Meet the technology-based, natural alternative to synthetic hair bond multipliers

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Introduction of research

The human hair is daily exposed to stressors, such as pollution, UV rays, as well as physical forces, such as hair-combing (friction) and/or drying/strengthening (heating), which may lead to hair damages. Furthermore, the most common chemical hair treatments, bleaching and hair-dyeing, are also very harsh to the hair and cause extreme hair damage. Hair color and bleaching lift-up the hair cuticle to allow the dye or bleaching agent to penetrate the hair. While necessary to the treatment, those harsh chemicals have some unwanted effects. Specifically, the hair shaft integrity is compromised when the strong disulfides bonds (-S-S-) existing among the keratin fibrils are broken and converted in -SH groups, whether by chemicals, thermal and mechanical styling, and/or environmental factors.[1] Reestablishing healthy S-S bonds is a good strategy to repair damaged hair and prevent further damage. Most solutions available rely on synthetic molecules despite consumer interest in natural. This is mainly because natural alternatives present various formulation challenges. Cysteine can be a natural alternative to synthetic bond multipliers, having a high-affinity towards -SH groups, however it suffers of stability issues, as well as has an unpleasant odor. To address these naturality goals, Infinitec (Evonik) has recently developed a novel and natural hair-bond multiplier, Si-Cys-complex, which shows excellence performances on the hair. Si-Cys-complex consists of natural, silica sub-micrometric particles (100-200 nm) which surface has been decorated with cysteines. The Cys coupled on the surface of the silica particles, first penetrates through the hair cuticles, and then interacts with the -SH groups of damaged keratin fibers, restoring S-S bridges among them. Since in Si-Cys-complex we have several Cys per each silica particle (approx. 275 cysteine per silica particle), the product allows to simultaneously anchor multiple hair keratin fibers and works a reservoir system of cysteines. Several studies performed on Si-Cys-complex have demonstrated that Si-Cys-complex is a true natural plex solution, showing similar performances to those of synthetic bond multipliers, once it comes the time to repair, protect and strengthen hair during aggressive, professional hair salon treatments.

Results

Si-Cys- complex consists of natural, silica sub-micrometric particles (100-200 nm) whose surface has been decorated with cysteines. Because of the interaction with the silica particles, cysteine is stabilized. Moreover, the product can adhere on the hair and penetrate the hair shaft, while the cysteines are able to restore S-S bonds among keratin fibers. The mechanism of action of Si-Cys-complex was confirmed by Ellman's reagent assay. For this study, untreated hair tresses, thermally damaged ones and bleached ones were incubated with Si-Cys-complex for 2 h (1% Cysteine). Then, the hair tresses were separated from the solution, and the residual amount of Cys available in supernatant was evaluated by Ellman's reagent.[2]

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As expected, the results confirmed that the consumption of Cys (100 % -SH group) was proportional to the hair damage, where the consumption of cysteine was 19% for untreated hair, 47% for blow-dried & straightened hair and 37% for beached hair (30% H_2O_2, 2 hr). These results confirmed the ability of Si-Cys-complex to supply cysteine to the hair, i.e. bond multiplier. The penetration ability of Si-Cys-complex through the hair shaft was also evaluated by fluorescent confocal microscopy; for this study FITC was used as model active. Si-Cys-complex loaded with FITC and free FITC were applied on hair tresses for 2 hr. The obtained images are reported in Figure 1, and respectively refer to (a) free FITC, (b) Si-Cys-complex-FITC after the application of the product and (c) Si-Cys-complex-FITC after 5 washing cycles (washing resistance). Each image consists of 3 sections: hair surface (top), hair longitudinal section (bottom on the left), hair transversal section (bottom on the right). Interestingly, free FITC is mainly localized on the surface of the hair, while almost no fluorescence is detected within the hair shaft (longitudinal and transversal section); conversely, in the case of Si-Cys-complex we can observe fluorescence also within the hair shaft, confirming that Si-Cys-complex enhance hair penetration. Finally, after 5 washing cycles is still possible to detect Si-Cys-complex on the surface of the hair and within the hair-shaft. Sy-Cys-complex is applied as rinse-off formulation, but because of its ability to penetrate and adhere on the hair, shows excellent water resistance, prolonging the treatment long after its application.

