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Correction of Volume Deficit in Fine Hair Using Texturizing Agents

Diana Poghosova

Stylist-Hairdresser at Chicasspace Salon, Yerevan, Armenia

ABSTRACT

This article examines a comprehensive approach to correcting volume deficit in fine hair using texturizing agents. The relevance of the study is substantiated by the widespread prevalence of fine hair problems among consumers and the insufficient efficacy of existing solutions, which leads to rapid loss of root lift under the influence of lipids, moisture, and age-related factors. The objective of the work was to conduct a systematic analysis of literature and patent sources to identify the main mechanisms of physical thickening of the fiber and enhancement of inter-fiber friction using various formulations. The novelty of the study lies in the integration of three complementary mechanisms: film-forming copolymers and low-molecular-weight proteins, texturizing powders and saline sprays, as well as the formation of an elastic polymer network in the composition of mousses and lotions; a sequential strategy for product application is proposed, taking into account their chemical compatibility and styling technological regimes. The main results showed that the application of film-formers increases the hair radius and retains moisture. Powder texturizers and saline sprays create a controlled microrelief that enhances frictional forces between fibers. The elastic polymer network in mousses and lotions provides long-lasting volume, even under high relative humidity and mechanical stress. The efficacy of the combined use of agents in a specific application order was demonstrated, which minimizes the risks of cuticle damage and hair overheating. This article will be helpful to cosmetic formulation developers, technologists, and trichologists.

Keywords: fine hair, root volume, texturizing agents, film-forming copolymers, microrelief, polymer network

Introduction

Deficit of root volume in fine hair affects a substantial proportion of consumers, as confirmed by a survey of 3,400 women in the United States: 39% of participants classified their hair as fine hair, and more than one-third of respondents named lack of volume as one of the main aesthetic problems (Herich, 2022). Morphologically, fine hair is characterized by a reduced cross-sectional diameter. Since the bending stiffness of a cylinder is proportional to the fourth power of its radius, even a few micrometers reduction in diameter leads to a noticeable drop in flexural rigidity, causing hairs to lie flatter against the scalp.

Volume is also lost due to the specifics of sebum secretion: at equal sebaceous gland activity, the mass of lipids per unit surface area of fine hair is greater, so twenty-four hours after washing, the strands become heavy and slippery, visually reducing the hairstyle's thickness. High relative humidity further contributes: laboratory analysis of water absorption showed a linear increase in fiber moisture content as RH rose from 40% to 85%, while the residual elastic modulus decreased over the same range, making the hair less resilient and more prone to deformation (Gao, 2007). Even brief exposure to high RH reduces elasticity by tens of percent, explaining the loss of root lift on rainy days. Finally, individuals with blonde or red hair, who have higher follicle density, achieve a more uniform mass of strands. Yet, each fiber remains thin, and the total weight of the hair remains low, causing it to collapse easily under hats or hoods.

Alongside immediate physical factors, volume decreases are influenced by age-related and endocrine changes. A population study of over 1,000 Caucasian women showed an increase in average fiber diameter until age 40, followed by a stable decline, with a sufficient number of fine fibers by age 50, allowing for visually altering the hairstyle architecture (Robbins et al., 2012). Reduced estrogen synthesis and prolonged telogen phase decrease density, simultaneously weakening the cuticle and increasing fragility. Concurrently, aging follicles produce less sebum, which in part of the population provokes compensatory hypersecretion and again leads to uneven loading along the fiber length. Lifestyle factors act as modulators: ultraviolet exposure, iron deficiency, repeated dieting, and chronic stress disrupt keratinization, while multiple colorings and heat styling degrade the intercellular cement, strengthening adhesion between individual hairs and facilitating hairstyle collapse.

Thus, a volume deficit in fine hair arises at the intersection of several factors: an inherently small diameter with associated low bending stiffness, accelerated impregnation by water and lipids, and age-related and hormonal changes that affect fiber density and strength. Addressing the problem requires a comprehensive approach that considers both the physiological state of the follicle and external environmental conditions.

