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INFLUENCE OF BLACK AND WHITE MASTERBATCHES ON THE TACK PERFORMANCE OF PIB USED IN SILAGE STRETCHWRAP FILMS

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1. PIB as a tackifying agent

PIB (polyisobutene or polybutene) is a migratory additive commonly used in stretch wrap films for the development of tack properties. It is known that the tack (or cling) properties of the tackified film are dependent on a number of factors including extrusion technique, film thickness, film structure, cooling rate, blow-up ratio, stretch ratio and so on. In order to determine whether, in coloured films, the pigment type also has an influence, CABOT has made a study of the tackiness of black films produced under controlled conditions incorporating 2 types of PIB and a number of very different grades of carbon black via PLASBLAK® masterbatches. Other information to assist users of PIB is also included.

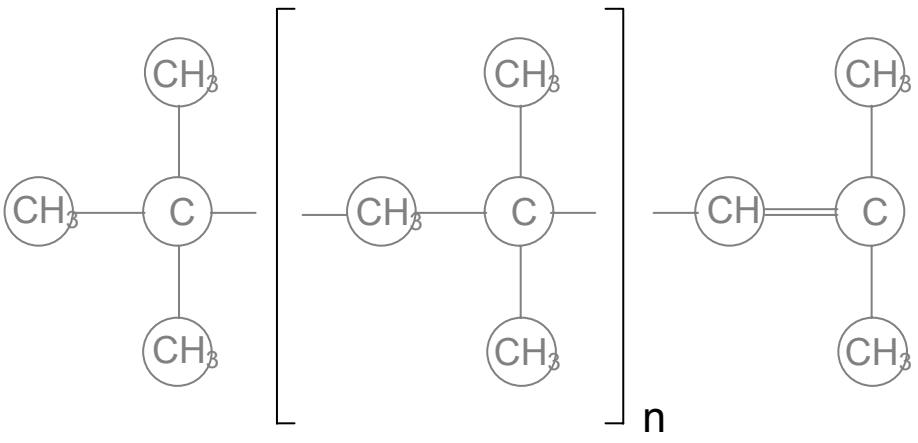
Why Use PIB?

There are a number of ways in which plastic films, usually LLDPE, can be given tack or cling properties. These include the use of different polymers such as EVA, VLDPE, atactic PP and metallocenes. However one of the most cost effective ways of introducing tack is the use of a relatively low amount of PIB either exclusively or in combination with one or more of the above mentioned polymers.

How Does PIB Work?

PIB is a synthetic hydrocarbon polymerised from an isobutene rich C4 stream. It approximates to pure polyisobutene but also has some n-butene incorporated in it. Each molecule contains an olefinic double bond at or near one end as shown.

Schematic Structure of PIB molecule.



The number average degree of polymerisation ("n") can range from about 3 to about 110. PIB itself is inherently tacky. Its incompatibility with the LLDPE used to produce the film means that it migrates to the film surface at a rate dependent on the temperature as well as the molecular weight of the PIB. Once at the film surface the presence of PIB will give tack properties to the film. In general the tackiness of PIB increases as molecular weight increases. The tackiness of formulations containing PIB depends not only on the type and concentration of PIB but also on the compatibility with other materials in the formulation.

2. Study of Film Formulations

Mono-layer films of 25µm thickness were blown at *Rapra Technology Limited* from C-8 LLDPE using a single screw extruder. The pigment and additives were incorporated via masterbatch which was pre-blended with the resin prior to film production. PIB was added by gravimetric injection via a heated pumping system into a CTM (cavity transfer mixer) fixed at the end of the film extruder.

Black films were produced at a typical carbon black loading of 2.4% although some containing 1.0% carbon black were also included. In addition to the carbon black a normal stabilisation package incorporating a low level of UV stabiliser was used. The films also contained 4.8% PIB which was either INDOPOL H300 or INDOPOL H1200 (courtesy of BP CHEMICALS).

The grades of carbon black selected had a wide range of surface areas with iodine numbers ranging from 30 to 270 m^2/g. They also had a range of structures with DBPA (dibutyl phthalate absorption) ranging from 48 to 120 $cm^3/100g$.

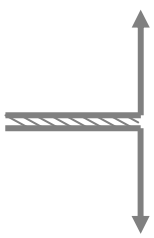
All films were refrigerated after production, followed a normal conditioning procedure of 3 days at 45°C and were then maintained in a humidity and temperature controlled environment at 25°C/50% RH prior to testing.

Tests for tack or cling

Test methods used were supplied by BP Chemicals

The **peel cling test** measures the force required to peel strips of film apart after pressing together under controlled conditions.

Peel cling test



The **lap cling test** measures the force required to separate a film overlap of given dimensions which has been pressed together under controlled conditions.

