

# Fast-Acting, Skin-Firming Polymer Technology

***Interpolymer researchers have developed a novel polymer technology with the ability to provide quick, quantifiable skin firming, without buildup or flaking.***

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**A** MULTITUDE OF SKIN CARE formulas have emerged recently on the market claiming the ability to tighten or firm skin over time. The method in which this is accomplished is as varied as the raw materials being employed. What many products have in common is their use of botanical, naturally-derived or cosme-

ceutical ingredients, which reinvigorate, replenish, restore or regenerate the skin. Longer-term anti-wrinkle, anti-aging or anti-stress results are often obtained biologically by retarding the aging process of cells. Yet, consumers must often wait for a period of 4-6 weeks before any noticeable or lasting effects occur.

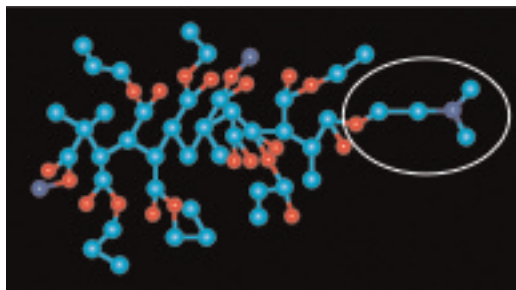
Formulators are being asked to respond to a call from end-users demanding more immediate and noticeable benefits. To meet this challenge, formulators must provide a mechanism capable of delivering more immediate sensorial effects without an

adverse impact on the aesthetics of the formula or inhibiting the active ingredient's ability to provide the longer-term benefits. This article describes a novel polymer technology with the ability to provide quick, quantifiable skin firming, without buildup or flaking.

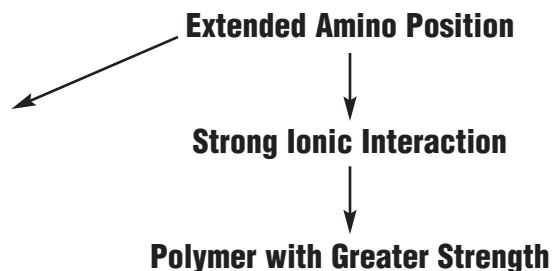
## **Mechanism of Action**

A unique bimodal polymer technology was designed to form an interpenetrating network delivering both cationic and anionic functions in the same aqueous vehicle. The result is a reversible, cross-linked polymer complex achieved by the ionic associations of the two

***Fig. 1: Molecule and extended amino portion***



**Attraction is one of the factors in the unique bimodal polymer's performance.**



types of functional groups attached to polymer chains which provide both holding power and ease of removal. The anionic chain contributes to the polymer's removal properties and the cationic chain imparts polymer substantivity. Bimodal polymers have film formation temperatures that are balanced to provide flexible, humidity resistant films with good adhesion to the stratum corneum.

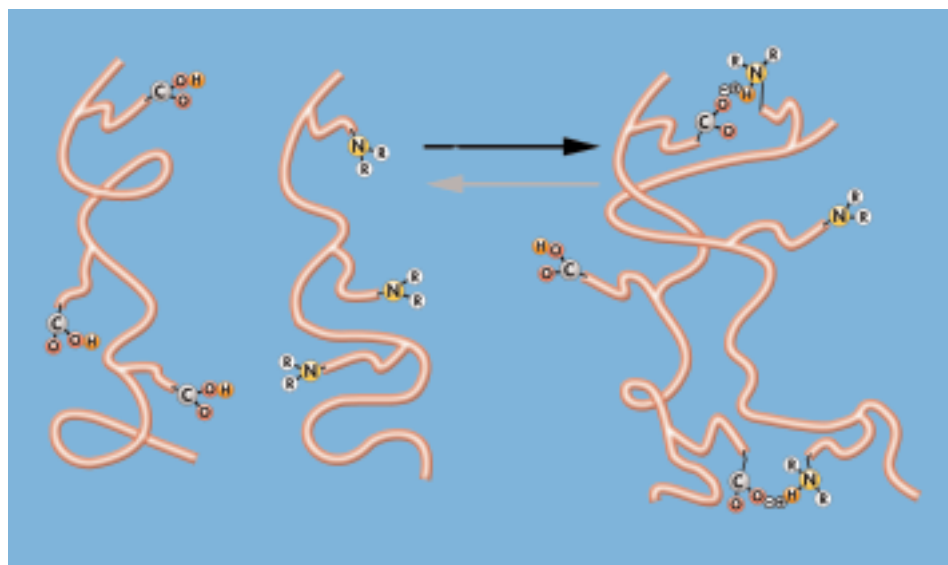
The illustration is a theoretical depiction of a polymer segment composition showing how co-monomer selection and molecular weight control optimize ionic interactions, which result in specific setting and film formation properties. The polymer composition

plays an important role in this geometrical steric configuration and electrical interaction. By including strongly electronegative or electropositive groups on separate molecules, an inductive shift of electrons can be attained during the drying phase. This shift plays an important role in the polymer's cohesive and adhesive properties. Since the bimodal polymers are composed of both anionic and cationic polymers, there is a great potential for the polymer chains to exhibit this shift in electron density. At large molecular distances, these polymer chains would behave like an electrically neutral system. However, as the ionic groups are brought into close proximity to their counter-ion during the drying process, strong secondary bond forces begin to exert their influence and the polymers begin to associate forming an interpenetrating network. This gives the bimodal polymers their unique characteristics. This novel and patent-pending technology relies on the ability to produce stable dispersion and solutions containing polymer molecules with different ionic charges.

