Next generation speciality rheology modifiers for hair styling

Andrea Tomlinson and Dr Peter Hössel of BASF introduce Luvigel Fit and Luviset One

The hair styling market is dominated by a small range of specific products, with aerosol hairsprays, aerosol mousses and hair gels being by far the most widespread. In addition to these traditional products, new formats, such as waxes, creams and putties, are now being seen. In general, aerosol mousses, gels, creams, waxes and putties are used for style creation whilst hairsprays are used to set the style once it is in place.

Hair gels are most commonly used by people with short hair, where the target is to add texture and structure to hair without greasiness or waxiness. The gel is dispensed on the hand and applied manually to the hair. Traditional styling gels fulfill this function well although some issues exist with a lack of humidity resistance, gels running on the hands or flaking once dry on the hair.

Styling gels are usually based upon a combination of two or more polymers with very different properties and completely separate functions. One is added to contribute the styling properties, the other acts as a rheology modifier, building the viscosity of the system.

Design for performance
The styling performance of a polymer is influenced by its molecular weight (MW), monomer composition and polymer architecture. The higher the MW, the better the fixative effect on hair.

To achieve thickening performance, further modifications to the high molecular weight polymer are needed. To optimise shear thinning behaviour and give a pleasant texture, it is necessary to add chemical cross-linking via tri-functional monomers and/or long alkyl chains in order to create physical cross-linking via hydrophobic-hydrophobic interaction. Both measures will lead to swelling via osmotic pressure to provide thickening in water-based formulations.

It is important to have the right monomer composition in order to create specialty styling polymers with enough water solubility to achieve good wash-out. This is done by adding non-ionic hydrophilic monomers, such as VP, acrylic-based acids or quaternised amines.

The right balance of these hydrophilic moieties with other hydrophobic monomers is important to achieve humidity resistance for more tropical climates. Styling performance on hair is improved with monomers that inhibit free rotation around the C-C bonds of the polymer backbone via steric hindrance, such as t-butylacrylate or methacrylamide.

Polymer architecture can also be used to achieve additional performance benefits. If the level of chemical cross-linkers in a thickener is limited, this can reduce the tendency of the gel to run on the hands by improving the electrolyte tolerance. A lower MW is necessary to achieve sprayability in gel sprays and aerosol sprays.

Finally, the film-forming properties of the polymer and the polymer combination used in the final styling formulation influences the styling performance. Elastic polymer films with balanced cohesive forces are preferred, so as to achieve good adhesion with less breakage of the polymer films on hair under mechanical stress. This can lead to better setting and less visible particles, which are seen by the consumer as flaking.

Rheology performance
Carbomer is one of the most efficient and widely used thickeners in cosmetic applications, including hair styling. However, there are several drawbacks to it in-use and an increasing number of products are being launched with alternative thickening systems.

Although carbomer offers the best performance for thickening in combination with PVP, there are limitations in styling performance, such as low setting power, low humidity resistance, running of the gel on application and visible flaking on hair. Improvement to
performance by combining carbomer with anionic and cationic polymers can be limited by polymer incompatibilities.

Liquid thickeners based upon hydrophobically modified alkali-swellable emulsion (HASE) technology provide better compatibility with anionic and cationic styling polymers and are able to overcome the drawbacks seen in traditional formulations. Due to physical cross-linking via hydrophobic-hydrophobic interaction, they are less salt-sensitive and provide a more creamy texture in formulations.

HASE thickeners can be designed by balancing chemical and physical cross-linking to achieve new and different textures from light to creamy or fibrous. Figure 1 shows the rheological behaviour of two BASF gel formulations based on HASE thickeners, Luvigel Fit (INCI: Acrylates/C10-30 Alkyl Methacrylate Copolymer) and Luviset One (INCI: Acrylates/Methacrylamide Copolymer), compared with a traditional carbomer/PVP formulation.