Lap cling test

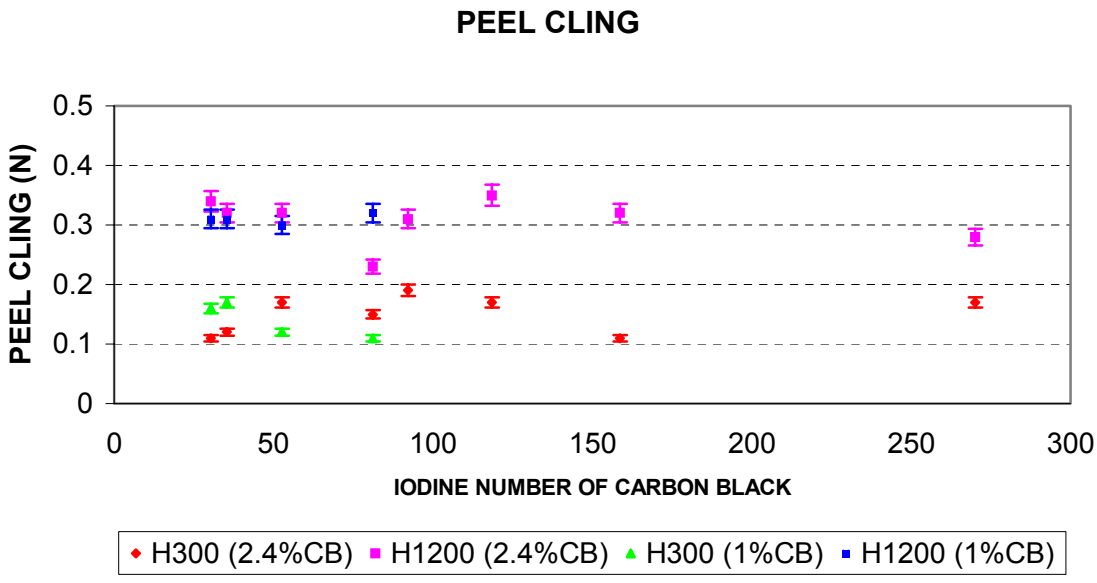
PIB content of the film and at the film surface is another way to check the migration of the PIB.

PIB level in the film is measured by extracting the films in n-heptane and evaporating the resulting solution.

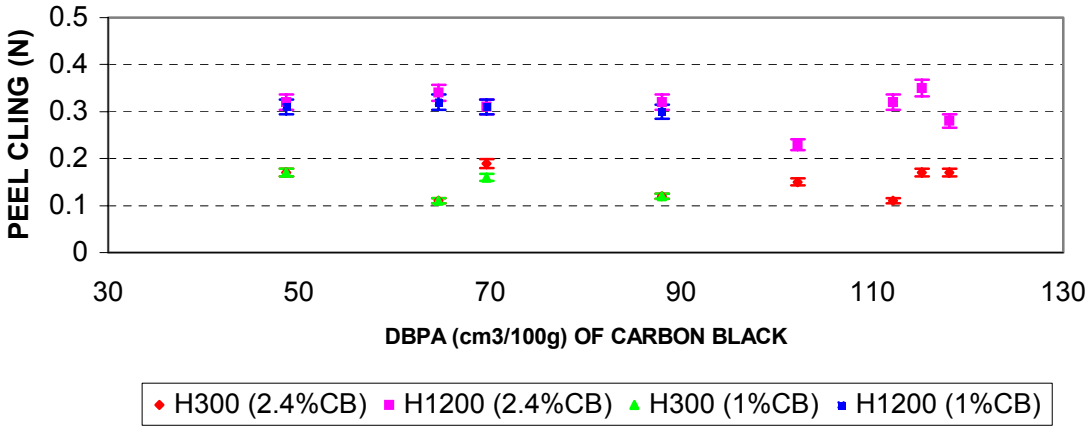
PIB level at the surface of the film is measured by washing a fixed area of film with a cotton cloth soaked in n-heptane then washing the cloth with the solvent and determining the amount of PIB in the resulting solution.

