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Reactions Involved in Fingerprint Development Using the Cyanoacrylate -Fuming Method

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Learning Objective: to present the basic chemistry research findings to the forensic community regarding development of latent fingerprints using the cyanoacrylate fuming method.

Chemical processes involved in the development of latent fingerprints using the cyanoacrylate fuming method have been studied, and will be presented. Two major types of latent prints have been investigated – clean (eccrine) and oily (sebaceous) prints. Scanning electron microscopy (SEM) was used as a tool for determining the morphology of the polymer developed separately on clean and oily prints after cyanoacrylate fuming. A correlation between the chemical composition of an aged latent fingerprint, prior to development, and the quality of a developed fingerprint was observed in the morphology. The moisture in the print prior to fuming was found to be a critical factor for the development of a useful latent print. In addition, the amount of time required to develop a high quality latent print was found to be minimal. The cyanoacrylate polymerization process is extremely rapid. When heat is used to accelerate the fuming process, typically a period of 2 minutes is required to develop the print. The optimum development time is dependent upon the concentration of cyanoacrylate vapors within the enclosure.

Research on the chemical processes involved in the development of latent fingerprints using the cyanoacrylate fuming method lead to the identification of specific water-soluble components of eccrine sweat as the initiators for the polymerization process. Scanning electron microscope (SEM) morphology results from thin films of individual initiator solutions, developed by cyanoacrylate fuming, indicated that small spheres and noodle-type structures are the two main polymer formations produced. These formations are consistent with the structures observed on cyanoacrylate-developed latent prints. Three different initiation/reaction mechanisms, dependent upon the initiator and/or pH, have been proposed. These mechanisms aid in explaining the polymer structures observed using SEM imaging on cyanoacrylate developed clean and oily latent fingerprints. FTIR and NMR analysis were employed to validate the proposed mechanisms.

Latent-print aging studies on clean and oily prints were carried out to determine the effectiveness of cyanoacrylate fuming on aged prints. Clean prints, older than 48 hours, were found to completely lose the ability to be visibly detected by cyanoacrylate fuming. Clean prints have been correlated with the latent prints of prepubescent children. Prior to the release of hormones (adrenal androgens) at the onset of puberty, sebum is not secreted in young children. Thus, latent fingerprints deposited by children tend to be eccrine in nature. In order to increase the superglue development efficiency of aged-clean latent prints deposited by children and adults, a means of regenerating the prints was evaluated. Attempts to regenerate clean prints using water vapor were not successful. However, regeneration of aged-clean prints using acetic acid was successful - even after aging a print 6 months prior to regeneration and cyanoacrylate fuming. A standard method for regenerating clean prints has been developed. Chemical process suspected of being involved in the clean print regeneration process will be discussed.

Oily prints were successfully developed without regeneration after aging up to 22 months. Oily prints possess an inherent mechanism that allows a latent print to maintain (or rehydrate) a given amount of moisture within the print. After oily prints aged approximately 6 months, the degradation of ridge detail was noted. This degradation increased as the age of the print increased prior to fuming. The exposure of an oily print to acetic acid vapors produced by the clean-print regeneration standard method did not adversely affect the quality of a superglue developed oily print.

Latent-Print Regeneration, Acetic Acid, Chemical Reactions