*Fig. 2* above illustrates the ionic interaction during the drying process.

During the drying process, the

**Fig. 2: Formation of the interpenetrating network**



bimodal polymer will form an ionic complex before the final film is completely dry and sets on the skin. The interpenetrating network is illustrated by the black arrow in *Fig. 2*. The ionically associated polymers not only adhere to themselves but to the skin substrate. As the water or solvent is evaporated and film volume lost, the polymer complex "pulls" the skin by the ionic charges of the complex. When the film has dried, the polymer has sufficient tensile strength to maintain the drawn skin in a taut position. This is a reversible process, as evidenced by the gray arrow, with the addition of any anionic cleansing solution. These mild solutions are capable of detangling the interpenetrating network by overcoming the weaker ionic bonds of the polymer association.

### Skin Tightening Studies

In order to validate whether the above described mechanism of action was tightening skin, tests were commissioned at Springhouse Skin Research, Inc. in Merion, PA during January and February of 2007.

In a double blind feasibility study, four prototype formulas were prepared utilizing combinations of a bimodal

polymer, which has the INCI of Polyacrylate 21 (and) acrylates/dimethylaminoethyl methacrylate copolymer. The formulas were:

A = Formula F-24-55, with the following INCI label ingredients: Water, polyacrylate 21 (and) acrylates/dimethylaminoethyl methacrylate copolymer, hydroxy propyl starch phosphate, butylene glycol, DMDM hydantoin, Ext. Violet 2.

The prototype formula contained a total of 5% solids of the bimodal polymer.

B = A solution containing 2.5% solids of the bimodal polymer.

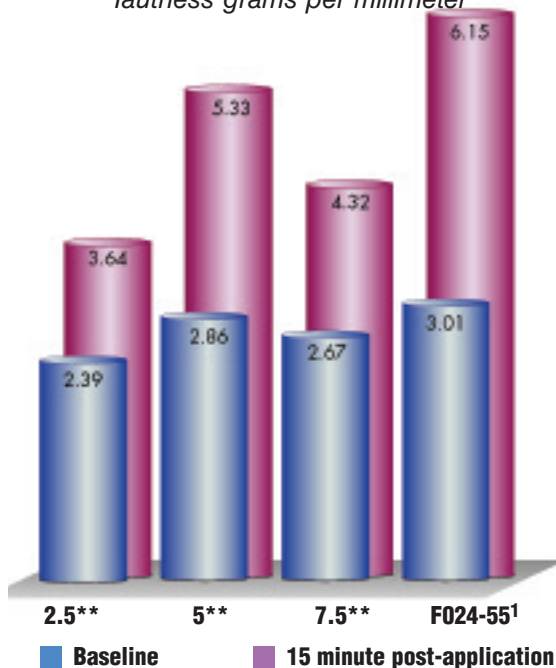
C = A solution containing 5% solids of the bimodal polymer.

D = A solution containing 7.5% solids of the bimodal polymer.

The formulas were applied to the face of an adult Caucasian female at the crow's foot and under eye area using a Q-tip. Formulas were applied on opposite sides of the face on two separate days: A and B on day 1 and C and D on day 2. After 15 minutes, the skin sur-

**Fig. 3: Results at 15 minutes**

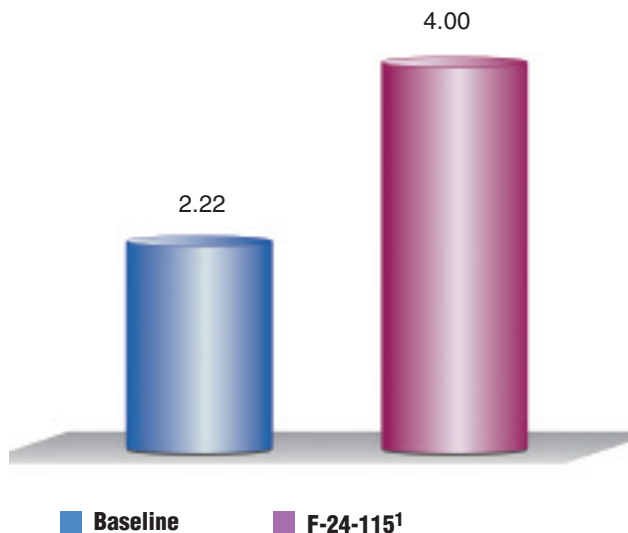
**Skin Surface Tautness\***  
15 Minutes Post Application  
Tautness grams per millimeter



\*In vivo test using gas-bearing electrodymanometer  
\*\*Percent solids of Syntran PC 5100  
1 Contains Syntran PC 5100@5% N.V.