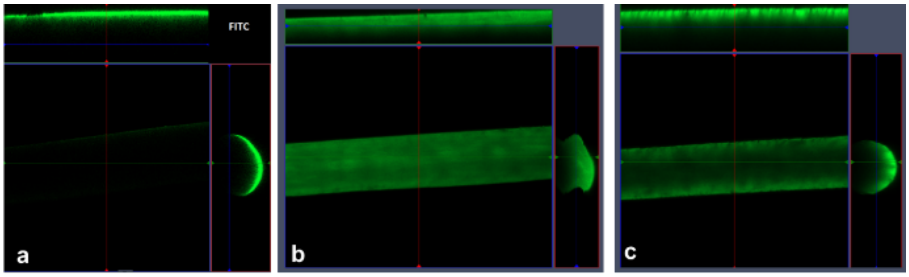

Figure 1. Ex vivo hair penetration of Si-Cys-complex; (a) free FITC, (b) Si-Cys-complex-FITC after application and (c) Si-Cys-complex-FITC after 5 washing cycles.

The performances of Si-Cys-complex were compared to those of the benchmark, first ex-vivo and then in-vivo. For the ex-vivo study, hair tresses were treated respectively with Si-Cys-complex and the benchmark, after bleaching. The hair protection of Si-Cys-complex was evaluated by SEM integrated with vCD detector to semi-quantitatively evaluate the roughness of the hair surface (cuticle overlay) after the treatment.[3] Figure 2 shows a set of SEM images of (a) control, bleached hair, (b) bleached hair treated with Si-Cys-complex and c) bleached hair treated with the benchmark. In the case of the control (bleached hair, Figure 2a), we can observe severe lift-up of the cuticles, with cracks or holes. Conversely, in the case of Si-Cys-complex and the benchmark, the hair shafts present less damage, showing a smoother surface and sealed cuticles. The roughness of the hair tresses was also quantified showing that Si-Cys-complex improves hair quality and shows better performances than those of the benchmark, with the advantage to be natural (roughness equal to 68 % for the control, 46 % for Si-Cys-complex and 57 % for the benchmark). A combing test was also performed, and Si-Cys-complex performed significantly better than the benchmark.

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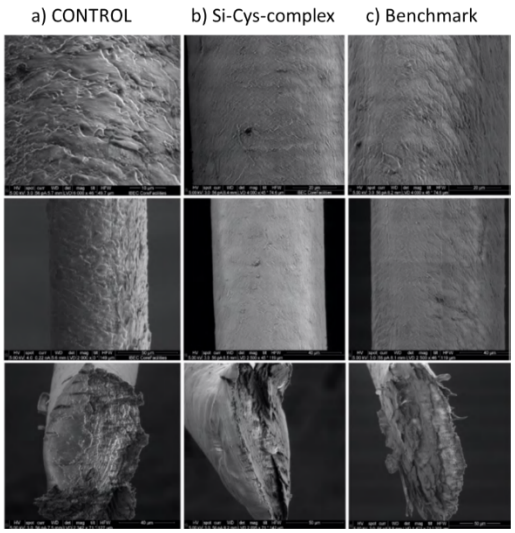

Figure 2. SEM images of (a) control, bleached hair, (b) bleached hair + Si-Cys-complex and c) bleached hair + benchmark.

