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Letter to the editor

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We published an article in the September/October 2011 issue of the *Journal of Cosmetic Science*, entitled "Qualification of an automated device to objectively assess the effect of hair care products on hair shine" (1), which attracted some criticism since then. Since the paper is already published and cannot be amended any more, we feel obliged to address some topics of criticism and provide some clarification by means of this letter.

The data provided in the above-mentioned report were generated with a recording device called "opsira Shine-Box," which was developed between 2006 and 2009 by the authors at Beiersdorf AG in cooperation with opsira GmbH, Weingarten, Germany, and Display Metrology & Systems, Karlsruhe, Germany. This device was developed to assess multiple components of hair shine in parallel, encompassing specular and diffuse reflection, half width of specular reflection, sparkle, hair color, and parallelism of hair fibers using the software tool luca'tool developed by opsira GmbH. The publication describes the level of development in 2009. As a matter of course, neither the overall optical geometry nor the arrangement of illumination, camera, or tress holder inside the device, nor the polarization technique, are genuinely new inventions. They are rather mandatory technical prerequisites, as published by others before (2), and are found in a rather similar way in several other commercially available hair shine measurement systems such as the Samba system developed by Bossa Nova Technologies, Culver City, California., just to mention one alternative measurement system available in the market. The level of novelty relating to the "opsira Shine-Box" is not the optical geometry of the measurement setup but rather the use and development of new image analysis algorithms for the measurement of hair shine, the measurement of hair sparkle with a dynamic illumination setup, and the use of a cooled camera device.

We want to point out that the intention of our report was the qualification of the opsira device as an automated screening tool for hair shine, as routinely performed at Beiersdorf AG. Qualification in this case was done using side-by-side comparison of opsira data with panelist assessments as the standard of reference. We decided to compare the opsira system with shine evaluation by panelists, because panelists are able to discriminate tresses treated with different rinse-off products, and the new opsira system had to meet all requirements of a panel and not the requirements of other measurement systems. Another intention of the report was the presentation of our new measurement of hair sparkle. This measurement of sparkle, which always contributes to the panelists' subjective assessment

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of hair shine, is a real novelty and was never published before. The paper was never meant as an advertisement of the opsira device, although it may have been read in this way by representatives of competing technologies for hair shine assessment. This was also the reason why we did not provide an in-depth discussion of the opsira device in relation to other competing technologies. We want to ask all competitors' forgiveness for not finding their devices mentioned or discussed in our paper.

The side-by-side comparison of different hair care and styling products with regard to hair shine using the opsira device in parallel with standard panel assessment showed that the automated system provides an almost identical ranking and the same statistical significances as the panel assessment. The algorithms to calculate the bidirectional reflectance distribution function from the point spread function (for the generation of angular-dependent reflection data coming from the illuminated hair tress) are the core elements of our development and based on different publications by Michael E. Becker, one of our coauthors (3–5). These algorithms are responsible for the good correlation between measurements and evaluation by panelists. Overall, the automated tool competed favorably with panel assessments of hair shine, providing clear advantages over panelist assessment in terms of repeatability, workload, and time consumption, as well as sensitivity and specificity to detect differences after shampoo, conditioner, and leave-in treatment. Thus, it qualified as a routine screening tool. This is the major take-home message of our report, not the superiority of the opsira device over other devices, which was never claimed by us.

Another topic of criticism relates to the calculation of luster in our study. The objective shine value or luster (L) was calculated by us using the equation

$$L = \frac{\mathrm{RS} \times \mathrm{HW}_{\mathrm{standard}}}{\mathrm{RD} \times \mathrm{HW}_{\mathrm{specular}}} \qquad (1)$$

where RS is the integrated intensity of specular reflection, RD is the integrated intensity of diffuse reflection, $\mathrm{HW}_{\mathrm{standard}}$ is the half width of an optimally reflecting area (representing the carrier without mounted hair tresses), and $\mathrm{HW}_{\mathrm{specular}}$ is the half width of specular reflection of the mounted hair tress.

We erroneously referred to equation (1) as the "equation of Reich/Robbins" (6), which calculates L as

$$L = \frac{S}{D \times W_{(1/2)}} \qquad (2)$$

where S is the integrated specular reflectance and is obtained by measuring the area of the specular peak, D is the integrated diffuse reflectance and is obtained by connecting the scattered light intensities at 0° and 75° and measuring the area under the resulting line, and $W_{(1/2)}$ is the width of the specular peak at half height of the mounted hair tress.

