

# A new multi-functional quaternary polymer: much more than a styling agent

*D. L. C. Jones, Dr S. P. Chahal and E. Smart, Croda Chemicals Limited*

## Key words

Hold, Curl Retention, Anti-Frizz, Flexible hold, Natural hold, Starch, Quaternary polymer

## Introduction

In recent years there has been a tremendous growth in the hair styling market leading to ingredients suppliers developing and offering a very wide range of styling polymers. Although these polymers are designed to impart different functionalities, they are predominantly related to hair fixative benefits, that is, offering strong hold or a more flexible natural hold, for example. The chemical nature of these styling polymers varies but the most widely used are typically copolymers or terpolymers based on monomers such as methacrylates (e.g. DMAEMA), vinyl pyrrolidone, vinyl acetate and acrylic acid.

This article discusses the functionality of a new innovative cationic styling polymer (MiruStyle MFP) that is derived from a natural source (hydrolysed maize starch). MiruStyle MFP offers outstanding hold benefits compared to traditional polymers, whilst maintaining a flexible feel that does not detract from the aesthetic properties of the hair. This innovative material also provides excellent anti-frizz properties and reduction of static fly-away.

Traditional fixing polymers, whilst offering good hold, can leave the hair feeling stiff, brittle and tacky to the touch. Hold is achieved by these materials through the formation of inter-fibre bonds; that is, gluing together adjacent hair fibres. These bonds are generally brittle and movement of the hair fibres will cause these bonds to break, thus reducing the hold observed.

MiruStyle MFP provides hold via a different mechanism; instead of forming brittle bonds between hair fibres, it coats

each hair fibre with a flexible film. The cationic nature of MiruStyle MFP gives rise to inter-fibre repulsion whilst also providing enhanced conditioning benefits giving rise to a more natural and softer hair feel.

This article also highlights the properties of this innovative cationic styling polymer in comparison to a number of market leading styling ingredients, using a range of laboratory tests .

## Methods and Materials

Switches of virgin European brown hair were used for all the studies. (Obtained from International Hair Importers.) A basic

| Formulation 1. Basic hair spritz. |               |
|-----------------------------------|---------------|
|                                   | % by weight   |
| Water                             | 65            |
| Ethanol DEB 100                   | 30            |
| Natrasol (HEC) 2% solution        | 5             |
| TEA                               | to pH 6.0     |
| Test Polymer                      | 2.5 % actives |

| Formulation 2. Styling Gel for curl retention study. |             |
|--|-------------|
|  | % by weight |
| Part A   |             |
| Water  | to 100%     |
| Carbopol Ultrez 21 (thickner)                        | 1%          |
| Triethanolamine                                      | 1%          |
| Part B   |             |
| Styling Polymer                                      | 2.5% active |
| Hydrosolanum (conditioning)                          | 1%          |
| Crovol PK-70 (plasticiser)                           | 1%          |
| Germaben II (preservative)                           | 1%          |
| Viscosity = 86,000cps, pH=6.0                        |             |

hair spritz formulation (Formulation 1) was used for all testing and test polymers were added to this formulation at 2.5% actives unless otherwise indicated.

## Results and Discussion

### Curl retention

It is well known that if human hair is held in a desired formation while drying it will tend to retain that shape, for example if hair is dried in rollers it will result in the hair being curly. This however is temporary and the hair will revert back to its natural state over time. Styling aids can be

used to retard the rate at which the hairs revert back to their natural shape.

A generally accepted method in the hair toiletries industry for measuring curl retention has been used to evaluate the effectiveness of MiruStyle MFP for styling hair. This was compared with the effectiveness for curl retention of a range of other traditionally accepted styling aids.

The essence of the method was that standard hair switches of 15mm in width were wound onto curlers, where they were treated under the specified conditions and dried at ambient humidity for 24 hours. Following this each switch was carefully removed from the curlers and freely suspended; the length of each switch was measured both initially and after allowing it to relax under the test conditions (80% RH, 25°C for 120mins).

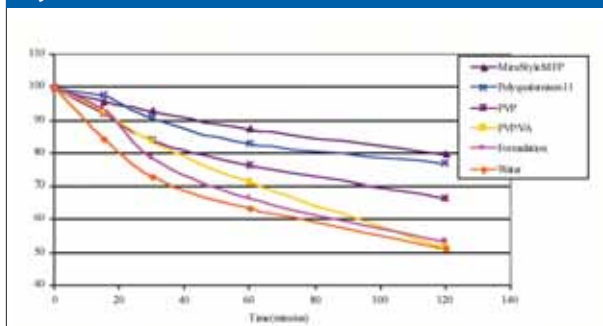
All materials were tested from the aqueous spritz formulation at 2.5% active inclusion levels. Figure 1 shows the results obtained.

