B56 Infrared Microspectroscopy for the Analysis of Nail Polish

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After attending this presentation, attendees will be able to discuss and evaluate the application of infrared microspectroscopy for the analysis of various types of nail polish.

This presentation will impact the forensic science community by informing examiners of: (1) the microscopic and spectroscopic differences between two visibly similar nail polish chips and other cosmetic smears that may be encountered as trace evidence; (2) the spectroscopic differences between classic and novel nail polish formulations; and, (3) the changes that impact comparative analysis of nail polish chips on exposure to various environmental conditions.

Coloring products are the mainstay of the cosmetic industry. These include products such as lipsticks, foundations, eye products, and nail polishes. Market research reports indicate that nail polish products have had record-breaking growth in recent years, spurred by celebrity endorsements. With the ubiquity of nail polish, it is highly likely that it would be encountered as evidence in a crime scene. As trace evidence, it may be encountered in the form of small chips, smears, and as coatings on a broken nail.

Nail polishes are pigmented coatings that are used to cosmetically enhance the appearance of toenails and fingernails. A typical nail polish is composed of film-formers, adhesive polymers, plasticizers, pigments, and other additives to add desired properties to the finished product. Nitrocellulose is the most common film-forming polymer used in the nail polish industry. Other film-formers include polycondensates of adipic acid, neopentyl glycol, and trimellitic anhydride or a styrene-acrylate copolymer. Tosylamide formaldehyde resin is a common adhesive polymer that is used. Plasticizers such as dibutyl phthalate, camphor, and citric acid resins are added to enhance the stability and flexibility of the polymers. Pigments could be either inorganic or organic pigments. Glitter particles are also added to some formulations to improve the shine of the cured product. All of these components and other curing and Ultraviolet (UV) -stabilizing additives are suspended in solvent with good drying properties. Examples of solvents include toluene, ethyl acetate, isopropyl acetate, isopropyl alcohol, methyl, and ethylacetone. Newer nail polish formulations are moving away from phthalates, toluene, formaldehyde, and other traditional components due to their toxic health effects. Three categories of novel formulations have invaded the market in recent years: water-based nail polish, 5-free nail polish, and 3-free nail polish. The water-based nail polish formulations use water instead of the above-listed solvents and sometimes use styrene-acrylate copolymers instead of nitrocellulose. The 5-free products do not include formaldehyde, formaldehyde resin, dibutyl phthalate, toluene, or camphor. The 3-free products eliminate dibutylphthalate, toluene, and formaldehyde.

The goal of this study was to characterize nail polish based on its microscopic and spectroscopic features using an infrared microscope. The development of an analytical method to conduct comparative analysis of nail polish chips is described. The method uses a germanium crystal Attenuated Total Reflectance (ATR) accessory for analysis of the samples. The surface area analyzed is 20x20µm and the sensitivity is greatly enhanced using a cooled Mercury Cadmium Telluride (MCT) detector. This study includes 12 brands of classic nail polish formulations. Each brand further includes multiple finishes. The microscope images are analyzed for particle size in products that have glitter and this information is combined with the spectroscopic information across the surface of the chip. Minor spectroscopic changes that occurred during storage of the smears and chips led to further study of environmental effects. In the classic formulations, the absorption peaks for nitrocellulose and tosylamide/formaldehyde resin dominate. The spectroscopic properties of the three novel formulations of nail polish described above have been studied. A color theme was selected and two products from each of the three categories were studied. This presentation includes Principal Component Analysis (PCA) and Discriminant Analysis (DA) of the data obtained for the various nail polish brands.

References:

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