The viscosities at high shear stress around 500 Pa are in the same range and reflect the gel consistency that is important during application (30-60 mPa s). The low shear viscosity at 0.1 Pa indicates the ability to stabilise air bubbles and suspend particles. This can be seen as either a benefit or a negative, depending upon consumers’ preferences. Air bubbles are stabilised when the low shear viscosity is higher than about 1,000 Pa. This property can be adjusted by the choice of the polymer combination.

These new rheology modifiers have been specifically designed with the functionality of hair styling in mind. The benefits of using a specialist thickener rather than a more general purpose rheology modifier mean that the performance of the styling system can be addressed by both the rheology modifier and the styling polymer.

Speciality styling polymers
Acrylic acid chemistry in particular offers a flexible route to cost-efficient polymers with enhanced performance. For example, Luvigel Fit has been designed specifically for hair styling applications. It functions as a thickener which also boosts the overall setting performance of the styling system compared to a base thickened with carbomer (Figure 2).

Figure 2 - Effect of Luvigel Fit v. carbomer on styling performance of PVP K9

This allows overall polymer levels to be reduced to achieve the same performance or, if polymer levels are maintained, a higher level of setting is achieved. Lower polymer levels can result in lower flaking and lower costs.

Luvigel Fit can be formulated with other BASF non-ionic, anionic and cationic styling resins, including Luvisel PVP K90 (INCI: Polyvinylpyrrolidone), Luvisol VA 64 (INCI: Vinylpyrrolidone/Vinyl Acetate), Luviset Clear (INCI: Vinylpyrrolidone/Methacrylamide/Vinyl Imidazole Copolymer and Luvisquat Supreme (INCI: Polysquaternium-68), to give clear and effective styling gels. However, it is important to note that the rheology profile is different to systems formulated with carbomer-type thickeners, with a greater degree of flow and more shear thinning.

Luviset One is a rheology modifier that can remove the need for an additional styling polymer altogether. The polymer functions as both the thickener and styling polymer. It can be formulated alone at 4% active solids to provide a fully functioning hair styling gel with excellent setting performance (Figure 3).

It is in the design of the polymer that curl retention and humidity resistance are achieved, while polymer levels can be adjusted to offer higher levels of hold. New consumer products in styling make claims for 24- and 48-hour hold and even sports and sweat resistance.

The monomer and cross-linker composition of new polymers like Luviset One have also been selected to offer curl retention and humidity resistance while still having easy wash-out. Older styling resins, such as PVP and VP/VA, while offering highly cost-effective styling, are also very hygroscopic monomers, making ‘long-lasting’ claims difficult.

Luviset One can be used to provide a chassis system for a wide range of styling products. At 4%, it offers excellent performance. However, the market is also seeing growth in the extreme styling sector and low level additions of anionic, non-ionic or cationic polymers, such as Luviner 100P (INCI: Acrylates Copolymer), Luvisquat Supreme or Luvisel PVP K90, can boost styling performance to extreme heights. It is usual to see an increase in flaking when polymer levels are increased but, in this case and in particular with acrylates copolymer, a synergistic reduction in flaking was actually seen.

Luviset One has also been found to demonstrate benefits in the preparation of a range of new and novel hair styling formulations. Trials were conducted where its emulsification power was tested. Levels of 5-10% of typical cosmetic oils were cold-processed with the polymer and it was found capable of providing stable emulsions with the oils tested, which included a mineral oil, a cosmetic ester, a silicone and a vegetable oil.

Further hot process tests were also conducted with waxes commonly used in hair styling and here again the polymer was found to emulsify and stabilise levels of 5% and 10%. These tests offer the basis for further new and novel formulations fitting with modern market trends.

Conclusion
Modern polymer technology allows the design of speciality materials meeting the needs of the modern consumer for hair styling. Speciality polymers can deliver benefits in terms or lower flaking, better humidity resistance and simpler formulations.

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