Materials and Methodology

This paper draws on twelve major sources, among them consumer surveys, patent information, registry data, and publications in leading journals. It takes as its points of departure a survey of 3,400 U.S. women to establish how important the root volume deficiency is (Herich, 2022), patent JP2018150271A, which described compositions of dry shampoos (Kan, 2017), and some statistics on dimethylsilyl silsesquioxane concentration in leave-on products from the registers (Becker et al., 2013). To include in the review, articles were chosen that addressed the influence of relative humidity on hair elasticity (Gao, 2007), age-related changes in fiber diameter (Robbins et al., 2012), penetration of proteins of varying molecular weights (Malinauskyte et al., 2020), formation of copolymer and cellulose ether films (Carvalho et al., 2024), tribological analysis of texturizers (Nonomura et al., 2022), evaluation of styling persistence under high humidity (Rigoletto, 2007) and adhesion of salt crystals to the cuticle (TRI, 2023).

The research methodology consisted of systematic searching and critical selection of publications in PubMed, Scopus, and Google Scholar up to June 2025 using keywords fine hair, volume, texturizing agents, film-forming copolymers, and hair tribology, including only works that detailed mechanisms of physical fiber thickening and enhancement of inter-fiber friction. Sources were then classified by type of texturizing agent, from each key performance indicators were extracted (change in fiber diameter, coefficient of friction, volume retention under high humidity), concentration ranges of active components and technological application conditions were compared, and a qualitative analysis of advantages and limitations of each approach was conducted to develop recommendations for sequential use of products.

Results and Discussion

Texturizing products compensate for the inherently small diameter of fine hair primarily through physical thickening of the fiber. Film-forming copolymers, such as VP/acrylates/lauryl methacrylate or polyurethane latices, distribute over the cuticle as a continuous sheath that replicates the microrelief of the scales. After water evaporation, this coating increases the fiber radius while retaining moisture and limiting microcracks (Zhou et al., 2011). Hydrolyzed proteins of low molecular weight penetrate the endocuticle and cortical matrix. Confocal microscopy has shown that such incorporation increases the volume of test strands and simultaneously serves as an anchor for subsequent deposition of cationic acrylates (Malinauskyte et al., 2020). Similarly, cellulose ethers applied from ionic liquids form a uniform layer on the fiber surface, visible in fluorescence and SEM imaging, which persists after three washing cycles and improves flexibility without compromising cuticle integrity. The results of the effects of various formulations on hair are presented in Fig. 1 (Carvalho et al., 2024).

