PHYSICO-CHEMICAL INTERACTIONS OF SURFACE TREATMENT ON PLASTIC FILMS USED IN FLEXIBLE PACKAGING

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The importance and growth of flexible packaging in modern fast life can not be overestimated. The outlook of people in every strata of society has undergone a tremendous change such that they expect every essential item in their routine life to be packaged. Illiterate and ignorant people from even the rural areas have become aware about the fact that a package stands not only for authentication of the product contained in it but also for its protection, prevention and presentation. The outburst of large number of plastic films attributed to the incessant growth of Polymer Science and Technology has led to a great revolution in packaging industries during the last fifty years. The scientists and researchers in the concerned field now have been passing sleepless nights to develop newer and newer specifications utilizing the varieties of plastic films now available in market. The technological innovations, of late are mostly concerned with better shelf life, ease of processing, handling and above all the cost.

In the meantime, the art of printing and concept of multi-layered films have added new dimension in the field of packaging. The packaging science now has become a multidisciplinary subject. The two principal wings of packaging namely “Printing” and “Lamination” are strongly dependent on physico-chemical characteristics of surfaces of the plastic films. It is worth mentioning here that the problems associated with these surfaces are perpetual, numerous and even changing in its nature. A proper understanding of these surface issues and their correlation is quite imminent and essential so as to maintain smooth operation in every section of a packaging industry. With the exception of one or two, most of the plastic films that we normally encounter in our daily life are hydrophobic, non-polar, inert and are very insensitive to adhere with any ink, adhesive or any coating solution. In most of the cases the two sides of a film are to serve different functions and thus necessitating processing in different manner.

So far as printing ink is concerned it has been observed that inks of different shades have different degrees of adhesion even on films of the same kind and also treated to the same extent. In case of lamination with reverse printed films with another substrate using adhesive the phenomenon of ink transfer on the second unprinted surface is quite common phenomenon as observed on peeling the laminates. The extent of transfer also varies with changes in shades and changes in DFT. There has been no systematic and scientific

investigation on the optimum degree of various types of treatment on a suitable plastic film that will provide satisfactory degree of adhesion for almost the entire range of inks in common use. There is also no well documented report on what physico-chemical interactions actually can occur on films surfaces that lead to good adhesion. Furthermore what type of adsorptive forces are developed at the interface of the said ink film and the treated plastic film in particular.

Lamination of similar and dissimilar substrates (film and foil) is a very common phenomenon in packaging industries. The use of adhesives for such lamination process is wide spread and a host of adhesives find applications for this purposes. Both water based and solvent based systems are recommended. Apart from this, hot melts, pressure sensitive adhesives etc. are to be used for some specific applications. The water based system of adhesives may further belong to either aqueous emulsions or aqueous solutions, the former being of high solid and low viscosity type and the latter of low solid and high viscosity class. The conventional plastic films are found to have very little affinity for such adhesives and thus create problems in ultimate performance of the laminate. Sometimes it is the contents of the package which are made up of such laminate that migration of diffusible components at the interface of the two laminants may occur and weaken the adhesive strength with time.

In view of the problems as outlined above it may be said that the packaging science has not yet reached the standard, normally expected for a trouble-free operation, particularly in the printing and laminating sector. Most of the industries run on “Hit and miss” policy with a tremendous compromise on standard.

Considering the above perennial problems encountered in even routine works in packaging industries it has been felt that there is ample scope of developing and modifying some of the process parameters so as to mitigate at least a few of the key issues of these industries. This will also probably enrich the still developing packaging sciences. The problems proposed to be investigated in the present work, its probable hypothesis and a brief plan of work are being given below.

1. Treatment level of hydrophobic polyolefinic film:

This class of film includes LDPE, LLDPE, LDPE/LLDPE coextruded film, OPP, CPP, Pearlised OPP and various other hydrocarbonaceous film. All these films are non-polar and inert such that they can not be printed or laminated as such and these require corona treatment so as to impart some polarity for adhesion of printing ink, for increasing affinity

towards somewhat polar adhesives etc. This corona treatment is carried out through electric discharge at a high voltage in line with the extrusion process employed for fabricating the film.

A detailed study of the level of treatment achieved at different voltages is proposed to be carried out and the relationship between them is to be investigated. The type of physico-chemical interactions and any possibility of chemical bond formation or formation of any chemical functional group is to be explored. Whether any roughness for mechanical entanglement is developed and to what depth (thickness) of the film has been affected due to corona discharge are to be determined. For a given treatment level the extent of adhesion of various printing ink is to be compared. Depending on thickness the possibility of treatment dissipative and the effect of ageing on treatment in different seasons, i.e. the influence of RH %, temperature etc. are to be investigated. In many industries the charge decay over a period of time is a common problem. The shelf life of charge in a tropical country like ours can possibly be recommended once this study is concerned. The extent of pressure decreases readily upwards from the base of the spool or core towards the upward direction as it is wound on it. Whether this pressure variation has any influence on charge or not is to be studied.

The entire study would be repeated for opaque film to find out the impact of the loading of TiO_2. For identical voltage and electric discharge whether the same extent of surface treatment is developed on other different films like BOPP, CPP, Pearlised OPP etc. is to be investigated. The following queries may be addressed.

1. PET film by virtue of its polarity develops surface charges during its fabrication whether further in line corona treatment just before its printing can modify the level of treatment or not is a matter of investigation, i.e.

   (a) does it enhance; (b) reduce or (c) have no influence may be investigated.

2. Does corona treatment on the surface of a printed film of a particular colour impart any additional adhesion called for its subsequent operation or have any negative influence may be investigated. In can be continued for other printable films also.

3. If two treated surfaces remain in contact over a long period of time under pressure, does the character of the surfaces charge.

4. The above series of experiments are to be repeated for neutralized films, foils and paper.

5. Now-a-days number of co-poly films, PVC, PVDC, PVDF films are in use for specific purposes. The influences of corona discharge on its surfaces and its subsequent operations are to be investigated in a similar manner as above.
6. The influence of treatment in adhesive jointing would be investigated.
7. The structural characterization through spectroscopic analysis and microscopic analysis would be carried out.
8. Whether any changes have been brought about due to treatment would be investigated by XRD analysis.
9. The frictional behaviour would be compared to the untreated surface.
10. The changes in surface haze and gloss or any other characteristics related to surface phenomenon might be investigated.

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