Comparative statistical analysis of the results between polymer types demonstrated that MiruStyle MFP outperforms PVP and PVP/VA styling polymers. The performance of MiruStyle MFP compared with Polyquaternium 11 is similar with both styling agents demonstrating excellent style retention benefits.

A second study was undertaken comparing the performance of MiruStyle MFP from a styling gel on curl retention compared to PVP and PVP/VA copolymer. This study used the formulation outlined previously and utilised a visual assessment technique. A half head study was carried out on a mannequin head, the hair was styled with the appropriate gels photographed then subjected to a high humidity environment (85% RH) for 4 hours, after which the heads were photographed again. Differences in the styling performance between the gels at high humidities are apparent from the before and after photographs (see Figure 2). The study was repeated using the same formulation but including PVP/VA in comparison to MiruStyle MFP, in this study the heads were subjected to a higher humidity (98% RH) over 4 hours and photographed before and after, (see Figure 3).

The results clearly show greater fall out of the curl on the sides of the heads treated with the PVP or PVP/VA styling gels compared to the MiruStyle MFP styling gel. This would indicate that the styling gel containing MiruStyle MFP outperforms the styling gel containing PVP or PVP/VA at high humidities.

Figure 1. Curl retention studies.



High humidity curl retention studies demonstrate the superior holding properties of MiruStyle MFP.

Figure 2. After 4 hours at 85% RH.

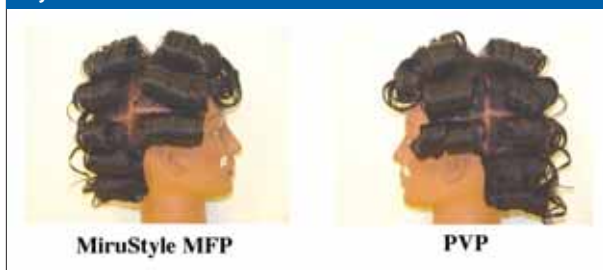


Figure 3. Before and after 4 hours at 98% RH.



Figure 4. 'Tack' assessment.

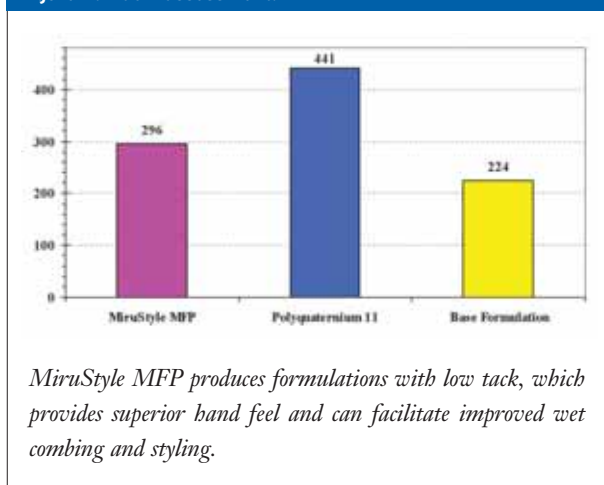
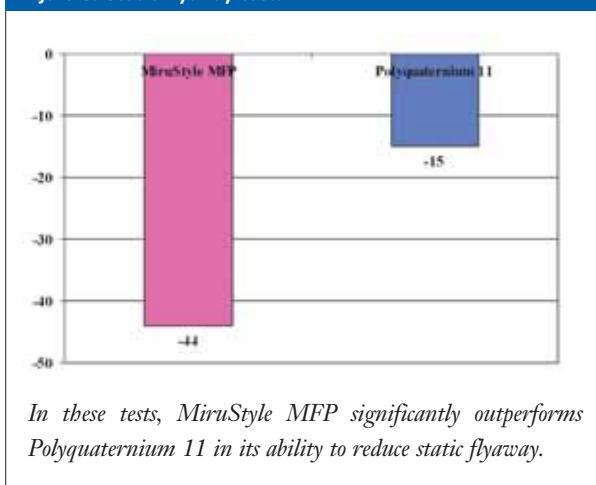


Figure 5. Static flyaway test.



**Tack**

The texture and feel of a product are important factors along with the appearance, smell and performance. One contributing factor towards the feel of a product is the tack, or stickiness. Styling products are by the nature of their holding properties susceptible to leaving an undesirable sticky feel on hair or hands after application.

The method used for assessing the tack of the formulation is the tack test. This method is carried out on a Dia-Stron Mini Tensile Tester (MTT).

All measurements were conducted in a controlled temperature and humidity environment, under standardised MTT operating conditions. 0.25ml of the formulation containing the styling agent at 2.5% actives was applied to the

equipment and five readings taken. This was repeated five times for each formulation.