Finally, the in vivo efficacy of Si-Cys-complex was confirmed by an expert. In analogy with other bond multipliers available on the market, 3 rinse-off formulations containing Si-Cys-complex were prepared: (i) Si-Cys-complex 1 (bond multiplier): to be mixed with hair color or bleaching at 6%, (ii) Si-Cys-complex 2 (bond perfector, containing 10% of Si-Cys-complex): to be applied after Si-Cys-complex 1; (iii) Si-Cys-complex 3 (hair repair, containing 5% of Si-Cys-complex): to be used as home-based treatment. Also an application protocol was established, similar to those of commercially available bond multipliers. 20 volunteers were exposed to a bleaching treatment, while 20 volunteers were exposed to hair-dye. In both cases, the expert applied Si-Cys-complex or the benchmark together with the treatment (blind, semi-head). The expert compared and evaluated the 2 products after the treatment in terms of shines, softness, combing ability, strength, color vibrancy, etc among others hair attributes. Figure 4 reports some representative pictures of the volunteers. Figure 4a and 4b refer to hair dye treatment (red color) right after the treatment (t0) and 28 days after the treatment, while Figure 4c and 4d refer to hair bleaching treatment right after the treatment (t0) and 28 days after the treatment. The expert evaluated positively Si-Cys-complex performances both in the case of the bleaching and hair dye. Moreover, the color resistance was evaluated after 28 days and again, similar performances between Si-Cys-complex and the benchmark were found. Also, the volunteers self-evaluation confirmed that Si-Cys-complex is a valid alternative to the benchmark (synthetic bond multiplier).

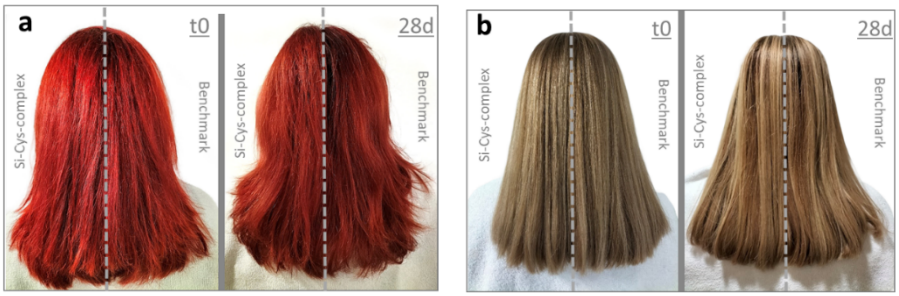

Figure 3. Expert evaluation of Si-Cys-complex vs. benchmark (a) hair dying and (b) bleaching treatment.

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Conclusions

Being natural, Si-Cys-complex perfectly responds to current hair-care market and consumer's needs. In fact, detrimental effects of using chemical-based hair-care products, such as bad hair quality and rough scalp, have goaded consumers to opt for natural products. All the gathered results support the described mechanism of action of Si-Cys-complex and prove the outstanding efficacy of Si-Cys-complex as natural, bond multiplier and hair and color protector. Interestingly, Si-Cys-complex shows comparable performances to those of the benchmark, when used in combination with professional treatments, confirming that Si-Cys-complex represents a valid, natural alternative to synthetic bond multipliers.

References

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About the speaker

Natascia Grimaldi got her PhD in Nanomaterials for Advanced Medicine (Polymeric and bio-hybrid nanovectors for drug delivery and imaging devices) in 2014 from the University of Palermo (Italy) and University of Maryland (USA). Afterwards, she joined the Institute of Material Science of Barcelona (Spain) as Post-Doctoral Fellow (Marie Curie Fellowship), working on the optimization of lipid-based nanoparticles production exploiting compressed CO_2. From 2011-2017, Natascia has joined various National Research Institutes among Italy, Spain and USA such as CRN, NIST, Brokevan Lab, CSIC etc. Her research efforts have been fully dedicated to the design and development of nano materials for biomedical application, being lately focused on cosmetics applications. Natascia has joined Infinitec in 2018 as Area Sales Manager and R&D Liaison, mastering her knowledge on cosmetic market and establishing strong relationships with customers. From July 2020, Natascia is the Head of the R&D Department at Infinitec (Evonik).

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