Redefining Hair Baseline Parameters in Some Claims Work

K. R. Ramaprasad, Ph.D., Mythili Nori and Yash K. Kamath, Ph.D.

TRI/Princeton, PO Box 625, Princeton, NJ 08542

Introduction

The quantification of formulation induced beneficial effects on single hair fiber and assembly properties is central to proper claims substantiation. In this context, the choice of methods and the specific aspect of the fiber property need critical scrutiny. Standard measurement protocols for any of the numerous hair attributes do not exist, which makes it difficult to compare performance of diverse products. Reversal of tensile damage by hair care products is a popular claim. To that end, it is the general practice, in studying the potential beneficial effects of formulations, to damage the hair to some extent, the nature of which is determined by the particular hair attribute under study. In examining the effect on hair strength, for example, the hair tress is bleach damaged. For combing claims, a mild bleach, followed by a mild perm, is an accepted protocol. The goal of this work is to examine the connection, if any, between the damage history of the hair and the extent of product efficacy, focusing on tensile strength and combability

Experimental

Hair: Medium brown European hair was the primary stock for all the experiments.

Hair damage: For tensile strength measurements, an over-the-counter (OTC) product was used to bleach the hair to different levels (characterized by a reduction in break stress of 13, 27 and 37%).

Mild bleach-and-perm damage: For combing work, the hair tresses were mildly peroxide bleached, followed by a mild ammonium thioglycolate perm.

Tensile strength: The following solutions (5% w/v) were used for studying changes in tensile properties: Sodium Lauryl sulfate (SLS)-anionic surfactant; Cetyl trimethyl Ammonium Bromide (CTAB)-cationic surfactant; Cocamidopropyl Betaine (CAPB)-Amphoteric surfactant; Triton-X-100-non ionic surfactant. The rationale for their choice is discussed in the results section. The various bleach damaged hair tresses were treated, respectively, with 5% solution of SLS, CTAB, CAPB and Tritonx-100. After a contact time of 15 min,, they were rinsed in tap water. Tensile properties of hair fibers were measured using Dia-Stron™. The undamaged hair was considered as the control.

Combability: An OTC formulation that had been shown to have a good conditioning effect on hair was used to investigate improvements in combability on hair tresses with different damage levels. Product application was followed by 1 min contact time and 1 min rinsing in tap water. TRI's double comb method was used for measuring the combing forces of the tresses. All measurements were carried out only after conditioning the hair overnight at 65% RH and 21°C.

Results and Discussion – Tensile Properties

The set of neat actives used for this study was selected on the basis that one or more of them are common ingredients of most shampoos and conditioners. As such, if they individually had a beneficial effect on the tensile strength of hair, then it is difficult to ascribe any claims value unambiguously to a particular conditioner active that is a co-constituent with any of them. Though all the tensile parameters were calculated, in the interest of brevity, only the break stress will be presented for discussion. The progressive bleaching carried out resulted in hair with reductions in break stress of 13%, 27% and 37%, respectively, compared to the unbleached control. The break stress results obtained using 5% SLS are shown in **Fig. 1**.

It is seen that SLS has very little effect on the tensile strength of unbleached brown hair. However, with bleach damaged hair, the effect of this common surfactant molecule has a pronounced dependence on the level of damage. For example (**Fig. 1**), at a 15% bleach damage, a 5 % SLS solution has no significant effect on the tensile strength of hair fibers. As the damage level increases, the improvement brought on by SLS also increases. At 37 % damage, there is an 11 % improvement in break stress. The dependence of

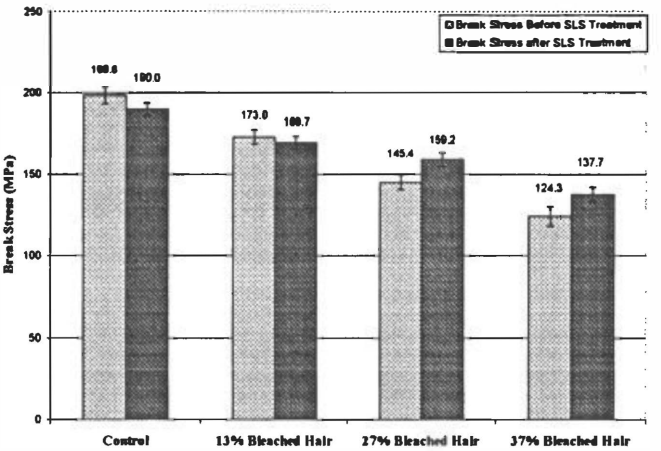

Fig. 1 Effect of 5 % SLS on the break stress of damaged hair

improvements in the tensile properties on the initial level of damage appears to indicate that sufficient damage sites are needed for the SLS molecules to anchor properly either through ionic or hydrophobic interactions. The prevalence of this surface active agent in most shampoos and other conditioning formulations that are claimed to improve hair strength calls for industry scrutiny to set proper baseline parameters for claims work. The co-existence of SLS with an active that is specifically expected to contribute to strength raises questions regarding our ability to resolve what is seen as an improvement into summation of contributions from various actives including the omnipresent SLS or related surfactant.