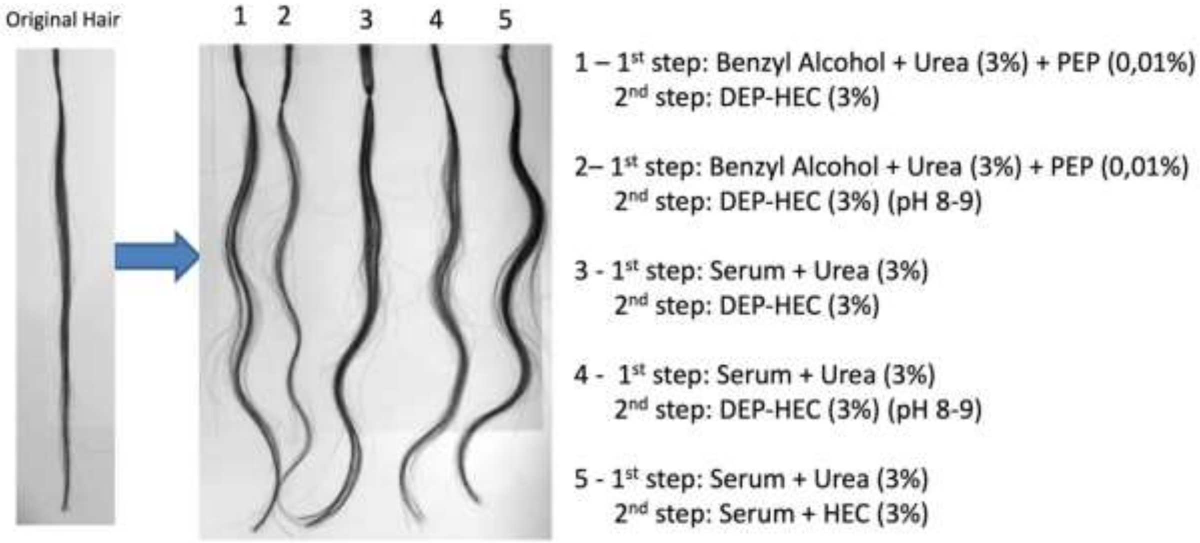

Fig. 1. Cellulose formulations for hair modelling (Carvalho et al., 2024)

Simultaneously with fiber swelling, the creation of a controlled microrelief plays a key role in increasing frictional forces between adjacent hairs. A classic example is marine salt sprays: NaCl crystals settle between the scales (Fig. 2), which increases the combing force of experimental strands and thereby stabilizes the styling shape (TRI, 2023).