Our equation differs from the original Reich–Robbins equation in that we included—as a constant—the full width at half maximum of a standard black metal cylinder ($HW_{standard}$ in equation 1) into the Reich/Robbins equation. By the inclusion of this constant, the calculated objective *L* has no dimension any more. Apart from this, our equation is very similar to the original Reich/Robbins equation. Thus, if we did our analysis without this constant factor, we would gain essentially the same results as with the original Reich/Robbins equation.

The concept of normalization of peak width at half height against that of a standard specular reflector, thus avoiding dimension in the formula for luster, was not invented by us, but was for the first time introduced by Keiss, Ramaprasad, and Kamath in 2004 (7), who proposed the following equation for the calculation of dimensionless luster (*L*):

$$L = \frac{S \times W_{1/2\text{standard}}}{(S + D) \times W_{1/2\text{sample}}} \qquad (3)$$

where *S* is the specular peak area obtained from the scattering curve, $S + D$ is the total area under the curve, and $W_{1/2standard}$ is the half width of a standard specular reflector, and $W_{1/2sample}$ is the half width of the specular peak of the mounted hair tress.

By the way of scientific correctness, we have to acknowledge that our equation to calculate luster (equation 1) is in fact a hybrid of the equation by Reich/Robbins and the equation of Keiss/Ramaprasad/Kamath.

To demonstrate the validity of our (hybrid) equation for the calculation of luster, we recently compared data generated with the Samba system from Bossa Nova Technologies using the Reich/Robbins equation [published by Kaplan *et al.* from TRI/Princeton (8)] with the corresponding data generated with the opsira "Shine Box" and our hybrid equation. We assume that our comparative measurements were done with the same products (identified by us via their INCI) as used by Kaplan *et al*. on medium brown virgin hair. Luster of medium brown virgin hair treated with shine controls as published by Kaplan *et al*. is depicted in Table I. The corresponding data generated by us, using the opsira "Shine Box" and our hybrid equation, are depicted in Table II.

Table I
Luster of Medium Brown Virgin Hair Treated with Shine Controls as Published by Kaplan *et al.*

Treatment	*N*	Mean	S.D.	S.E. mean			
2 in 1	25	115.3	7.1	1.4	B	—	—
XM conditioner	25	109.3	8.2	1.6	B	C	—
Untreated	25	108.3	8.1	1.6	—	C	—
Leave-in conditioner	25	57.5	4.2	0.8	—	—	D

In this table, luster is calculated using the Reich/Robbins formula as implemented in the Samba system. Treatments not connected by the same letter are significantly different. Data from (5).
The corresponding data generated by us, using the opsira "Shine Box" and our hybrid equation, are depicted in Table II. Overall, we obtain the same results as Kaplan *et al*.

Table II
Luster of Medium Brown Virgin Hair Treated with the Same Shine Products as Above, Determined Using the Opsira "Shine Box" and the Hybrid Equation

Treatment	*N*	Mean	S.D.	S.E. mean			
10—2 in 1 Shampoo	10	0.79	0.08	0.025	B	—	—
20—XM conditioner	10	0.76	0.05	0.016	B	—	—
30—Untreated	10	0.86	0.05	0.016	—	C	—
40—Leave-in conditioner	10	0.53	0.06	0.019	—	—	D

All hair was pretreated with a cleansing shampoo (10% SLS solution).
Tested products were: 10—Pantene Ice Shine Shampoo & Conditioner; 20—Herbal Essences "hello hydration" moisturizing conditioner; 40—Garnier Fructis Sleek & Shine leave-in conditioner cream.

The corresponding data generated by us using the opsira "Shine Box" and equation (1) without the constant factor included are depicted in Table III. As a matter of course, the mean luster values are different in this case, but the overall result is the same as in Table II.

Table III
Luster of Medium Brown Virgin Hair Treated with the Same Shine Products as Above, Determined Using the Opsira "Shine Box" and Equation (1) Without the Constant Factor Included

Treatment	*N*	Mean	S.D.	S.E. mean			
10—2 in 1 Shampoo	10	0.39	0.04	0.013	B	—	—
20—XM conditioner	10	0.38	0.02	0.066	B	—	—
30—Untreated	10	0.42	0.03	0.009	—	C	—
40—Leave-in conditioner	10	0.26	0.03	0.009	—	—	D

Tested products as in Table II.

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