrier material with respect to oil, grease, organic solvents and oxygen.

It is moisture sensitive and in film form is water soluble. PVOH itself has packaging applications in film form but not in food products and it is used as a coating of BOPP. It is also an excellent barrier to oxygen and is resistant to the absorption of permeate of many products especially those containing oil, fat and sensitive aromas and flavors. Though it is moisture sensitive to a much lesser degree than PVOH, it is still necessary to bury it in multivariate co-extruded structures such as film for flexible packaging, sheets for thermo forming and in blow molded bottles so that it is not in contact with liquid. The other polymers used depend on the application that is the food product and

type of pack.

PS/EVOH/PS and PS/EVOH/PB sheets are used for processed cheese, pate, UST milk and milk based desserts and drinks. It is also used for MAP of fresh meat and for pasta, salads, coffee and hot filled processed cheese including portions, packed cheese and fruit compote. A high higher barrier sheet can be constructed with PP, EVOH, PP for pasteurizable and retortable pouches such as fruit, pate, baby food, sauce like ketchup and ready meals some of which are reheated by microwave. Extrusion lamination can involve EVOH with PET, LDPE and LLDPE for coffee, condiments and snacks. It is used with PET and PP for tray leading materials.

Extrusion lamination of paper board with EVOH and PE is used to aseptically packed UST milk and fruit juices where the EVOH layer provides an oxygen barrier as a replacement for aluminum foil. In blow molding, ethylene vinyl alcohol is used with PP for sauces, ketchup, mayonnaises and cooking oil and with HDPE for salad dressings and juices. Ketchup and mayonnaises bottles based on EVOH are squeezable. Next important material is poly methylpentene which is known as TPX. TPX is the trade name of the methylpentene copolymer.

It is based on 4-methyl-1-ene and possesses the lowest density of commercially available packaging plastics that is 0.83 grams per centimeter cube. It is a clear heat resistant plastic which can be used in applications up to 200 degree Celsius. The crystalline melting point is 240 degree Celsius. The TPX offers good chemical resistance, excellent transparency and gloss.

It can be extruded and injection molded. The main food packaging used is an extrusion coating onto paper board for use in baking applications in the form of curtains and trays for bread, cakes and other cook in packed foods. This packaging is dual ovenable that is food packed in this way may be heated in microwave and radiation ovens. The surface of this plastic gives superior product release compared with aluminum and PET surfaces. TPX coated trays must be formed by the use of interlocking corners as they cannot be erected by heat sealing.

The next important plastic material used in food packaging is high nitrile polymer. High nitrile polymers are copolymers of acrylonitrile. These are used in the manufacture of other plastics such as ABS and SAN. This nitrile component contributes very good gas and odor barrier properties to the common gases together with good chemical resistance. HNPs therefore, offer very good flavor and aroma protection.

A commercially available range of HPNs approved for food packaging is made under

the trade name of BEREX introduced by SOHEO chemical and now BP chemicals. This is a rubber modified acrylonitrile methyl acrylate copolymer. Grades are available for blown and cast film extrusion blow molding, injection stretch blow molding and injection molding. It is a clear tough rigid material with a very good gas barrier and chemical resistance. It is used as the inner layer in blow molded bottles coextruded with HDPE.

BEREX films can be coextruded as film and sheet are laminated with PE, PP and aluminum foil for flexible packaging applications with food products. Sheet materials can be thermo formed. Now, the fluoropolymers. Fluoropolymers or fluoroplastics are high performance polymers related to ethylene Where some or all of the hydrogen atoms are replaced by fluorine and in the packaging polymer a hydrogen is also replaced by a chlorine atom to produce polychlorofluoroethylene that is PCTEFE.

This material has the highest water vapor barrier of all the commercially available packaging polymers. It is a very good gas barrier and offers high resistance to most chemicals at low temperature. In many applications it is a suitable replacement for aluminum foil. It is available as a film or sheet. It is transparent, heat sealable and can be laminated, thermo formed, metalized and sterilized.

It is relatively expensive and is best known as a thermo formable blister pack material laminated with PVC for pharmaceutical tablets. Food packaging applications are possible, but are not highlighted at the present time. The polytetrafluoroethylene better known as duponteflon is a high melting point inert and waxy polymer. It is used in the form of tape and coatings on packaging machines to reduce adhesion where that could be a problem for example, heat seal bars and to reduce friction where packaging materials move over metal surfaces. The another important material is cellulose based materials.

