# Evaluating Shine on Hair

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*Abstract*
*Marketing research studies have shown that shine is one of the key benefits that women expect from hair care products, particularly from shampoos and conditioners. This article defines shine in the context of hair care and discusses ways to measure it.*

*Webster's 3rd New International Dictionary* tells us that shine means "to be bright with the reflection of light, to gleam or glisten." But what *Webster* doesn't tell us is that shine is one of the most sought after, yet most elusive, of all hair care benefits.

## What makes hair shine?

***Physical structure of hair:*** To understand what makes hair shine we must first understand its physical structure. The cuticle (the shingle-like outer layer of the hair) is primarily responsible for shine. In virgin hair these overlapping scales are undisturbed and are stacked tightly one on top of another approximately five to ten layers deep. In this configuration they form a very flat surface that is relatively reflective. They are held tightly in place by intercellular lipids, including ceramides, and they are protected by a fatty layer consisting of materials such as 18-methyl eicosanoic acid. These materials naturally protect hair from surface damage.

As hair ages it is exposed to a variety of damaging effects from sunlight, physical abrasion, repeated washing and drying, and chemical treatments such as perms and coloring. These physical and chemical intrusions can gradually strip away the hair's natural protection. Once the cuticle is no longer cemented in place, the individual scales loosen and begin to lift away from the surface. This lifting process makes the hair more irregular and initiates an inevitable downward spiral of damage. As the cuticular plates begin to lift, it becomes easier for them to be torn away by combing and brushing. And as each successive layer of cuticle is stripped away, the layer beneath is exposed to more damaging effects, which in turn cause them to be loosened and stripped away. Left untreated, this process will continue to strip away the cuticular layers, making the surface increasingly irregular.

***Optical properties of hair:*** The regularity of the hair's surface helps determine how reflective it is. When a beam of light strikes a perfectly smooth surface, such as a mirror, the angle of the incident light exactly matches the angle at which the light is reflected. This type of reflection is known as spectacular reflectance and it does occur on hair to some degree. However, since hair is not as smooth as a mirror, it interacts with light in other ways as well. Some portion of the light bounces off hair at a different angle than the incident beam. This type of reflectance is called diffuse reflectance. Some of the light passes through the cuticle, which is transparent, and is reflected off the back wall of the hair. In light scattering analysis, this "back wall" reflection is seen as a second peak. This secondary peak has greater intensity for blonde hair but less for dark hair, because the melanin pigment present in darker shades tends to absorb more light.

The physical construction of the hair and the optics involved in reflection are only part of the story. To understand how complex the phenomena of hair shine is, consider that hair consists of over 150,000 discrete fibers that can move independently. Every movement of the body, every turn of the head can cause the hair to cascade in new patterns that affect the continuity of its surface. Unlike hard surfaces, hair is not continuous and is never completely at rest. The discontinuous nature of hair makes an accurate assessment of shine very difficult.

***Consumer expectations:*** To complicate matters even further, the formulator must take into consideration the consumer's mind set regarding hair shine. A brief review of the claims made by today's hair care products shows that shine is a nearly ubiquitous benefit promised to some degree by almost every shampoo and conditioner.

For the majority of products, shine is simply mentioned along with the other conditioning benefits. But for some prod-

ucts shine is a pre-eminent claim. Take, for example, Procter & Gamble's Pantene Pro V. Throughout the 1990s Pantene's advertising proclaimed they would give you "hair so healthy it shines." According to data from Information Resources Inc., a Chicago-based market research organization, P&G spends somewhere in the neighborhood of $40 million on Pantene advertising each year. Therefore, it is reasonable to assume they've spent close to hundreds of millions over the past 10 years to convince women that their hair should be shiny. Although P&G has since discontinued this campaign, shine remains strongly associated with healthy hair in the minds of many consumers.