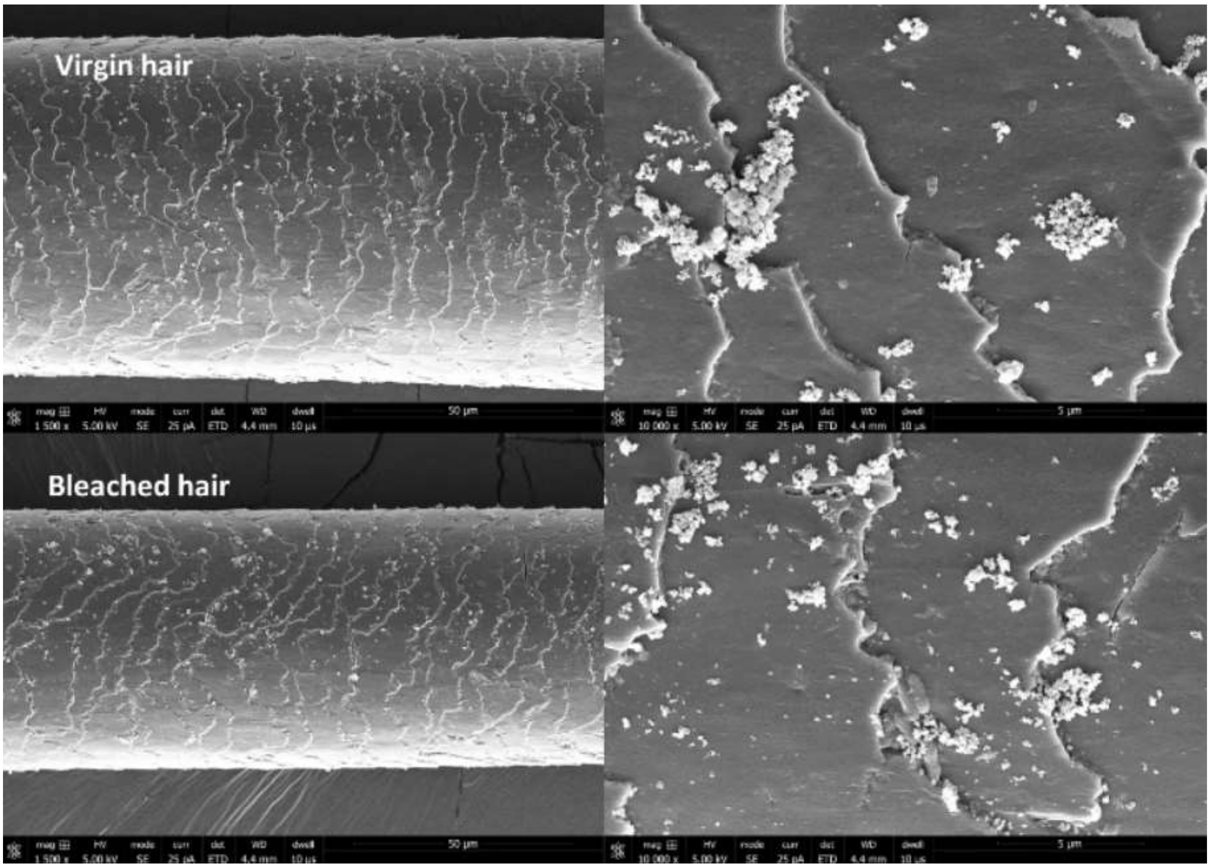

Fig. 2. Salt (NaCl) crystals on the surface of virgin and bleached hair (TRI, 2023)

Powders Based on Magnesium Silicates or Amorphous Silica Work in a Similar Manner, Adding Porous Particles with a High Coefficient of Friction. The variety of formulations allows for the combination of both mechanisms, considering the mode of application. Powder texturizers (such as silica, kaolin, and magnesium silicates) instantly remove sebum and lift the root zone. Dry shampoos use the same principle but in an aerosol format, facilitating even distribution of particles. Sea salt sprays offer a light, matte finish and provide adaptive movement for curls. Volumizing mousses and lotions contain aqueous dispersions of VP/VA copolymers, which form an elastic network upon drying, providing long-lasting volume with minimal rigidity. Together, these systems create a synergistic effect: first increasing the diameter and resilience of the individual fiber, and then enhancing inter-fiber friction, which allows the hairstyle to retain its shape longer, even under high humidity and mechanical stress.

Texturizing products, which compensate for the limited thickening of the fiber, employ different engineering solutions, each of which complements the previously described mechanisms of fiber expansion and increased inter-fiber friction. The simplest, yet technically diverse group, remains powders. Sprayed magnesium silicates, amorphous silica, or cellulose starches instantly create a dry texture: in the dynamic tribological analysis of 21 ready-made powder cosmetic products, the kinetic friction coefficient ranged from 0.29 to 0.74, with samples containing silica and talc plates showing values of 0.6–0.7, whereas formulations with slippery spherical particles did not exceed 0.4, which directly correlated with the sensation of dense root lift (Nonomura et al., 2022). Registry data on 245 commercial formulas indicate that dimethylsiloxyl silsesquioxane is present in concentrations ranging from 0.2% to 25% in leave-on products, establishing the limits of technologically justified inclusion for styling powders (Becker et al., 2013).

Salt sprays employ a different physical effect: NaCl crystals, after water evaporation, are adsorbed between the cuticle scales, enhancing both transverse adhesion and optical mattness. Modeling by immersion in a 3.5% sodium chloride solution revealed an increase in combing force, i.e., internal friction, resulting in a more voluminous fiber, albeit slightly less rigid due to a 12% reduction in Young's modulus (TRI, 2023). In small doses, when used in aerosols, this beach effect provides a distinct texture without critical damage, especially when combined with silicone thermal protection.

Volumizing mousses solve the problem through a polymer network. Water-alcohol dispersions of VP/VA, acrylates, or modern copolymers based on polyquaternium-69 form an elastic film upon drying, which keeps the strand open. In a control test at 90% relative humidity, curls treated with a mousse containing 4% solid Aquastyle 300 retained over 90% of the original amplitude for 24 hours, whereas a commercial gel on PVP lost its shape after the first hour of storage, as shown in Fig. 3 (Rigoletto, 2007). This water resistance is particularly important for fine hair, which tends to fall out in humid climates.