The original packaging film was regenerated cellulose films. The pure cellulose fiber derived from wood is dissolved and then regenerated by extrusion through a slot casting on to a drum and following acid treatment is wound up as film. It is commonly known as cellophane though this is in fact, a trade name. Regenerated cellulose film is not a thermoplastic material in that it is not processed in a molten phase or softened by heat. Cellulose is however, a high molecular weight naturally derived polymer.

To make it flexible it is plasticized with humectants that is glycol type. The degree of flexibility can be adjusted to suit the application. The degree of flexibility can range from a fairly rigid level to the most flexible which is known as twist wrap used to wrap individual units of sugar confectionery. Regenerated cellulose fibers films is dead folding so that it keeps a folded or twist wrap condition. It is poor barrier to water vapor

and its property is made use of which products which need to lose moisture such as pastries and some floor confections to achieve the correct texture when packed.

Plastic films such as PP or PE would keep the relative humidity too high inside such a package and therefore, encourage mold growth. When dry RCF is a good barrier to oxygen. Uncoated thick RCF is used to demonstrate tamper evidence on a bottle. This is done by moistening a small diameter RCF sleeve. Slipping it over the bottle closure and top part of the neck and allowing it to dry when it shrinks tightly to the bottle and closure.

RCF is used in food packaging for gift packs and for packaging which is specified as biodegradable or compostable. Now, polyvinyl acetate. Polyvinyl acetate is a polymer of vinyl acetate which forms a high amorphous material with good adhesive properties in terms of open time track and dry bond strength. The main use of PVA in food packaging is as an adhesive dispersion in water. PVA adhesive are used to seal the side seams of folding curtains and corrugated fiber board cases and to laminate paper to aluminum foil.

A general statements, many plastics are better known for their trade names and abbreviations. In the European packaging market PE constitutes the highest proportion of consumption with about 56 percent of the market by weight and 4 others PP, PET, PS including expanded polyesterine and PVC comprises most of the remaining that is 46 percent. The percentage may vary in other markets, but the ranking is similar. The other plastics listed meet particularly niche needs such as improved barrier, heat sealability, adhesion, strength or heat resistance. These materials are all thermoplastic polymers.

Each is based on one or more simple compound or monomer. An example of a simple monomer would be ethylene which is derived from oil and natural gas. It is based on a specific arrangement of carbon and hydrogen atoms. Polymerization results in joining thousands of molecules together to make polyethylene. The length of the chain the way the chains pack together and the degree of branches affect properties such as density, crystallinity, gas and water vapor barrier, heat sealing, strength, flexibility and processibility.

The factors which control polymerization or temperature, pressure, reaction time, concentration, chemical nature of the monomers and major significance of catalysts. The recent introduction of metallocene catalyst has resulted in the production of high performance plastics and has had a major impact on the properties of PE, PP and other plastics such as PS. In some cases the resulting polymers are virtually new polymers with new applications for example, breathable PE films for fresh produce packing and sealant layers in laminates and coextrusion. It is appropriate to consider polyethylene as

a family of related PE's which vary in the structure, density, crystallinity and other properties of packaging importance. It is possible to include other simple molecules in the structure and all these variables can be controlled by the conditions of polymerization, heat, pressure, reaction, reaction time and the type of catalyst.

All PE's have certain characteristics in common which polymerization can modify some of a greater and some to a lesser extent, but all PE's will be different for example, all polypropylene's are the family of poly esters. Similar considerations apply to all the plastics listed they are all families of related materials with each family originating from one type or more types of monomer molecules. It is also important to appreciate the fact that plastics are continually being developed that is modified in the polymerization process to enhance a specific properties to meet the needs of the manufacture of film sheet molded rigid plastic containers etcet and the end use of the plastic film container etcetera. In the case of food packaging end use properties relate to performance properties such as strength, permeability to gases and water vapor, heat sealability and heat resistance and optical properties such as clarity. Additionally the way the plastic is subsequently processed and converted in the manufacture of the packaging film sheet container etc will also have an effect on the properties of that packaging item. Thank you very much.