Polyolefin elastomers boost end use performance of hot melt adhesives

Dr Burçak Conley, Dr Allan McLennaghan and Dr Selim Yalvac, Dow Elastomers, look at the growing market need for hot melt adhesives

The global adhesives market accounted for 24bn lb in 2013*, with hot melt adhesives (HMA) accounting for 15%, making it the third largest segment behind water-based and solvent-based adhesives. The HMA market is highly fragmented and includes more than 10 end-user applications, such as packaging, non-woven, pressure sensitive adhesive and book binding, as well as furniture and construction applications.

A RAPIDLY EVOLVING MARKET THAT BRINGS ITS OWN CHALLENGES

The development of the global hot melt adhesives industry is being driven by a number of evolving trends. Packaging industry brand owners and adhesive formulators are faced with the complex challenge of meeting end-user demands for food safety, while ensuring the shelf appeal, cost efficiency and sustainability of their solutions. Changes in consumer demographics, notably as the population ages, are adding factors, such as enhanced wear and comfort to the growing list of demands in the hygiene market.

The resulting relentless increase in the demand from adhesives formulators and brand owners for high-performance solutions that deliver new and improved application and performance properties, is driving suppliers to deploy their efforts to boost the end use performance of their hot melt adhesives solutions and, in doing so, providing a response to those challenges.

Source: *DPNA, Kusumgar

POLYOLEFIN-BASED ELASTOMERS DELIVER PERFORMANCE FOR HMA

Polyolefin elastomer (POE)-based HMA give excellent performance by surpassing EVA-based HMA formulations in three main categories: processability, adhesive performance and reduced total cost.

PROCESSING

POE-based HMAs deliver improved processing because of their better thermal stability, resulting in char-free and clean application equipment. The low or no gel formation reduces the applicator downtime and gives a consistent adhesive application, resulting in improved running costs and reduced scrap. There is also less wear and tear on the equipment, primarily due to the lack of acidity of the base polymer compared to EVA resulting in extended lifetime of filters and nozzles. Additionally, the ease of cleaning from machinery and the lack of angel hair result in more savings through reduced labour costs.

ADHESIVE PERFORMANCE

POE-based HMAs are better adhesives. Due to their low initial colour and good thermal stability of POE the end HMA has better colour compared to alternatives, as well as a lack of odour, thus making them a great fit for both packaging and hygiene applications. POE-based HMAs can also be applied on a variety of surfaces and, due to the lower density and viscosity, they can provide great adhesion, even if the POEs may not contain any polar functionality.

ENHANCED TOTAL COST

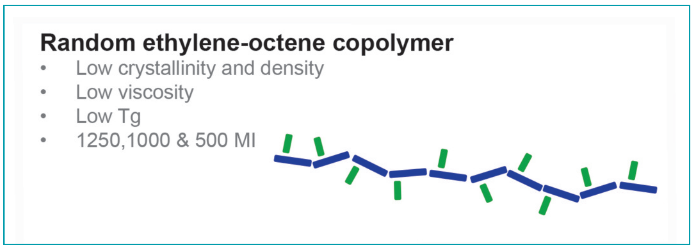
Overall, POE-based HMAs give the formulators and brand owners and packers improved mileage and lower maintenance for a better total cost and performance compared to EVA-based HMAs. Due to the improved thermal stability and lower density of Affinity GA POE-based HMAs, the mileage advantage can bring up to 30% saving. Also no need to change nozzles and filters for Affinity GA POE-based HMAs resulted in a significant decrease in downtime of machines compared to EVA-based HMAs again bringing additional operational cost saving.

PO-BASED ELASTOMERS MEET HMA MARKET NEEDS

The Dow Chemical Company was the first to introduce polyolefin-based copolymers into hot melt adhesive formulations some 15 years ago. Since then, this HMA formulation produced with Dow's Insite Technology, has demonstrated significant advantages compared to the use of traditional EVA-based HMAs.

The first introduced polyolefin-based polymer family was ethylene-octene random copolymers with the brand name of Affinity GA POE (**figure 1**). These random copolymers combine low crystallinity and low density (≤0.887 g/cc) with a very low viscosity. Due to Dow's Insite Technology, polymer architecture can be precisely controlled, so that the optimum balance of the necessary amorphous properties and strength can be achieved. Thanks to the higher

Fig 1. Affinity GA POE structure



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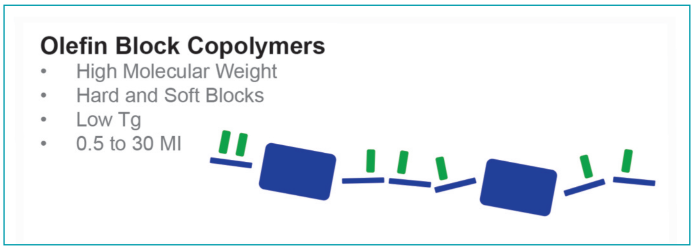
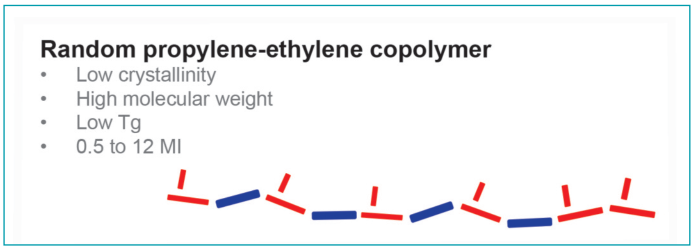