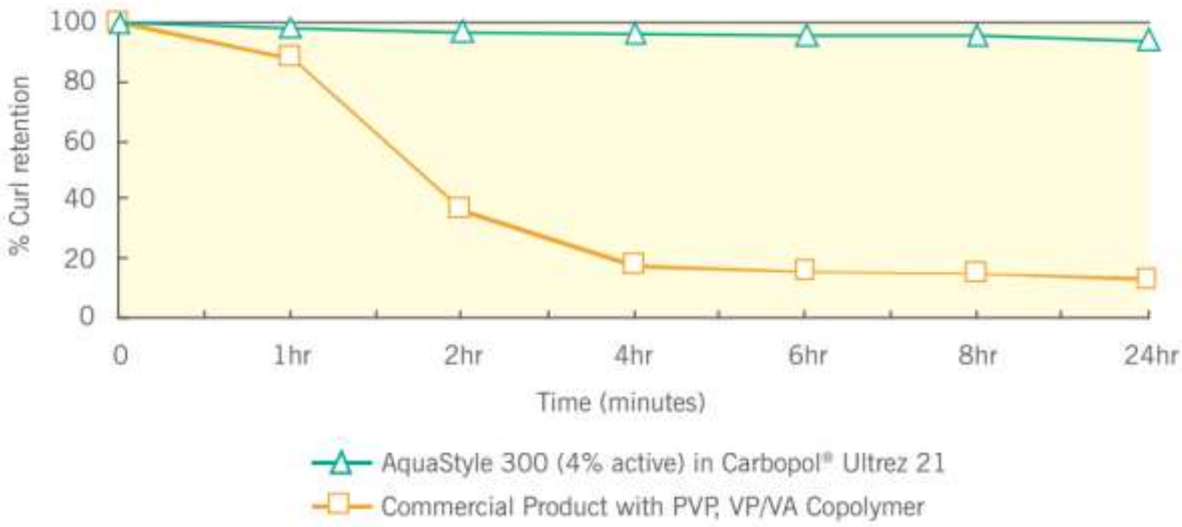

Fig. 3. High Humidity Curl Retention after 24 Hours @ 90% RH, 80°F (Rigoletto, 2007)

Dry shampoos belong to the category of texturizers because starches, kaolin, or porous silica simultaneously absorb sebum and enhance the microrelief. Patent JP2018150271A describes a composition where corn or rice starch, together with porous SiO_2, adsorbs lipids, becoming optically opaque; the developers emphasize that this transformation explains the instant visual lift when 1–2% residual fat remains on the fiber (Kan, 2017). The aerosol format also distributes particles to areas with maximum sebum exudation, which is especially important for fine hair with high follicle density and rapid growth at the root.

Root fixation lotions combine the low viscosity of the base and the high concentration of fixing resins. Systems based on acrylate or cationic copolymers, similar to those used in mousses, evenly coat the root zone and, when blow-dried, create local columns of rigid film. Therefore, lotions provide the most accurate and controlled rise of the root area, allowing for mixture with various products, such as powder for a matte look or salt spray for a textured feel along the length.

The assortment of preparations gives the hairdresser a chance to build a compound structure: powder immediately raises friction, sea salt offers a rich, beachy, matte feel, mousse widens the diameter, dry shampoo manages sebum between washes, and lotion holds the root setup. Correct alternation of these steps addresses both physical and optical requirements of fine hair, providing stable volume without excessive rigidity.

Effective volume correction begins with preparatory washing. Hair is cleaned with a mild shampoo labeled as light or volumizing to avoid weighing down the cuticle with polishing waxes. Conditioner is applied only to the lower third of the length, avoiding the root zone, and then thoroughly rinsed with cool water; this helps close the scales and minimize residual moisture. After the shower, strands are gently patted dry with a towel, avoiding twisting, which leaves them slightly damp and pliable for styling.

At this stage, basic products are applied. A light mousse is distributed at the roots while holding the can vertically to keep the foam airy. A friction-improving coating is created by even, combing motions with a wide-toothed comb. A thermal protection spray with proteins is applied along the length, which simultaneously reduces subsequent moisture loss and enhances elasticity. Before drying, it is essential to comb the strands again, distributing the polymer network until it stops foaming.