The results clearly indicate that the addition of MiruStyle MFP to the formulation has only a slight impact on the tack of the base formulation, whereas Polyquaternium 11 that scored second in the curl retention test almost doubles the tack of the base formulation.

**Static flyaway**

Static flyaway is a common cosmetic condition, resulting from the build-up of electrical charge on the hair surface, impairing hair manageability. There are two primary factors involved in the generation of a static charge on hair:

- The rubbing forces involved during combing of the hair;

Figure 6. MiruStyle MFP confers significant anti-frizz benefits to hair prone to frizzing.



- The difference in electrochemical potentials of the surfaces of hair and grooming instruments (combs/brushes etc.).

Standard hair switches of 15mm in width were taken and washed with a 10% SLES solution and allowed to dry under ambient conditions for 24 hours. The switches were then treated with the study formulations and allowed to dry under ambient conditions for 24 hours. Each switch was then combed through and placed under 35% RH for 90 minutes. The switch angle was then measured and the switch was then combed through in a controlled manner using a plastic comb ten times to achieve static flyaway. The angle of switch flyaway was then recorded. This was done using ten paired switches.

MiruStyle MFP was shown to reduce static flyaway by 44% whilst Polyquaternium 11 (figure 5), under the same conditions gave a reduction in static flyaway of 15% ( $P < 0.001$  for both results). Water was used as the control in this test. Comparative statistical analysis showed that MiruStyle MFP outperformed Polyquaternium 11 by 55% ( $P < 0.002$ ).

### Frizz reduction

Frizz is a common cosmetic condition, resulting from alterations to the chemical bonding within the hair fibre. The hydrogen bonds within hair are affected by its water content and therefore by changes in atmospheric humidity. As humidity rises, the configuration of hydrogen bonds changes, as the bonds break and reform. This creates increased curl and/or frizz in hair that has a natural tendency to curl.

Tresses of hair prone to frizzing were subjected to an atmosphere of 70% relative humidity at room temperature for 2 hours.

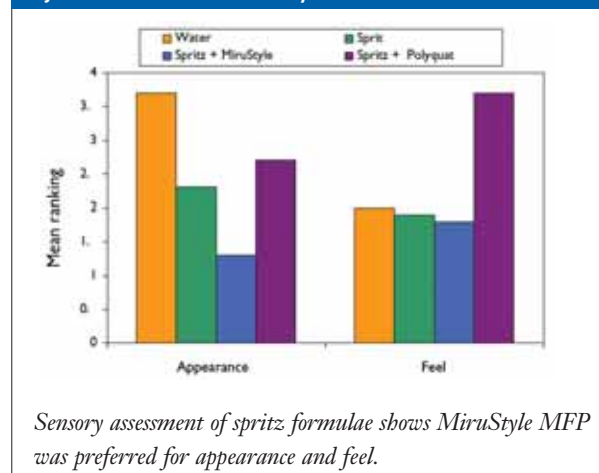
The hair pre-treated with a simple aqueous spritz containing MiruStyle MFP (2.5% active) showed a significant reduction in frizz compared to the other tresses tested (figure 6).

### Sensory evaluation

Subjective evaluation demonstrated that MiruStyle MFP provides excellent hold without dulling or adversely affecting the feel of the hair. A subjective panel methodology was used; a panel of evaluators compared the feel and appearance of hair treated with MiruStyle MFP, delivered from the simple aqueous spritz formulation, to that treated with Polyquaternium 11 delivered from the same spritz formulation. In this we asked the panel to rank the tresses on

a five point scale of quality, considering in each case the separate attributes of feel and appearance. The scores are represented in figure 7. In particular the hair treated with MiruStyle MFP was noticeably softer and appeared silkier than the hair treated with Polyquaternium 11.

Figure 7. Panel test for sensory evaluation.



### Mildness

*In vivo* patch test assessments demonstrate that MiruStyle MFP is ideally suited to use in leave-on styling products and other applications where mildness is an important factor. Measurement of erythema and increase in TEWL (indicating barrier disruption) showed no significant difference, after five hours of application, between a site treated with a 5% active solution of MiruStyle MFP and an untreated site

### Conclusions

This paper highlights the outstanding styling performance of MiruStyle MFP, with its excellent natural, flexible feel rather than solid hold. Its ability to reduce static and frizz, whilst not providing any observable extra tack to a formulation. MiruStyle MFP also provides excellent sensory benefits leaving hair feeling soft, natural and appearing silkier.

### Authors

D. L. C. Jones, Dr S. P. Chahal and E. Smart  
Croda Chemicals Limited,  
Cowick Hall, Snaith,  
Goole, East Yorkshire DN14 9AA,  
United Kingdom.