Controlled Surfaces and Novel Polymers for Personal Care: Self-Assembly of Polymers and Surface Modification

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ABSTRACT

Cosmetica develops and applies nanotechnology and advanced polymer chemistry to create novel products for the cosmetic industry. We achieve this goal by controlling the spontaneous self-assembly of polymers and/or colorants at surfaces. Current research projects include new hybrid special effects pigments, and systems for hair color, hair hold, sun protection and conditioner. Many of today's commercial coloring products involve reactive precursor blends, which cause staining and other undesirable effects. In contrast, hybrid pigments can be deployed to impart both desired physical attributes and enhanced color. Self-assembly of polymers and biopolymers can also be used to produce hair styling formulations and conditioning agents. A diverse range of polymers with differing physical properties which synergistically combine to stabilize the form of hair impart both styling and conditioning effects. In addition, self-assembly of a network forming polymer delivered in an aqueous solution can be engineered to produce a fabric softener, to offer UV blocking, and to provide stain protection for fabrics without the use of fluorine.

Keywords: self-assembly, polymer, conditioner, hair styling, pigments.

1 SURFACE MODIFIED EFFECTS PIGMENTS

Traditionally, titanium dioxide coated micas have found utility for producing color effects in a wide range of applications. By varying or controlling the thicknesses of the coatings on the particles, optically variant properties can be generated such as reflecting red to blue color. This has been the state of the art of the effects pigments.

1.1 Pigment Coupling to Surface

Optically active pigments provide a nacreous effect with color. However, the color that is generated is subtle, and a more intense version that still maintains the nacreous effect would be desirable. Utilizing the appropriate chemistries, it is possible to create a strong interaction between colorants and substrate particles. This can produce a new pigment with a range of properties, such as enhanced coloration, color effects using the reflective color of the substrate and the absorption color of the pigment, and can allow one to modify the hydrophilic / hydrophobic surface energies of the composite particles.

2 HAIR COLORATION

Traditional hair coloration techniques can damage the hair or can result in harsh chemical byproducts that may be dangerous to the recipient.

2.1 Control of Pigment Chemistry

Coloration of hair by performing the chemistry offline instead of on the head is an ideal situation to insure the safety for both the recipient and the stylist. This can be achieved by advanced polymer chemistry using surface induced self assembly in a one-step or a two-step system for coloring hair.

3 HAIR STYLING SYSTEMS

Many commercial hair styling systems leave the hair in either a damaged or an altered state. Many systems rely on a heavy build up of polymers or by chemical alteration. We shape the hair by one-part or two-part systems that use the structure of specific polymeric systems to impart control.

3.1 Polymeric interactions

In a one-part system, an emulsion is used to deliver appropriate polymers for controlled self-assembly to their preferred state, following which a drying action locks the polymers together..

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Figure 1: Hair hold from emulsion at 0.1, 0.2 and 0.4% after 24 hr at 90% humidity- no emulsion, no hold

The two-part system involves a subsequent delivery of the appropriate polymers to the surface of hair. If the combination of polymers is not deployed in either the appropriate sequence or derived from the appropriate precursor polymer, the desired effect is lost. The fundamental principle here is complexation of polymers and self-assembly of the first polymer on the surface of the substrate.

4 HAIR CONDITIONERS

Many commercial hair conditioners can build up on the hair and leave it with the opposite effect of what is desired. The build-up is due to subsequent conditioning applications along with natural and environmental compounds that add to the originally deposited conditioner. To avoid this, the hair needs to be stripped down and reconditioned every time. We offer instead a conditioner that is designed to self-assemble onto the surface of the hair in the appropriate configuration, while simultaneously imparting UV-absorbing functionality.

4.1 Designer Hair Conditioners

Hair conditioners typically consist of a cationic soft polymer. We have developed a novel refinement of the traditional conditioning agent by synthesizing a polymer that has many components to it. One component has high affinity to the hair surface. Another component imparts softness. As the system dries, the polymers re-arrange to shield the hair with the low-surface energy component. In another instance, UV absorbing materials are added to the polymer. These "designer" conditioners have been shown to exhibit a moisture-repelling effect, such that water beads up and runs off the surface of the hair. Formulations are being tested to provide both conditioning effects and for protection against mist or light rain.

5 TEXTILE PROTECTION SYSTEMS

Many commercial stain protection systems used today are based on fluorinated compounds. These substances are undesirable because they are not biodegradable in the environment; the precursors or even the application systems themselves have been found to accumulate in the fat reserves of fish and animals. Although the long term effects are still not completely understood, alternative technologies are being sought after.

5.1 Textile Softeners / Stain Resistance

Our polymeric system for textile applications is analogous to the hair conditioning agents described above. For textiles, one component of our polymer system allows for aqueous formulation such that the polymer can be added as a fabric softener to the laundry with a higher carry-over. The other components of the system lead to simultaneous oil and water repellency. The polymer is attracted to the surface of the fibers and self-assembles to form a protective conditioner. This imparts a low-surface energy surface which provides protection to the fibers by keeping stains from impregnating the fiber or by making them easy to remove while leaving the fabric with a soft feel. This formulation allows consumers to protect any washable garment that they desire.

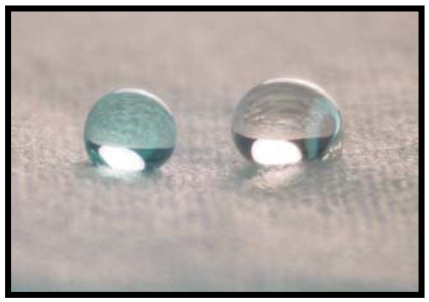

Figure 2: Water and oil (respectively shown) on a treated piece of fabric composed of cotton fibers.

6 CONCLUSION

Surface modification and self-assembly of polymers are powerful techniques to alter the performance characteristics of many consumer products. Utilizing these concepts we can create value for a number of mature industries.