Blow-drying is done with a narrow concentrator aimed parallel to the hair growth. The head is tilted forward to let gravity assist with root lift, and a round brush creates additional tension at the roots. Warm air is alternated with cool air to achieve gradual evaporation of moisture without overheating the cuticle. The process is completed with a short burst of cool air, which stabilizes the forming polymer film.

When the hair is dehydrated, finishing products are applied. Powder or dry shampoo is sprinkled along the parting, then gently massaged with fingertips, lifting the strands at the scalp. For texture along the length, a salt spray is applied from a distance sufficient to form a light mist; the strands are then gently squeezed with the palms to create a natural wave. This creates a combination of increased diameter and controlled roughness, which maintains shape without excessive rigidity.

Final fixation involves the use of a lotion with a light resin or an aerosol hair spray applied at an angle to the scalp. Excess coverage is smoothed with a damp palm to maintain the movement of individual hairs. In the final step, the cool airflow of the blow dryer is reintroduced: brief cooling sets the polymer network and also removes any residual static electricity. After cooling, the hairstyle is shaped with fingers, avoiding the use of a comb, and the volume remains stable even under high humidity and moderate mechanical stress.

Even with strict adherence to the technological procedure, volume can be easily lost if common mistakes are made. A frequent cause of failure is the application of conditioner to the root zone. Formulations designed to smooth the cuticle leaving a thin moisturizing film on the fiber; in fine hair, this film immediately adds mass and reduces inter-fiber friction. As a result, the roots quickly slip, and efforts to form a microrelief lose their effect. Conditioning agents should remain only on the middle and end portions of the strand, where they close the scales without interfering with root fixation.

Overheating during styling is equally critical. If a blow dryer or curling iron operates at maximum temperature for longer than recommended, the keratin bonds relax, and the polymer network responsible for volume softens. Overdried hair becomes stiff but lacks resilience: it bends and remains flattened because the network no longer restores its original shape. A thermal protection spray reduces the risk, but the final result depends on a gentle temperature regime and the mandatory use of cool air at the end.

Problems often arise when products with incompatible textures are used simultaneously. Tonic formulas based on volatile alcohols interact poorly with silicone serums, while powdery powders clump when they come into contact with oily fluids, forming granules that weigh down the root and visually dirty the strand. The layer of products should be applied in a light-to-heavy order—first water- or alcohol-based formulas, then polymer mousses, followed by powders or salts once dry, and finally, pinpoint oils for the ends.

Finally, combing after fixation destroys the created network faster than any environmental factors. A brush or fine-tooth comb removes protruding powder particles and stretches the film-forming agents, turning the fine film into random ribbons. The hair sticks together again; volume disappears, and static electricity increases. After the final application of hair spray or lotion, the style is corrected only with fingers, gently lifting individual strands and avoiding direct sliding.

Thus, correcting volume deficit in fine hair requires a comprehensive approach that considers both the physiological features of the fiber and the influence of external factors: thickening of the hair is achieved through film-forming copolymers and low-molecular-weight proteins, microrelief and friction enhancement through powder texturizers and salt sprays, and long-lasting lift through the elastic polymer network in mousses and lotions, with the correct sequence of product application and a gentle drying temperature regime remaining key.

Conclusion

The conducted study confirms that the volume deficit in fine hair is multi-component: the inherently small fiber diameter, high ability to absorb lipids and moisture, as well as age-related and hormonal changes that lead to reduced strength and density of hair. Literature and experimental data analysis have demonstrated that optimizing root lift is possible by combining engineering solutions for fiber thickening and increasing inter-fiber friction.

The first key mechanism involves applying film-forming copolymers and low-molecular-weight proteins, which increase the fiber radius, enhance moisture content, and serve as an anchor for subsequent polymer layers. The second mechanism is provided by texturizing powders and salt sprays, which create a controlled microrelief on the surface, significantly increasing friction between the fibers and stabilizing the volume in the root zone. The third component is the formation of an elastic polymer network in mousses and lotions, which is resistant to high relative humidities, allowing the volume to be maintained even under adverse climatic and mechanical conditions.