Another example of a product line in which shine is the key benefit is Advanced Research Laboratories' Citre Shine. The Citre Shine line consists entirely of treatment products focused on making hair shiny. While not as influential in terms of advertising as Pantene, Citre Shine continues to be successful in the market place.

The net effect of brands like Pantene and Citre Shine has been to raise consumer awareness and expectations regarding shine even though it is difficult for women to ascertain when it is being delivered. Therefore, formulators must understand that hair care products can affect shine both positively and negatively. The remainder of this article is designed to give the cosmetic scientist a fundamental understanding of how hair care products affect shine and how changes in shine can be measured.

## The Role of Hair Care Products

The basic approach to increasing shine involves smoothing the hair's surface. When the aforementioned cuticular layers lay flat on hair the light is reflected more uniformly. Some improvement can be made just by lubricating the hair so the cuticles are not disturbed during grooming. Smoothness can be further increased by coating the hair with materials that are reflective themselves. Certain silicone- and hydrocarbon-derived materials will form reflective films on hair. Similarly, shiny particles like titanated mica can give hair a glitter effect.

However, the drawback is that in both these cases the process requires that a substantial amount of material be left behind on the hair. Here we encounter one of the most dreaded of all haircare sins – weighing down the hair. According to a 1999-2000 Gallup study of female hair-care practices, nearly 15% of all women are concerned specifically about hair shine. But, 28% percent of women are worried about their hair becoming limp and weighed down. For this reason, merely coating the hair with a shiny layer is not a solution that will be acceptable to all consumers.

Not only is it difficult to increase shine, but many hair care products can actually decrease it. Even the hair's own natural sebum can make its surface look dull. Robbins cites a study by Scherbece that shows the natural oils on the hair can indeed negatively impact shine. Similarly, soaps that can leave a hard water residue on hair also diminish shine. This effect occurs because fatty anions in the soap combine with metallic cations in the water and form an insoluble complex that deposits on the hair. This is a less common problem today since true soaps are very rarely found in shampoo products.

This same type of dulling effect has also been shown to occur in some shampoo formulations that contain cationic polymers. These polymers do not deposit uniformly on the hair and may therefore increase light scattering. Studies have shown that hairsprays can also dull hair, once again presumably because deposition of the resin reduces uniform reflectance. Not surprisingly, hair treatments which chemically degrade the hair, such as permanent waves and oxidative colors, also reduced shine. This is presumed to be due to the fact that they weaken the cuticle.

It is important for formulators to be aware of the potential dulling effects that these products may have. They should not assume their product will increase shine just because it provides conditioning benefits. If hair shine is a desired benefit, each product should be evaluated on hair tresses and on panelists to ensure it is having a positive effect on light reflection.

## Hair Shine Testing Methods

Formulating products that increase hair shine is challenging because the subtle, incremental increases that are invariably obtained can be difficult to perceive. They can be even harder to quantify. None the less, a variety of methods have been developed for measuring hair shine and the effect that cosmetic products have on it. These can be conveniently classified as instrumental and subjective methods.

***Instrumental evaluations:*** Instrumental tests should theoretically provide the most consistent and controlled results for shine evaluations. In the best instrumental tests, the data obtained is highly-repeatable, has a low standard deviation and corresponds with subjective evaluations. They also do not suffer from the uncontrolled variability of subjective evaluations.

***Gloss meter*:** One of the earliest methods of instrumental shine determination was using a gloss meter. The gloss meter is a device that was developed for the coatings industry. It consists of a light source and a photoreceiver. Light is shone on the

test surface at a specific angle and the photoreceiver captures the reflected light at the corresponding angle. The device then outputs a specular gloss value based on the intensity of light reflected. Unfortunately, this device was designed for a flat, regular surface, which hair is not. Hair is more of a cylinder shape and when light is shone on it, it reflects at multiple angles. Since the perceived hair shine is dependent on much of the light reflecting at different angles, the gloss meter does not detect a large portion of this light. Consequently, the gloss meter is of limited value for determining hair shine.

