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Assessment of silicon build-up after using hair care products by EDX-method

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BACKGROUND

Many hair care products contain silicones in their formulation due to their beneficial attributes. These chemical compounds act as agents to protect the hair shaft from damage by creating a coating around the cuticles or enlarge the hair fiber. [1] As a result claims such as: silky feeling, heat-resistance, detangling or smoothing can be made in connection with silicon-containing hair products. [2] There are two types of silicones: water-soluble and non-water-soluble. Whereas the water-soluble, as the name also suggests, can be easily removed during the washing process, the non-water-soluble may accumulate over time creating build-ups that will make the hair feel heavy and greasy. [3]

However, in the recent years there is a consumer-driven shift with concerns to sustainability and a stronger focus on health of scalp and hair. Silicon-free products entered the market and products for deep cleansing should remove residues of silicones and pollution. [4] In this work, we present study results for assessing the cleansing efficacy of a shampoo by using energy dispersive X-ray (EDX) analysis on different levels of siliconization of hair.

METHOD

The EDX analysis was performed on white European natural human hair for different conditions: untreated and treated with a strong silicon-containing product. The samples treated with the silicon-containing products were then washed with a shampoo to assess the cleansing efficacy. EDX analysis focused on the elemental composition of Carbon, Nitrogen, Oxygen, Sulfur and Silicon (C, N, O, S, Si). In order to increase the conductivity of the samples and also the quality of the analytical results, the samples were sputtered with gold. An accelerating voltage of 5 kV was used to detect the elemental composition on the surface as can be seen in Figure 1 and 2.
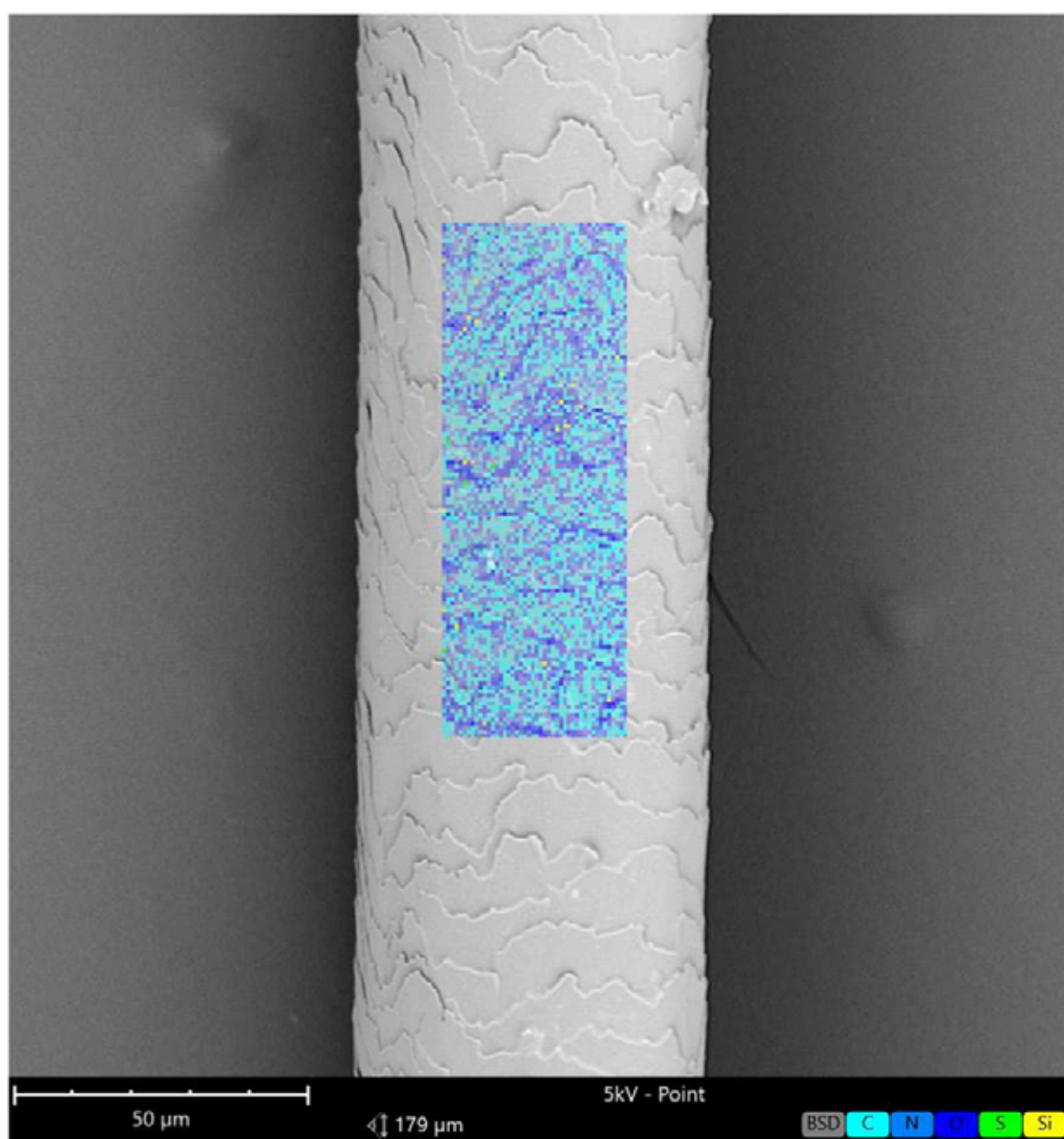