3. Results of Study

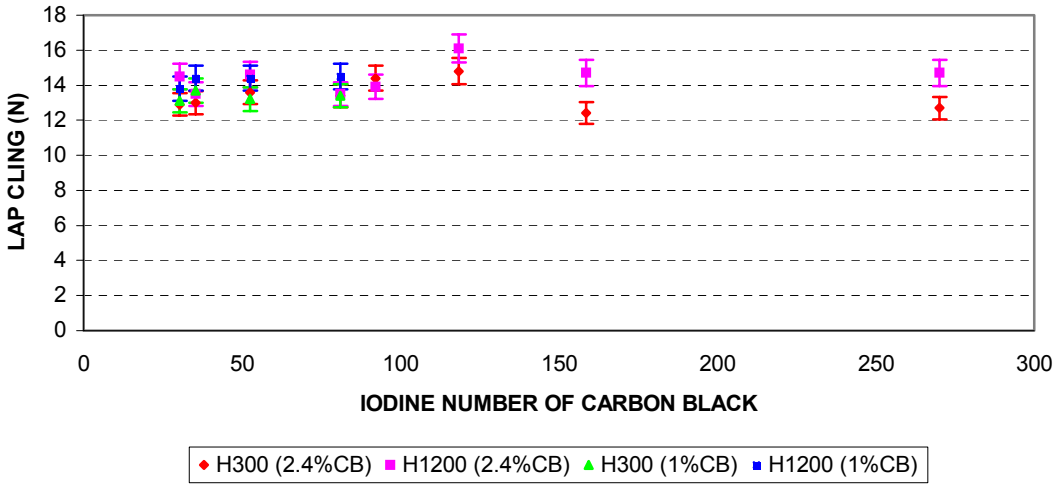
Measurements of peel cling and lap cling properties of the black films are depicted in the following charts. Values for each property, showing error bars, are plotted against carbon black surface area (iodine number) and carbon black structure (DBPA). 4 of the 8 types of carbon black included in the study have results at both 2.4% and 1.0% loading.



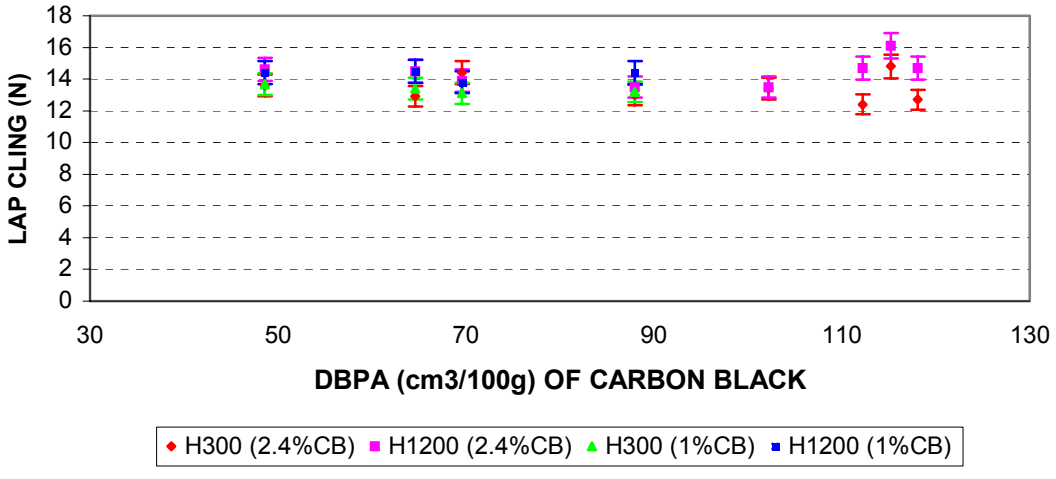
PEEL CLING



LAP CLING



LAP CLING



It can be seen that the molecular weight of the PIB used has a greater influence on the resulting tack properties, especially peel cling, than do the characteristics of the carbon black in the film formulation. The higher molecular weight PIB gives higher tack properties.

It can also be seen that the difference in peel cling and lap cling properties between an addition rate of 2.4% carbon black and 1.0% carbon black is negligible.

PIB CONTENT OF FILMS

Results of measurements made of the total PIB in each film and level of PIB on the surface of each film are given in the following table (the films are in order of carbon black particle size):

Film	Total H300 (%)	Surface H300 (%)	Total H1200 (%)	Surface H1200 (%)
2.4% CB1	4.6	0.45	3.9	0.43
2.4% CB2	4.7	0.42	4.3	0.39
2.4% CB3	4.5	0.39	4.3	0.35
2.4% CB4	4.7	0.41	4.0	0.48
2.4% CB5	4.5	0.38	4.3	0.38
2.4% CB6	4.5	0.41	3.9	0.40
2.4% CB7	5.5	0.40	3.9	0.41
2.4% CB8	4.4	0.48	4.2	0.40
1% CB2	4.9	0.38	4.2	0.43
1% CB3	5.0	0.46	4.0	0.44
1% CB4	4.9	0.49	3.9	0.41
1% CB5	4.7	0.41	4.1	0.40

These results show that similar levels of PIB are present in each film and that similar levels have migrated to the surface in each case independent of the type of PIB, type of pigment and level of pigment.

4. Conclusion and recommendations for use of PIB

Within the scope of this study, it is clear that the type and level of carbon black present in stretch wrap film does not influence the tack performance of the film given by PIB. The peel cling properties are greatly influenced by the molecular weight of the PIB used and a higher molecular weight should be chosen if greater tack performance is required.

The influences of processing have not been measured in this study as all processing conditions were kept constant.

For optimum masterbatch dilution, it is recommended that PIB is pumped into the extruder after the carbon black masterbatch and polymer have melted and are well mixed or homogenised in order to allow efficient mixing before the viscosity is greatly reduced due to the presence of the PIB.

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