***Goniophotometer*:** A better device for measuring hair shine is a goniophotometer (or photogoniometer). This device has a moving detector which measures the reflected light over a range of angles. Light is shone on a hair fiber and the detector moves along a set path to measure the reflected light intensity over a range. In this way a more complete picture of the hair's light reflection is obtained. In a typical study, a number of hair fibers are taken from numerous tresses and tested on the goniophotometer. The results are recorded as the initial values before treatment. The tresses are then treated with the shine-enhancing product, such as a shampoo, conditioner or styling formula. Fibers are then removed and run on the goniophotometer. If the product increased shine there will be an increase in the amount of reflected light across the detected limits. This increase can provide the basis for a shine-enhancing claim. Typically, an untreated control sample is run for comparison. It is worthwhile to note that damaged hair reflects less light than non-damaged hair. This fact should be considered when testing shine-enhancing products.

While instrumental tests can provide excellent data, they suffer from certain drawbacks for formulators. First, the instruments themselves can be expensive, so they are not generally available. Testing of just a few samples can be cost prohibitive. This reduces the usefulness during the formulation phase. Also, instrumental improvements in hair shine often correlate with consumer perceptions, but not always. Sometimes the instruments show differences that can not be noticed by product users. These drawbacks demonstrate that subjective testing is useful during both the formulating and finished-product development phase.

***Subjective shine testing*:** If an instrumental test method demonstrates that a product makes hair 50% more shiny but consumers cannot tell a difference, the formulation may not satisfy its intended market. On the other hand, if the product does not show any instrumental difference but consumers believe it improves shine, then the product should meet consumer expectations. Subjective tests using real people will get closer to finding out how well consumers will perceive increases in hair shine. This testing can be done on both hair tresses and in a salon.

***Tress analysis*:** One of the simplest types of subjective analysis for hair shine is performed using hair tresses. In these studies, human evaluators rate multiple hair tresses before and after treatment with a product. The most important factors to control in these studies are the characteristics of the hair tresses and the way they are displayed. The type of tress used can significantly affect the results from subjective evaluations. For shine studies, darker hair generally works better than lighter hair because the contrast with reflected light is greater. The tresses should be of identical length and type. It has been suggested that six to nine tresses are the most that should be used for any single test. Any more can lead to evaluator burn out.

Since hair shine is dependent on how a tress is displayed, care should be taken to reduce variations. When having tresses evaluated, the alignment of hair fibers should be consistent and parallel. It is advisable to get a shine box for displaying tresses. A shine box is an all black box equipped with uniform lighting and mounting devices. Tresses in a shine box can be viewed in a consistent manner which helps reduce variability. To reduce positional bias, tresses should be rearranged between evaluations.

Whenever subjective analyses are done, the question arises as to whether to use trained or untrained evaluators. Which to use depends on the type of data desired. Trained evaluators are taught to consistently give shine ratings in line with a controlled scale. They are shown tresses with different levels of shine intensity and told the shine rating. They are then tested on a blind basis to see how well their blinded rating matches the given rating. They will provide tighter and "theoretically" more objective data that will be useful during the formulation stage. Untrained evaluators are given no initial testing prior to evaluation. In this way different evaluators may give entirely different relative shine ratings. However, untrained evaluators may better reflect the perception of the consumers. Therefore, it may be better to use untrained evaluators after instrumental testing has shown that a formulation improves hair shine and before performing a consumer use study.

To get repeatable data, 15 to 20 evaluators should be used. This should provide adequately precise data so a study is repeatable. In a typical study, tresses are treated with a product, allowed to dry and displayed in a shine box. The evaluators

score each of the tresses on a set scale and then rank the tresses in order of shine intensity. Reliable and consistent data can be obtained by using the optimum number of tresses and evaluators.

