E100 An Investigation Into the Discriminating Potential of Different Techniques for the Analysis of Cosmetic Foundations

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Learning Overview: After attending this presentation, attendees will have a better understanding of how cosmetic foundations can be discriminated using Raman microspectrophotometry, Attenuated Total Reflectance (ATR) infrared spectroscopy, and Scanning Election Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM/EDX).

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a basis for the use of multiple techniques to distinguish between cosmetic foundation samples. All three techniques can be used without any sample preparation, which makes them quick and easy and allows for a minimal risk of contaminating or diluting the sample.

Cosmetics, such as foundations, are easily transferrable personal care products that can leave evidence at a crime scene. A smear could be left behind on anything that comes into contact with a victim or assailant wearing a cosmetic. This transferred smear could then be used to corroborate accounts of events, if the evidence can be compared with a known sample. Little research has been done in the way of analyzing foundation samples in a forensic context, although it is unclear as to why.[1] There is a large variety of components in cosmetic foundations, and these vary between manufacturers, foundation types, and foundation colors.[2] If a technique, or combination of techniques, could determine the differences, then it could be used to differentiate between foundations.

In this study, 34 cosmetic foundation samples from a variety of manufacturers and types were analyzed. For all techniques, the samples were analyzed with little sample preparation. For Raman analysis, each sample was placed directly onto a glass slide for analysis. Three different locations on the sample were scanned 16 times. The spectra for each sample were determined to be reproduceable. Each sample spectrum was then compared to every other sample spectrum in pairs. Of the 561 pairs, 90.55% could be discriminated.

Using ATR, each sample was analyzed in triplicate. Each spectrum was obtained using 32 scans at a resolution of $4cm^{-1}$, with a background taken prior to each collection. The spectra for each sample were determined to be reproduceable. Each sample spectrum was then compared to every other sample spectrum in pairs. Of the 210 pairs, 95.23% could be discriminated.

An SEM fitted with an iXRF® EDX unit was used to collect elemental information about each of the samples. Each sample was placed onto a piece of carbon tape before being analyzed. Every sample was analyzed at 200 times magnification in three different areas. A 20-kV beam with a 4.4 spot size was used. The concentration of elements in each sample was then analyzed with Principal Component Analysis (PCA) using BioVinci (version 1.1.3). Principal components 1, 2, and 3 were found to account for 40.60%, 22.55%, and 14.76% of the variance, respectively. Visual examination of 3D plots showed that replicates of each sample clustered together and could be distinguished from others.

In conclusion, using a combination of Raman microspectrophotometry, ATR infrared spectroscopy, and SEM/EDX shows the potential to differentiate between 34 cosmetic foundation samples. The use of non-destructive techniques with little to no sample preparation allows for the preservation of samples. The combination of the three techniques provides the forensic scientist a method for comparison of cosmetic foundation samples that are complimentary, easy to use, and sensitive.

Reference(s):

1. Gordon A., Coulson S. The Evidential Value of Cosmetic Foundation Smears in Forensic Casework. *J Forensic Sci* 2004 Nov; 49 (6): 1-9
2. Lores M., Llompart M., Alvarez-Rivera G., Guerra E., Vila M., Celerio M. et al. Positive Lists of Cosmetic Ingredients: Analytical Methodology for Regulatory and Safety Controls—A Review. *Analytica Chimica Acta* 2016; 915: 1-26

Trace Evidence, Raman Spectroscopy, Cosmetic Foundations