The practical implementation of the comprehensive approach requires strict adherence to the technological sequence: gentle preliminary cleansing and localized conditioning, even distribution of base products, a drying step alternating warm and cool airflows, and the final application of dry texturizers and light finishing sprays. Particular attention should be paid to avoiding overheating of the hair, incompatible product combinations, and excessive combing after the hair is fixed.

Thus, the correction of volume deficit in fine hair is achieved through the synergy of three complementary mechanisms: physical thickening of the fiber, enhancement of microrelief, and the formation of a long-lasting framework from elastic polymers, provided that the optimal technology for product application is precisely followed. This comprehensive approach ensures stable root lift without excessive rigidity, minimizing the risk of cuticle damage.

References

Becker, L. C., Bergfeld, W. F., Belsito, D. V., Hill, R. A., Klaassen, C. D., Liebler, D., Marks, J. G., Shank, R. C., Slaga, T. J., Snyder, P. W., & Andersen, F. A. (2013). Safety Assessment of Silylates and Surface-Modified Siloxysilicates. *International Journal of Toxicology*, *32*(3_suppl), 5S24S. https://doi.org/10.1177/1091581813486299

Carvalho, J. P., Martins, M., & Paulo, A. C. (2024). Cellulose formulations for hair modelling. *Cellulose*, *31*(11), 6897–6909. https://doi.org/10.1007/s10570-024-06020-6

Gao, T. (2007). Evaluation of hair humidity resistance/moisturization from hair elasticity. *Journal of Cosmetic Science*, *58*(4), 393–404. https://pubmed.ncbi.nlm.nih.gov/17728940/

Herich, D. (2022, January 31). *2022 Consumer Hair Care Survey*. Global Cosmetic Industry. https://www.gcimagazine.com/brands-products/hair-care/article/22030705/2022-consumer-hair-care-survey

Kan, T. (2017, March 13). *JP2018150271A - Composition for dry shampoos*. Google Patents. https://patents.google.com/patent/JP2018150271A/en

Malinauskyte, E., Shrestha, R., Cornwell, P. A., Gourion-Arsiquaud, S., & Hindley, M. (2020). Penetration of different molecular weight hydrolysed keratins into hair fibres and their effects on the physical properties of textured hair. *International Journal of Cosmetic Science*, *43*(1), 26–37. https://doi.org/10.1111/ics.12663

Nonomura, Y., Tsuchiya, U., Taguchi, M., Tsuchiya, R., & Goto, T. (2022). Characterization of Powder Cosmetics Based on Friction Dynamics. *Journal of Oleo Science*, *71*(10), 1459–1467. https://doi.org/10.5650/jos.ess22173

Rigoletto, R. (2007). Polyquaternium-69: A New Fixative Polymer with Enhanced Styling Benefits. *Cosmetic Science Technology*. https://cosmeticsciencetechnology.com/companies/articles/1281.pdf

Robbins, C., Mirmirani, P., Messenger, A. G., Birch, M. P., Youngquist, R. S., Tamura, M., Filloon, T., Luo, F., & Dawson, T. L. (2012). What women want - quantifying the perception of hair amount: an analysis of hair diameter and density changes with age in caucasian women. *British Journal of Dermatology*, *167*(2), 324–332. https://doi.org/10.1111/j.1365-2133.2012.11010.x

TRI. (2023, August 24). *Aqua-Mane-ia: The Science and Art of Water on Your Hair*. TRI. https://www.triprinceton.org/post/aqua-mane-ia-the-science-and-art-of-water-on-your-hair-1

Zhou, Y., Rigoletto, R., Koelmel, D., Zhang, G., & Sun, C. (2011). The effect of various cosmetic pretreatments on protecting hair from thermal damage by hot flat ironing. *Journal of Cosmetic Science*, *62*(2), 265–282. https://www.researchgate.net/publication/51186310_The_effect_of_various_cosmetic_pretreatments_on_protecting_hair_from_thermal_damage_by_hot_flat_ironing