Tress testing is a convenient method for evaluating shine, making it useful during the formulation process. It does have certain drawbacks, however. For example, the differences in hair shine are typically subtle. Tress testing typically will find only big differences, missing smaller, subtle changes. Also, tresses only simulate real life, which means they do not show exactly how a product will perform on a consumer's head.

***Salon evaluations*:** Another useful type of testing for hair shine is salon testing. In these tests, professional salon technicians apply the product in a half-head manner. One is the test side and the other is the control. The products are applied in a blinded manner and the hair is rated after treatment. These tests are much like tress tests although they are even more indicative of a real-life situation. For best results, twenty or more test subjects should be used along with multiple salon evaluators.

Salon tests suffer from the same drawbacks as tress tests in that they can only show large differences and may miss small, subtle differences. However, salon tests use human volunteers so they require significantly more resources than lab instrumental or tress tests. This makes them more difficult to use for directing formulation and evaluating raw materials. They are better for comparing different finished products.

***Consumer-use studies*:** Consumer perception is the ultimate judge as to whether a product increases shine, so a Consumer-use study is an appropriate way to measure it. A general plan for conducting a Consumer-use study is to have panelists rate the level of hair shine before and after product use. The increase (or decrease) in shine is determined by the difference between the initial and final ratings.

It is important that subjects are chosen thoughtfully for these types of studies to be most effective. First, the panelists should be selected to reflect the demographics of the consumers who would use a shine product. They should also be pre-screened and only those who would find benefit from a hair-shine product should be used. Factors such as hair type, color and condition should all be recorded and controlled. A significantly large number of panelists (30) should be used to get reliable, repeatable data.

The initial phase of a consumer-use test would be to develop a questionnaire. It should minimally ask the panelists to rate

their hair shine using, for example, a ten-point scale. Prior to testing, it is legitimate to require a minimum shine rating for any panelist who will be included in the study. This ensures that only people who would measurably benefit from using a hair shine enhancing product are tested. At least two questionnaires are given during the study. The initial questionnaire should be designed to collect all the appropriate ancillary data such as hair type, color and condition. Subsequent questionnaires should repeat the questions from the initial survey excluding the background information.

Depending on the desired information, panelists can be instructed to use the product once or repeatedly over the course of a few weeks. Certain products such as shine sprays, gels or hair sprays are better for single use tests. Other products such as shampoos and conditioners are better tested over the course of a few days or weeks.

The test can be monadic or comparative. A monadic test involves having panelists use the product for a certain length of time and rating their hair before and after. This type of test works well for claim substantiation. A comparative study is more useful for product development. In this type of study, the group of panelists are segmented into control and test groups. The average initial hair shine rating should be the same for both groups. One group is given the test prototype and the other is given a control product. The control product should be one that gives a known shine value or one that would not be expected to impart hair shine such as a normal shampoo.

Another possible test design is to have both test groups try each product sequentially. That is, one group tries the control product first and then the test product. The other group tries the test product first and then the control product. The benefit to conducting this type of study is that each panelist tries both products so a more direct comparison is possible. The drawback is that the effects of one product may be influenced by the other product. For example, if a shampoo that relies on coating the hair is being evaluated, the panelists who use the control product second may have artificially high scores.

Rating scores obtained from these types of consumer use tests can be converted into a percentage increase or decrease in shine. The changes can be quite large and impressive. It should be noted, however, that to some extent these types of tests are affected by the halo effect. If a consumer likes the product because of how it smells or how easy it makes hair to comb, he or she may give higher ratings for hair shine even though no shine improvement was present. Another drawback to this type of testing is that unless a large number of test panelists are used, small differences between how two products affect hair shine may not be found.

The ideal testing situation for any hair product is a combination of both instrumental and consumer tests. The instrumental tests provide a scientific rationale for consumer perception. They also provide a good screening tool that can be used to guide formulation. The consumer tests tell the formulator how well consumers will like the product and their perceptions of how well the product works.



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