**Fig. 4: Results at five minutes**

**Skin Surface Tautness\***  
5 Minutes Post Application  
Tautness grams per millimeter



\*In vivo test using gas-bearing electrodymanometer  
1 Contains Syntran PC 5100@5% N.V.

face laxity was measured using a Hargens Gas Bearing Electrodymanometer (GBE). To obtain GBE measurements, a small plastic button was cemented to the skin using cyanoacrylate, and the GBE probe affixed to this button with double-faced adhesive tape, for each of the successive measurements. Skin surface tautness is equated to the Dynamic Spring Rate (DSR) as defined on page 300 appendix I of 1989 American Oil Chemists Society article by M.S. Christensen and E.W. Packman. This parameter is analogous to Young's modulus, measuring the sheer force required to stretch the skin, in the plane of the surface.

The results of the test indicated that 5% solids levels of the bimodal polymer (formulas A & D) were optimal for obtaining skin tightening results, with scores of 104% and 86% respectively (Fig. 3). Formula A, which contained

ingredients known to plasticize films, did not have an adverse effect on the end results as shown below. Finally, none of the films formed during testing appeared to peel, crack or flake.

### Superior Humidity Resistance

Another test was conducted in an attempt to determine whether the bimodal polymer could tighten in less than 15 minutes. In this next study, a baseline measurement was taken followed by a reading at five minutes utilizing the established protocol outlined above with the GBE. A new control formula, F-24-115, was developed to remove a known plastizer and to ensure faster drying times. The formula contained 5% polymer solids, as before, and the following INCI label:

*Water, alcohol denatured, polyacrylate 21 (and) acrylates/dimethylaminoethyl methacrylate copolymer,*

*hydroxypropyl starch phosphate, DMDM hydantoin, green #5, fragrance.*

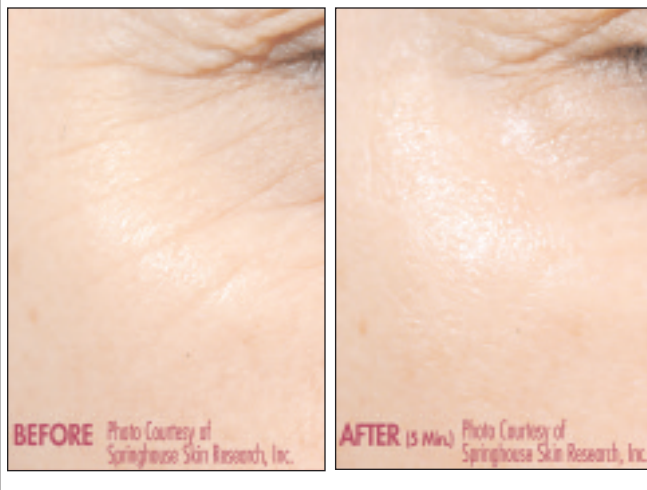
Results demonstrated that after an initial period of five minutes, the skin tautness was 86% greater than initially observed during the baseline measurement as shown above in Fig. 4. As before, the formula tested did not appear to crack or flake.

During this study, formula F-24-115 was applied to the subject's face and close up digital color photos were taken before and five minutes after the formula was applied (Figure 5, next page). There appeared to be a very noticeable effacement of the lines/wrinkles around and under the eye. This visual effect of skin tightening was consistent with the data that was generated during both rounds of GBE tests.

During the GBE testing, the duration of effect was only measured out to the 2-hour mark. In the first study, formu-

### **Fig. 5: Before and After**

Five minutes after polymer application, there appears to be a noticeable effacement of lines/wrinkles around and under the eye.



las containing polymer dilutions approached the baseline scores for skin firming around the 2-hour mark. With control formulas containing 5% bimodal polymer solids levels, tautness was sustained at 25-33% of first measured readings. Since cosmetic formulas contain a multitude of ingredients that may either interfere with the bimodal polymer's ability to form ionic bonds or plastisize the resultant film, initial expectations were that GBE readings for the formulated controls would be less than those of the diluted polymer. This however, was not the case and would suggest that longer durations could be sustained with appropriate formulation adjustments.

Formulators should consider incorporating a bimodal polymer such as Polyacrylate 21 (and) acrylates/dimethylaminoethyl methacrylate copolymer to their arsenal of raw material ingredients designed for use in skin firming products. This novel cosmetic ingredient provides the end-user with relatively quick skin-firming results and can complement other active ingredients designed to provide longer term and longer-lasting benefits. The ability of bimodal polymers to set quickly in high humid conditions and yet form a resilient, non-flaking and breathable film, make them a viable alternative to present day film formers used in skin care formulations. ●

***For more information regarding this technology, contact:***

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