Figure 1: Combined map of the hair surface and the detection points of the elemental compounds.
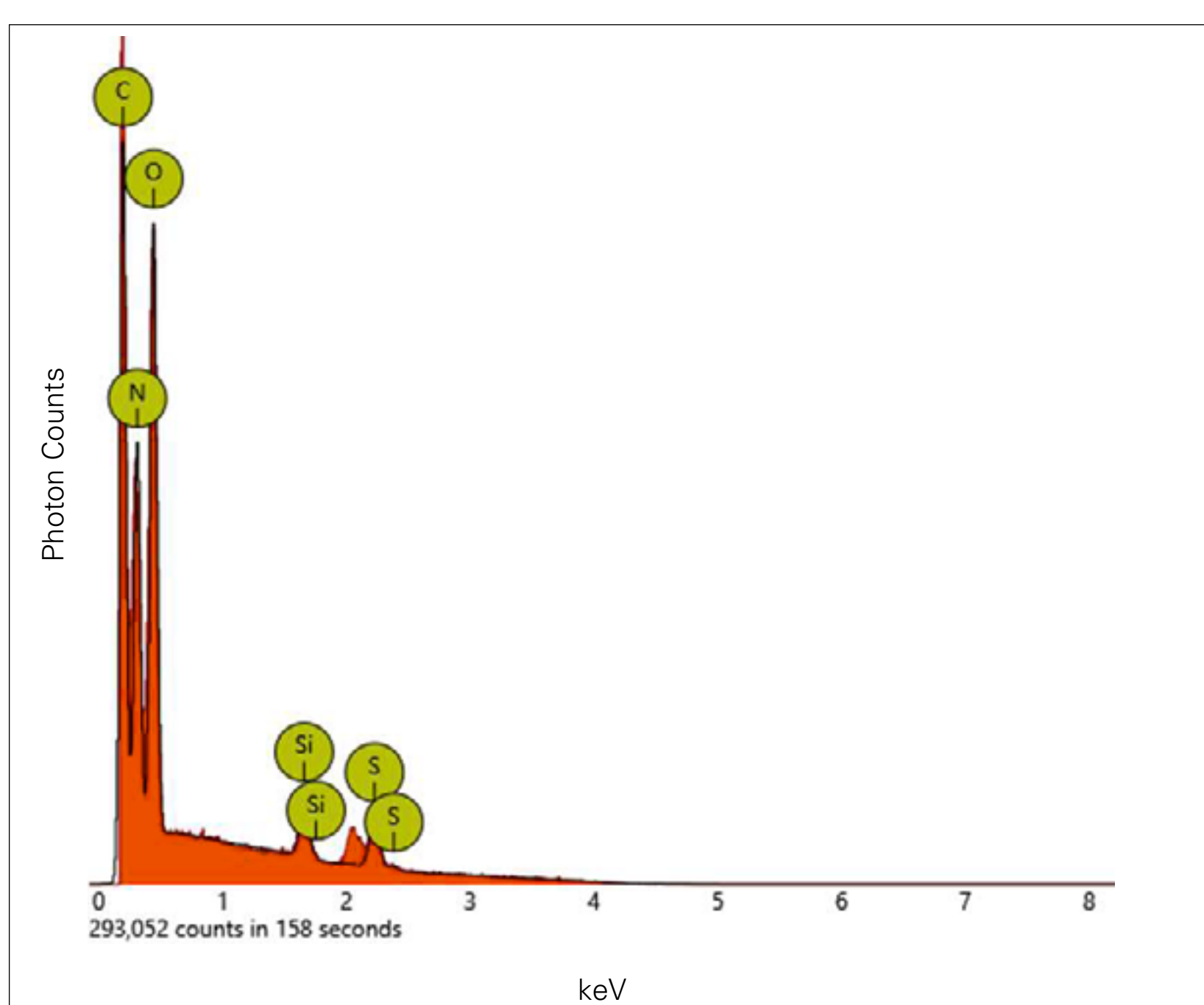

Figure 2: EDX-spectrum with the element-specific peaks for a 5 kV voltage.