Fig 2. Above: Infuse OBC structure

Fig 3. Below: Versify elastomer structure



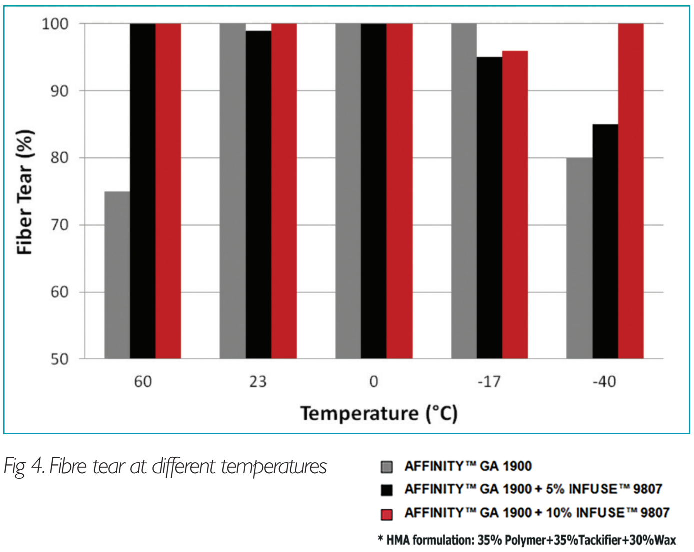


Fig 4. Fibre tear at different temperatures

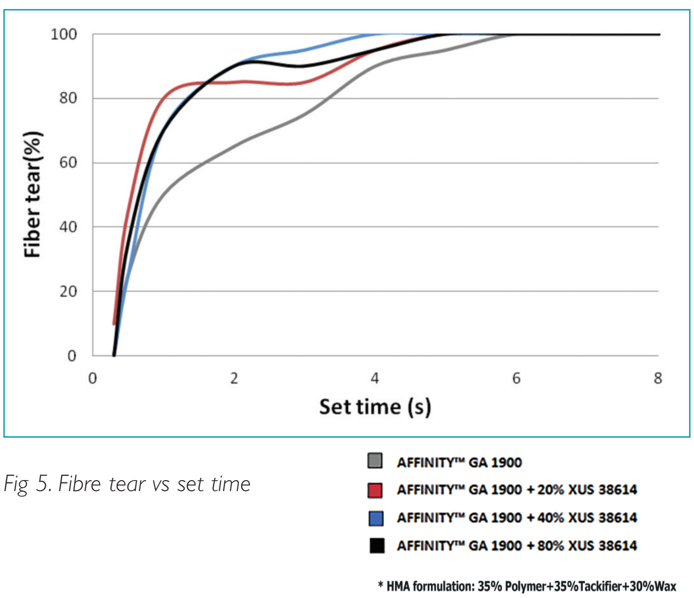


Fig 5. Fibre tear vs set time

levels of incorporated octene co-monomer, the glass transition temperatures of these polymers are lower than those of EVA grades used in HMA formulations. This makes the polymers more suitable for low temperature HMA applications (**figure 1**).

Since then, new classes of polyolefin-based elastomers have been developed through Dow's advanced knowledge in Insite Technology to precisely control the molecular architecture of the polymers. One such breakthrough was Infuse Olefin Block Copolymers (OBC) produced by 'chain shuttling technology'. These block polymers contain semi-crystalline 'hard blocks' and elastomeric 'soft blocks', making them unique as POEs. The hard blocks provide a high melting temperature, while the soft segments maintain the overall polymer elastic properties.

Among key differences between Infuse OBC and Styrenic Block Copolymers (SBC) are:

- SBCs are typically polymerised by living anionic polymerisation conditions with a narrow molecular weight distribution (Mw/Mn≈1.0-1.5) resulting in monodispersed diblocks or triblocks.
- OBCs are produced with chain shuttling technology and have a multiblock structure of alternating hard and soft blocks with a molecular weight distribution (Mw/Mn ≈2). Examples from Dow are Infuse OBC and Intune OBC (**figure 2**).

Last but not least, among the material types are propylene-ethylene random copolymers, marketed by Dow under the brand name of Versify Plastomer and Elastomer (**figure 3**).

A DIFFERENTIATED APPROACH TO ADDRESS DIVERSE PACKAGING TRENDS

Among key trends driving the development of adhesives for the packaging segments are the following:

- High to low temperature adhesion performance

In line with the lifestyle demands of today's consumers, food packages are exposed to different temperature conditions from high temperature (eg hot fill or pasteurisation) down to very low temperature (eg frozen food). HMA formulators are directing efforts towards developing adhesives for this evolving market trend, which will hold the package under a wide range of temperature conditions by giving increased packaging security.