Similar trends were observed when damaged hair was treated with CETAB (5%), CAPB (5%) and Triton-X-100 (5%) (Break stress values shown in **Fig. 2** for 37% damaged hair). It is seen that all these actives

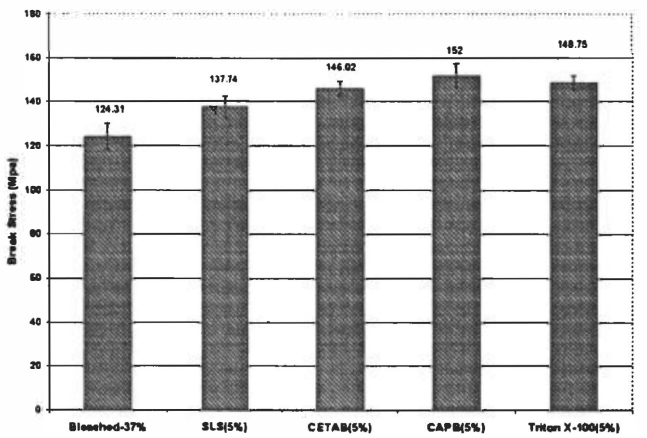

Fig. 2 Improvements in break stress of 37 % bleach damaged hair after various treatments

have a beneficial effect on the tensile strength of damaged hair. The type of molecular interaction that follows treatment with the solutions of these compounds could all be very different in each case. For

example, CETAB, by virtue of its small size, is known to penetrate into the cortex of hair. Because of its amphoteric nature, CAPB could have a bipolar interaction with the damaged hair. The non-ionic Triton-X 100 will also have only acid-base type of interactions with the hair matrix.

Results and Discussion – Combability

Combing force curves were generated throughout the history of the tresses – undamaged, bleach/perm damaged and damaged/treated. The damage level, as mentioned before, was controlled by changing the perming time. In **Fig. 3** are plotted both the percent increase in mid-length forces upon bleach/perming the hair and the percent decrease in the same after product application. This is monitored as a function of extent of hair damage.

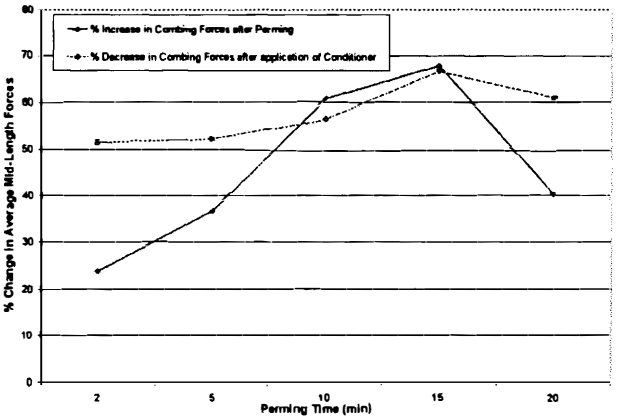

Fig. 3 Percent changes (increase in the control and decrease in the treated tresses) in the mid-length combing forces for the damaged tresses

It is observed that, after 20 min perming, even though there is an increase in the combing force of the untreated set as expected, it is not as high as for the 15 min permed tress. The reason for this is yet to be arrived at. Generally, in the perming domain up to about 15 min, the combing forces increase with time of perming, showing a correlation between the level of damage and the combing forces. For the treated tresses, using this well performing OTC product, there is a small dependence of product performance on the initial level of damage (small slope - **Fig. 3**). Similar trends are seen for the end-peak forces too and, hence, are not shown here.

Scanning electron micrography of the hair fibers with different damage levels were also carried out to assess the state of the cuticle surface. After all it is the state of the fiber surface that determines the magnitude of the combing forces. The examination of the SEM's shows that there is some degree of scale thinning at all levels of perm damage, that at very high levels of damage (for example, 20 min or more), the surface thinning, as a prelude to exposing a fresh cuticle layer, might lead to slight reduction in combing forces, as seen in the present work.

In summary, in the area of claims work, there is experimental evidence to show that the extent of product efficacy in restoring tensile strength is determined by previous damage level of the hair fiber. Further, many common additives that are part of the shampoo/conditioner hair treatment protocol have themselves an effect on hair strength. Hence, the isolation of individual contributions is important for demonstration of the effect of new actives. The damage protocol seems to generate functional groups with which actives can form salt linkages and hydrophobic bonds. Higher levels of damage increase the amount of swelling, so that larger amounts of actives penetrate into the fiber.

As for hair manageability claims, there is also a dependence on initial level of damage, but this is not very pronounced for a well performing conditioner.