RESULTS

Elemental composition of the hair fibers was assessed based on the atomic concentration. In case of oxygen and carbon, atomic concentration increased after application of the silicon-containing product as seen in Figure 3. After the washing procedure, the values were closer to untreated. For nitrogen, a decrease of the atomic concentration could be seen after application of the silicon-containing product. This decrease can be attributed to a forming of a layer on the hair and, therefore, shielding the original hair to the exposure of the X rays. Values increased again after the washing step. The atomic concentration of sulfur increased after application of the silicon-containing product and peaked after the washing step. The accumulations on the hair fibers are due to the use of sulfur compounds in the hair care product as well as in the cleanser in higher concentrations.
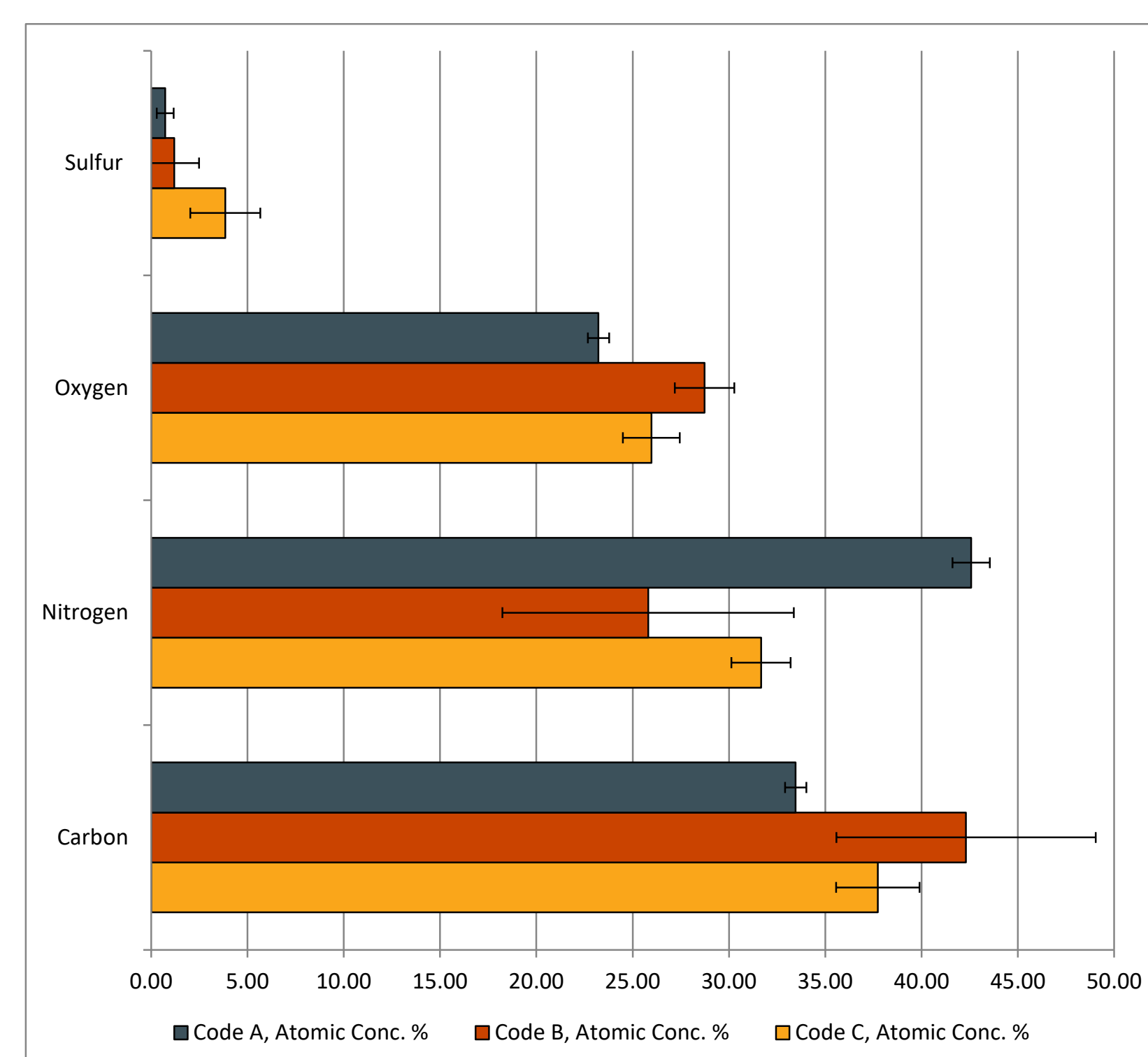

Figure 3: Atomic concentration of C, N, O and S for samples A) untreated, B) treated with a strong silicon-based product, C) treated with a strong silicon-based product, after cleansing (n=3).