The success of Dow Affinity GA-based HMA at low temperature can be attributed to the low Tg of Affinity GA providing ductility at low temperatures (**figure 4**). However, if formulators are looking for solutions pushing the limits, one possible approach is to add Infuse OBC 9807 into the HMA formulation. The hard blocks in Infuse will provide additional fibre tear at high temperature, while the soft blocks will give low temperature bond flexibility (**figure 4**).

- High speed packaging lines

With an eye on cost effectiveness, the industry is moving towards new manufacturing lines offering faster speeds. The HMA is expected to hold the package even after a short set time.

By using XUS 38614.00 an Experimental Polyolefin Plastomer (0.887g/cc with 1000 MI) material from Dow with a slightly higher density and crystallinity compared to Affinity GA 1900 (0.870 g/cc with 1000 MI) the HMA formulation will have additional strength at a shorter set time (**figure 5**) – thus facilitating a fast bond formation.

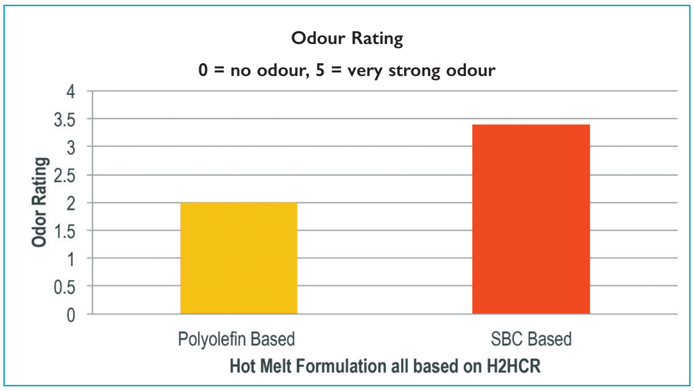
- Hard-to-bond surfaces

Either because of a focus on shelf attractiveness or to achieve certain barrier properties, it has been challenging to ensure adherence of some substrates to the boards, known as 'hard-to-bond' surfaces. Typical examples of hard-to-bond surfaces are PET, BOPP or coated Kraft papers.

In order to improve the adhe-

Table 1. Fibre tear on different substrates measured at a different temperature

Polymer (40%)	Substrate	Fiber Tear 60	23	- 25C
AFFINITY™ GA 1900	Black coated	97	100	27
AFFINITY™ GA 1900 + AFFINITY™ GA 1000R (20%)	Blank coated	100	100	77
AFFINITY™ GA 1900	Maize Meal Bag	93	92	3
AFFINITY™ GA 1900 + AFFINITY™ GA 1000R(20%)	Maize Meal Bag	100	93	75



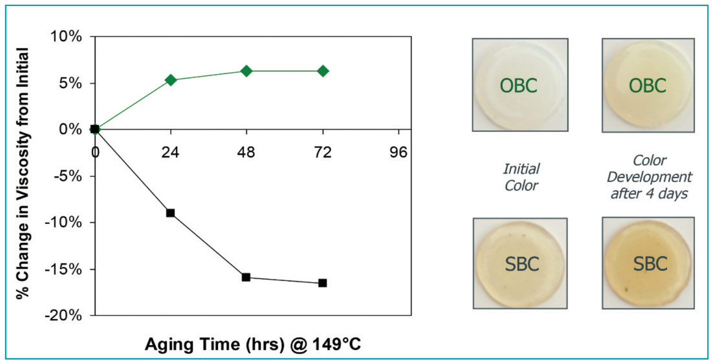


Fig 6. Odour rating of PO-based HMA vs SBC-based HMA
Fig 7. Above right: Colour and ageing of OBC-based HMA vs SBC-based HMA

sion performance, Dow has developed MAH functionalised ethylene-octene copolymer: Affinity GA 1000R. This material will provide additional strength to different substrates which are 'hard-to-bond' due to the polar groups (**Table 1**).

KEY HYGIENE TRENDS

There are also a number of critical trends affecting the development of HMA for the hygiene segment, including the need for reliable and secure feedstocks. In addition, the demanding customer base is looking for solutions that deliver:

● ***Low odour***

Customers want high quality materials that avoid unpleasant odours. When POE-based adhesives are used with the same tackifier as SBC, they provide better odour characteristics (**figure 6**).

● ***Colour and ageing***

The market increasingly demands solutions that deliver improved colour and viscosity stability over time. Ethylene-based polyolefin elastomers offer improved colour and viscosity stability (**figure 7**).

DOW WORKS WITH CUSTOMERS TO PROVIDE A STRONG RESPONSE TO MARKET NEEDS

As has been seen, brand owners and adhesives formulators are faced with an increasingly complex and demanding marketplace. Dow Elastomers is the 'go-to' innovation partner, delivering high performance solutions that provide customers with a strong response to their needs. The broad range of Dow's POE solutions combines performance criteria with cost efficiency and sustainability, thus creating a sustainable difference across the value chain.