No silicon deposits were present on the untreated hair fibers whereas the strong siliconized hairs displayed a significant increase both in the silicon atomic concentration as well as in weight concentration compared to the untreated samples. After washing the hair with the shampoo, a significant decrease in silicon concentration was found, showing the cleansing effect of the shampoo.
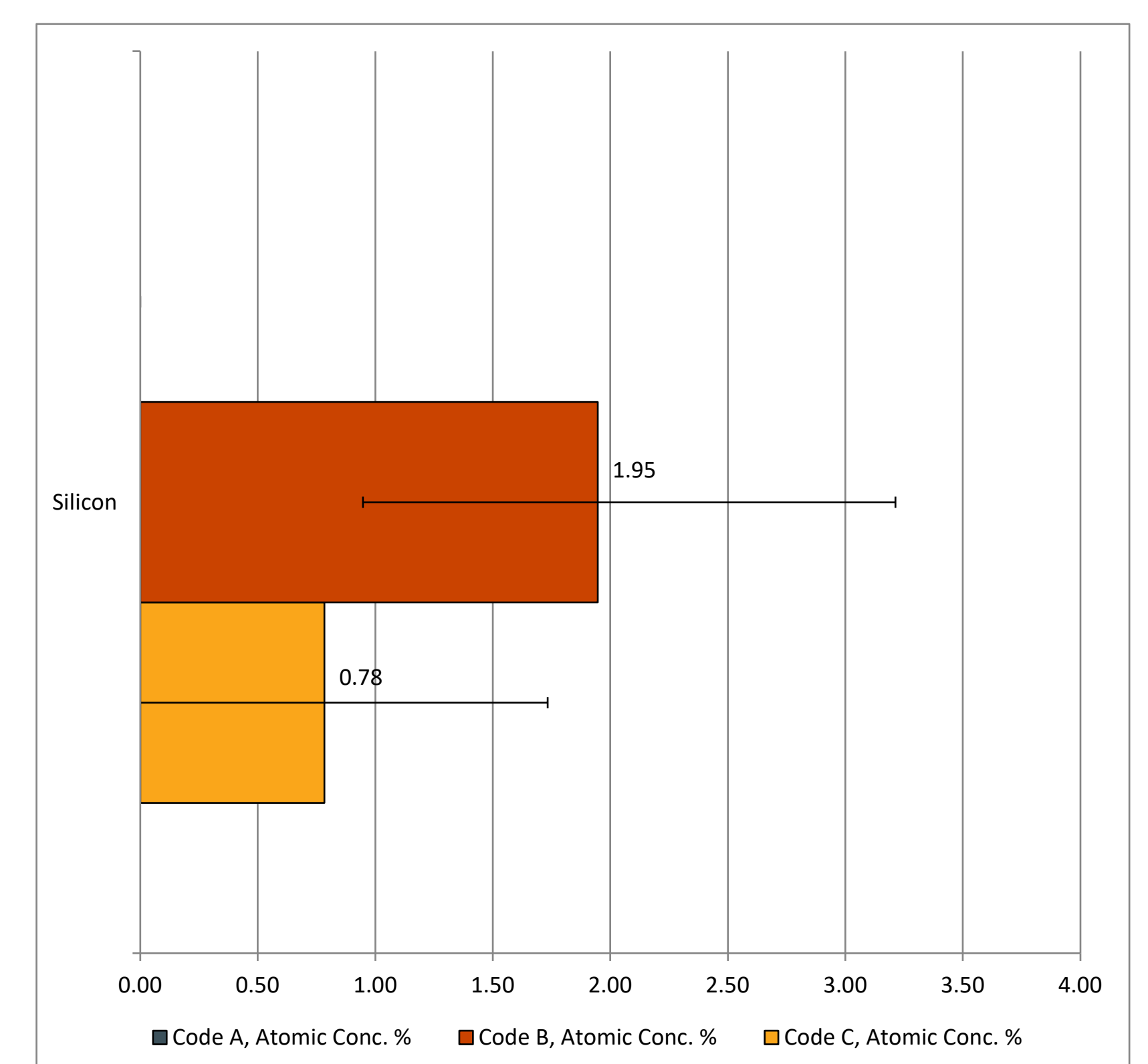

Figure 4: Comparison of atomic concentrations of silicon for samples A) untreated, B) treated with a strong silicon -based product, C) treated with a strong silicon-based product, after cleansing (n=3).

CONCLUSION

With the presented EDX-method the quantitative measurement of silicon accumulations as a consequence of using silicon-based products can be reliably measured if there are any detectable residues on hair fiber. This can support claims such as „reduces the silicon build-up on hair", „no silicon build-up effect" or „deep cleansing". Additionally, assessments on build-up effects after the use of hair products (masks or conditioners) can be made based also on the changes of the other elemental compounds that were measured for the untreated hair.

REFERENCES

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